

2018 Wheat, Barley, and Oats Variety Performance in Minnesota

- Preliminary Report

Hard red spring wheat acreage jumped 450,000 acres or 39%, while barley and oat acreage remained stable or only increased a few percentage points. Much of the jump in HRSW acres can probably be attributed to the record yields attained in 2017 when the state's average yield jumped 8 bushels from the previous record high of 59 bu/acre to 67 bu/acre. A rare mid-April winter storm brought nearly 2 feet of snow across much of the southern half of the state, while well below normal temperatures prevented any field work in the northern half of the state. Consequently, field work started even later than in 2017, with less than a few percentage points of the state's acreages of barley, oats, or wheat seeded by the end of April. This compares to the 5-year average planting progress of 20, 25, and 41% of the acreage of wheat, barley and oats, respectively. Field work started in earnest in the second week of May and by May 20th, planting progress had caught up to the 5-year average with over 80% of the acreages of wheat, barley, and oats having been seeded in the previous two weeks. This was not just the result of the 10 days that were suitable for field work but is also a testament of the tremendous capacity that is at the producers' disposal.

While April had been unseasonably cold, May and June brought above average temperatures, with the monthly average temperatures 5 to 10 and the last week of May 10 to 15 degrees warmer than the 1981-2010 climate normal. By the third week of June already a third of the spring wheat crop had headed, 2 days ahead of the 5-year average. By July 1st nearly three quarters of the wheat and barley and just under half of the oat acreage had headed. The above average temperatures had sped up growth and development enough that the late start had been completely erased with the crops now well ahead of the 5-year average pace. This in turn had many worried about the crops' yield potential. An analysis of weather data and planting progress reports between 1990 and 2017 for the southern part of the Red River Valley, however, showed although grain yield declined by about three quarters of a bushel per day for each day of delay in planting past May 1st, the regression model could only explain 10% of the observed variability. This suggests that weather conditions during the grain fill period are of greater importance to the final yield. A point underscored by the results of the 2017 growing season.

Unfortunately, conditions during grain fill were not as favorable when compared to 2017 when the night time temperatures especially were much below normal. Instead, much the opposite was endured in 2018, especially in the southern half of the state, resulting in reports of much lower test weight and disappointing grain yield. While USDA-NASS had forecasted a 67 bu/acre state

average for spring wheat on July 1st, it adjusted this downwards to 63 bushels/acre a month later. Ultimately the state's average spring wheat grain yield was 59 bu/acre, while the average grain yield for barley and oat were 76 and 59 bushels per acre, respectively. Although the average grain yield for barley remained unchanged from 2017, the average yield of oats declined by more than 20%. Again underscoring how unfavorable conditions were for small grains in the southern half of the state, where most of the oats are grown.

Disease and pest problems in 2018 were relatively few, in part due to dry conditions in much of the Red River Valley. Early season diseases included tan spot. Leaf and stripe rust were largely absent across the state. The higher temperatures and humidity resulted in problems with FHB in winter wheat and rye in the southern half of the state and resulted in awn infections of Fusarium head blight in spring wheat across the state, but as conditions dried up, these infections stalled out. Wheat stem saw fly was again found in fields that were either wheat on wheat or adjacent to last year's wheat fields in about a 30 mile radius around Crookston.

The quality of the wheat, barley and oats is much more variable than most years. Extremely low test weight, presence of vomitoxin, and even ergot have resulted in some cases of the grain only being marketable after cleaning. The US Hard Red Spring Wheat Regional Quality Report from US Wheat Associates indicates that average grain protein is nearly a half point higher than the 2017 crop with slightly lower test weight, slightly smaller kernels and an average falling number above 400 seconds, resulting in an overall grade of No. 1 DNS (Dark Northern Spring).

INTRODUCTION

Successful small grain production begins with selection of the best varieties for a particular farm or field. For that reason, varieties are compared in trial plots on the Minnesota Agricultural Experiment Station (MAES) sites at St. Paul, Rosemount, Waseca, Lamberton, Morris, and Crookston. In addition to the six MAES locations, trials are also planted with a number of farmer cooperators. The cooperator plots are handled so factors affecting yield and performance are as close to uniform for all entries at each location as possible.

The MAES 2018 Wheat, Barley, and Oat Variety Performance in Minnesota Preliminary Report 24 is presented under authority granted by the Hatch Act of 1887 to the Minnesota Agricultural Experiment Station to conduct performance trials on farm crops and interpret data for the public.

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VARIETY CLASSIFICATIONS

Varieties are listed in the tables alphabetically. Seed of tested varieties can be eligible for certification, and use of certified seed is encouraged. However, certification does not imply a recommendation. The intellectual property rights of the breeders or owners of the variety are listed as either PVP, PVP(pending), PVP(94), patent, or none. PVP protection means that the a variety is protected under the Plant Variety Protection Act for a period of 20 years, while PVP(94) means that the variety is protected for 20 years with the additional stipulation that seed of the variety can only be sold as registered and certified classes of seed. PVP(pending) indicates that the PVP application has been made and that you should consider the variety to have the same intellectual property rights as those provided by PVP(94). The designation of 'Patent' means that the variety is protected by a utility patent and that farm-saved seed may be prohibited by the patent holder. The designation 'None' means that the breeder or owner never requested any intellectual property protection or that legal protection has expired. Registered and certified seed is available from seed dealers or from growers listed in the 'Minnesota Crop Improvement Association 2018 Directory', available through the Minnesota Crop Improvement Association office in St. Paul or online at <http://www.mncia.org>

INTERPRETATION OF THE DATA

The presented data are the preliminary variety trial information for single (2018) and multiple year (2016-2018) comparisons in Minnesota. The yields are reported as a percentage of the location mean, with the overall mean (bu/acre) listed below. Two-year and especially one-year data are less reliable and should be interpreted with caution. In contrast, averages across multiple environments, whether they are different years and/or locations, provide a more reliable estimate of mean performance and are more predictive of what you may expect from the variety the next growing season. The least significant difference or LSD is a statistical method to determine whether the observed yield difference between any two varieties is due to true, genetic differences between the varieties or due to experimental error. If the difference in yield between two varieties equals or exceeds the LSD value, the higher yielding one was indeed superior in yield. If the difference is less, the yield difference may have been due to chance rather than genetic differences, and we are unable to differentiate the two varieties. The 10% unit indicates that,

with 90% confidence, the observed difference is indeed a true difference in performance. Lowering this confidence level will allow more varieties to appear different from each other, but also increases the chances that false conclusions are drawn.

THE AUTHORS AND CONTRIBUTORS

This report is written, compiled, and edited by Dr. Jochum Wiersma, Small Grains Specialist. The contributing authors/principal investigators are:

Dr. James Anderson, Wheat Breeder, Department of Agronomy & Plant Genetics, St. Paul; Dr. Kevin Smith, Barley Breeder, Department of Agronomy & Plant Genetics, St. Paul; Dr. Jo Heuschele, Post-doctoral fellow oat breeding, Department of Agronomy & Plant Genetics, St. Paul; Dr. Ruth Dill-Macky, Plant Pathologist, Department of Plant Pathology, St. Paul; Dr. James Kolmer, USDA-ARS, Cereal Disease Laboratory, St. Paul; Dr. Matt Rouse, USDA-ARS, Cereal Disease Laboratory, St. Paul; Dr. Madeleine Smith, Extension Plant Pathologist, Northwest Research & Outreach Center, Crookston; Dr. Brian Steffenson, Plant Pathologist, Department of Plant Pathology, St. Paul; Dr. Yue Jin, USDA-ARS, Cereal Disease Laboratory, St. Paul.

Matt Bickell, Robert Bouvette, Dave Grafstrom, Mark Hanson, Tom Hoverstad, Michael Leiseth, Houston Lindell, Steve Quiring, Curt Reese, Susan Reynolds, Dimitri von Ruckert, Edward Schiefelbein, Nathan Stuart, Donn Vellekson, and Joe Wodarek supervised fieldwork at the various sites. Special thanks are also due to all cooperating producers.

SPRING WHEAT

James Anderson, Jochum Wiersma, Susan Reynolds, Nathan Stuart, Houston Lindell, Ruth Dill-Macky, Madeleine Smith, James Kolmer, Matt Rouse, and Yue Jin.

For a second year in a row Minnesota of University varieties accounted for more than half of the state's HRSW acreage. Linkert maintained its top ranking with about 28% of the acreage, while Bolles and WB Mayville stayed in second and third place, respectively. Acreage of both Bolles and WB-Mayville declined a few percentage points in favor of SY Valda, Shelly, and Lang-MN. First-time entrants in the 2018 trials were Dyna-Gro Ballistic, LCS Trigger, MS Barracuda, MS Camaro, TCG-Glenville, and WB9719. Testing of CP3361 (formerly HRS 3361), LCS Albany, LCS Anchor, LCS Iguacu, LCS Nitro, LCS Prime, RB07, and TCG Cornerstone was discontinued.

The results of the variety performance evaluations for spring wheat are summarized in Tables 1 through 7. The varietal characteristics are presented in Tables 1 through 3. Tables 4, 5, and 6 present the relative grain yield of tested varieties in 1, 2, and 3-year comparisons.

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» Table 7 presents the grain yield when fungal pathogens are controlled to the maximum extent possible compared to the same trials without the use of fungicides. The average yield across the six southern testing locations was 65 bu/acre in 2018. This compares to an average of 84 bu/acre in 2017 and a three-year average of 76 bu/acre. The eight northern locations averaged 88 bu/acre in 2018 compared to 99 bu/acre last year and 92 bu/acre for the three-year average. CP3419 (formerly HRS 3419), Faller, Prosper, Shelly, and SY Valda were the highest yielding varieties in both the south as well as the northern half of the state in both single year and multiyear comparisons. Higher yielding cultivars tend to be lower in grain protein. Variety selection is one approach to avoid discounts for low protein, but N fertility management remains paramount to maximize grain yield and grain protein.

Varieties that are rated 4 or lower are considered the best defense against a particular disease. Varieties that are rated 7 or higher are likely to suffer significant economic losses under even moderate disease pressure. The foliar disease rating represents the total complex of leaf diseases other than the rusts, and includes the Septoria complex and tan spot. Although varieties may differ from their response to each of those diseases, the rating does not differentiate among them. Therefore, the rating should be used as a general indication and only for varietal selection in areas where these diseases historically have been a problem or if the previous crop is wheat or barley. Control of leaf diseases with fungicides may be warranted, even for those varieties with an above average rating.

Bacterial leaf streak (BLS) cannot be controlled with fungicides. Variety selection of more resistant varieties is the only recommended practice at this time if you have a history of problems with this disease. Boost, CP3504 (formerly HRS 3504), Lang-MN, LCS Rebel, LCS Trigger, ND-VitPro, Prevail, Surpass, SY Ingmar, SY Valda, TCG-Spitfire, WB9653, and WB9719 provide the best resistance against BLS. Forefront, Lang-MN, ND-VitPro, and Rollag provide the best resistance against FHB while another twelve varieties have a rating of 4 for FHB. Combined, this group of varieties includes some of the top yielders and varieties with higher grain protein content such as Bolles and Rollag.

BARLEY

Kevin Smith, Ruth Dill-Macky, Jochum Wiersma, Madeleine Smith, Brian Steffenson, Karen Beaubien and Ed Schiefelbein

The results of the variety performance evaluations for spring barley are summarized in Tables 8 through 12. The varietal characteristics are presented in Tables 8 and 9. Tables 10 through 12 present the relative grain yield of the tested varieties in 1, 2 and 3-year comparisons. The average yield across the five testing locations was 99 bu/

acre in 2018. This is 12 bushels lower than the state average in 2017. The highest yields were recorded in Hallock while the lowest yields were recorded in Morris.

Rasmusson, Innovation, and Lacey were the highest yielding varieties based on the 3-year state average. ND-Genesis was the highest yielding two-rowed variety. ND-Genesis, Innovation, and Tradition were the most lodging resistant variety while Quest, Pinnacle, and Celebration are the most prone to lodging. Conlon and ND-Genesis were the two-rows with the plumpest grain while Lacey and Tradition were the plumpest six-rows. Grain protein content for the six-rowed varieties varied between 12.6% and 14.3%. Two-rowed varieties have, on average, lower grain protein content. ND-Genesis averaged 11.6% grain protein, a percentage point lower than Rasmusson, the six-row variety with the lowest grain protein content.

Table 9 describes the reaction of the currently grown varieties to the five major diseases in the region. Disease reaction is based on at least two years of data and scored from 1–9 where 1 is most resistant and 9 is most susceptible. Conlon and Celebration have the best net blotch resistance while Quest and Conlon have the lowest DON among the varieties tested. Bacterial Leaf Streak (BLS) cannot be controlled by fungicides and there are only minimal differences in resistance among the current varieties. All listed varieties carry broad-based stem rust resistance to the predominate stem rust races present in the United States at this time. They do not, however, carry resistance to African stem rust races in the Ug99 lineage or the virulent domestic race QCCJ. The data provided in Table 9 are in response to race QCCJ. Most varieties possess pre-heading resistance to stem rust and they likely will not incur much yield damage unless the disease epidemic is severe.

OATS

Jo Heuschele, Ruth Dill-Macky, Dimitri von Ruckert, Jochum Wiersma, Kevin Smith

This past growing season was harsh for both oat production and oat variety evaluations. Uniform replicated trials tested across Southern Minnesota (south of I-94) included Waseca, Le Center, Lamberton, Kimball, and Morris. In Northern Minnesota (north of I-94) trials were conducted in Fergus Falls, Crookston, Stephen, and Roseau. In addition, entries were evaluated for disease resistance to crown rust, barley yellow dwarf virus (BYDV), and smut in specific inoculated nurseries. High winds, flooding, and/or hail caused yield trials near Morris, Kimball, Waseca and Crookston to be abandoned.

The results of the variety evaluations are summarized in Tables 13 to 15. The greatest challenges in oat production and performance evaluation continues to be lodging and crown rust. All yield performance trials were treated with

a propiconazole based fungicide when the flag leaf was fully extended (Feekes 9) to evaluate the yield potential. However, in some locations in Southern Minnesota crown rust infection was still present later in the season.

The origin and agronomic characteristics of oat varieties tested are listed in Table 13. The U.S. Plant Variety Protection Act (PVP) status is also listed. PVP(94) notation indicates that seed of that variety may not be sold by a grower without the permission of the variety's owner. If the PVP is pending consider the variety as having PVP(94) protection. Maturity, height and test weight data are presented here as state wide averages from 2016-2018 except where noted. Lodging data is also a state wide average from the same time period, but only from locations where lodging was present. Maturity, height, and lodging are an important consideration for variety selection based on the intended location and expected end use of the crop. In general earlier maturing varieties perform better in Southern Minnesota so flowering can occur during cooler periods. In these locations, a variety maturing similar to Saber or Reins may be a good choice. In Northern locations varieties that mature later such as Hayden or Deon may be prudent.

If the intended end use of the variety is forage or alfalfa nurse crop a taller variety with lodging resistance such as Goliath may be a good choice. For grain production, lodging is still an important consideration as well as grain quality traits such as groat percent, protein percent, and oil percent (Table 11). Groat percent is an average of the 2016 and 2017 crop years, whereas the others are averages of 2017 and 2018 crop years. Test weight and groat percentage are important considerations for grain production, perhaps carrying equal consideration to yield if the crop is intended for food or feed. Hull color may also be a consideration for different end uses. Percent protein and oil are important considerations for human food oat production, where high protein and low oil may be desirable. Contact your local elevator or buyer whether processors have a preferred or (recommended varieties for milling. Two hull-less lines were evaluated for possible use as a feed crop.

Crown rust and other disease resistance ratings are listed in Table 14. All disease scores were converted to a "1-9" scale where "1" is very resistant and "9" is very susceptible. Crown rust continues to be a major limiting factor to oat production in Minnesota that must be managed to achieve optimal yield. Buckthorn, the alternate host of crown rust, is widespread in Minnesota, allowing the pathogen population to be present annually and particularly aggressive. Crown rust resistance was evaluated in the Buckthorn Nursery in St. Paul by the USDA-ARS, and represents an exceptionally aggressive crown rust population. The most economical way of controlling crown rust is the use of a resistant variety. However, application of fun-

gicide to a variety with a rating of "4" or greater is prudent if crown rust is present in the lower canopy at Feekes 9.

Deon continues to be one of the best varieties for crown rust resistance. In addition, the new variety Antigo also show good resistance. Crown rust is a rapidly evolving disease; the rust ratings taken this year compared to last year's numbers are the same indicating that the pathogen has not overcome current genetics. Other important diseases include BYDV and smut which were evaluated in inoculated nurseries at the University of Illinois and the University of Minnesota, respectively. Varieties susceptible to BYDV (>3) should be selected with caution particularly in the Southern Minnesota, where infected aphids are more common early in the season. A seed treatment and certified seed should be utilized to manage smut. Disease resistance may be a driving factor if pesticides are not economical or intended production is an organic system.

Yield performance evaluation from locations in 2018 and the associated 2-year and 3-year averages are listed in Table 15. In addition, the state wide averages are also listed. To standardize the data across locations the yield is expressed as percent of the trial mean. MN Pearl has replaced Deon as UMN top yielding line in state wide averages for 2018 and in multi-year comparisons. However, Hayden and Ron may have also surpassed MN Pearl in yield this year. Ron appears to mostly derive the yield advantage from locations in Southern Minnesota whereas Hayden may be more adapted to Northern Minnesota.

Among the newer varieties in evaluation are Saddle and MN Pearl. Saddle has moderate crown rust resistance, early maturity and high lodging resistance. MN Pearl has moderate crown rust resistance and good yield potential in northern Minnesota with moderate lodging resistance. In general yield performance from single years should be viewed cautiously as environmental variability may significantly affect the yields in single locations or years. For example, lodging in LeCenter and crown rust in Waseca in past years may have skewed yield results to favor varieties with resistance to these production issues. From this year's trials MN Pearl, Natty, CS Camden, Goliath and Deon are recommended in northern Minnesota and CS Camden, Hayden, Ron, and Goliath in southern Minnesota.

University of Minnesota
Tables #1-15 can be found on pages 80 through 97.

Table 1. Origin and agronomic characteristics of hard red spring wheat varieties in Minnesota in single-year (2018) and multiple-year comparisons.

Variety	Origin ¹	Year of Release	Legal Status	Days to Heading ²	Plant Height ²	Straw Strength ³
				(days)	(inches)	(1-9)
Bolles	MN	2015	PVP (94)	53.3	31.3	4
Boost	SDSU	2016	PVP (94)	53.1	32.7	5
Chevelle	Meridian Seeds	2014	PVP (94)	48.9	29.0	5
CP3419	CROPLAN by WinField	2014	PVP (94)	55.3	31.8	3
CP3504	CROPLAN by WinField	2015	Patented	52.3	27.9	3
CP3530	CROPLAN by WinField	2015	Patented	52.1	33.7	5
CP3616	CROPLAN by WinField	2016	PVP (94)	50.6	30.2	5
Dyna-Gro Ambush	Dyna-Gro	2016	PVP (94)	48.5	30.0	5
Dyna-Gro Ballistic	Dyna-Gro	2018	PVP (94)	51.8	32.3	5
Dyna-Gro Caliber	Dyna-Gro	2017	PVP (94)	51.3	25.1	2
Faller	NDSU	2007	PVP (94)	52.3	32.2	6
Forefront	SDSU	2012	PVP (94)	46.8	34.8	7
Lang-MN	MN	2017	PVP (94)	52.3	32.5	5
LCS Breakaway	Limagrain Cereal Seeds	2012	PVP (94)	48.0	28.2	4
LCS Cannon	Limagrain Cereal Seeds	2018	PVP (94)	46.7	28.7	3
LCS Rebel	Limagrain Cereal Seeds	2017	PVP (94)	48.2	32.5	6
LCS Trigger	Limagrain Cereal Seeds	2016	PVP (94)	55.6	32.1	5
Linkert	MN	2013	PVP (94)	50.2	27.8	2
MS Barracuda	Meridian Seeds	2018	PVP (94)	47.2	28.3	4
MS Camaro	Meridian Seeds	2017	PVP (94)	48.9	28.2	5
ND-VitPro	NDSU	2017	PVP (94)	49.5	31.6	5
Prevail	SDSU	2014	PVP (94)	49.4	32.7	4
Prosper	NDSU	2011	PVP (94)	52.1	32.8	6
Rollag	MN	2011	PVP (94)	50.2	29.9	3
Shelly	MN	2016	PVP (94)	53.2	29.5	5
Surpass	SDSU	2016	PVP (94)	47.7	31.7	7
SY Ingmar	AgriPro/Syngenta	2014	PVP (94)	51.1	28.8	4
SY Rowyn	AgriPro/Syngenta	2013	PVP (94)	48.3	28.8	6
SY Soren	AgriPro/Syngenta	2011	PVP (94)	49.3	28.7	4
SY Valda	AgriPro/Syngenta	2015	PVP (94)	50.3	30.3	5
TCG-Climax	21st Century Genetics	2017	PVP (94)	55.0	30.0	2
TCG-Glennville	21st Century Genetics	2018	PVP (94)	48.7	27.8	3
TCG-Spitfire	21st Century Genetics	2016	PVP (94)	52.5	30.8	3
WB-Mayville	WestBred	2011	PVP (94)	47.6	27.4	3
WB9479	WestBred	2017	Patented, PVP (94)	49.5	27.5	3
WB9590	WestBred	2017	Patented, PVP (94)	48.8	27.5	3
WB9653	WestBred	2015	Patented, PVP (94)	50.8	28.4	4
WB9719	WestBred	2017	Patented, PVP (94)	51.9	28.1	4
Mean				50.8	30.4	4.3

¹ Abbreviations: MN = Minnesota Agricultural Experiment Station; NDSU = North Dakota State University Research Foundation; SDSU = South Dakota State Experiment Station ² 2018 data ³ 1-9 scale in which 1=strongest straw, 9=weakest straw. Based on 2016-2018 data. The rating of newer entries may change by as much as one rating point as more data are collected.

Table 2. Grain quality of hard red spring wheat varieties in Minnesota in single-year (2018) and multiple-year comparisons.

Variety	Test Weight		Grain Protein ¹		Baking Quality ²	Preharvest Sprouting ³
	2018	2 yr	2018	2 yr		
	---(lbs/bu) ---		------(%) -----		(1-9)	(1-9)
Bolles	58.9	59.6	16.7	16.1	1	1
Boost	59.0	59.7	15.1	14.9	3	5
Chevelle	59.4	59.9	14.0	13.7	5	3
CP3419	58.8	59.5	13.7	13.5	6	4
CP3504	59.2	59.4	14.0	13.9	6	1
CP3530	59.0	59.8	15.3	14.8	4	2
CP3616	58.7	59.4	15.9	15.5	2	3
Dyna-Gro Ambush	59.7	60.7	15.5	15.0	2	3
Dyna-Gro Ballistic	58.5	-	14.3	-	-	-
Dyna-Gro Caliber	59.1	59.7	16.0	15.5	3	2
Faller	59.4	60.0	14.3	13.8	5	1
Forefront	59.7	60.3	15.3	14.9	5	3
Lang-MN	60.2	60.9	15.3	15.0	3	1
LCS Breakaway	60.5	61.4	15.4	14.9	5	2
LCS Cannon	60.8	-	14.7	-	-	-
LCS Rebel	60.6	61.1	15.4	14.9	3	4
LCS Trigger	59.8	-	13.0	-	-	-
Linkert	59.3	60.1	16.0	15.7	1	2
MS Barracuda	59.6	-	15.6	-	-	-
MS Camaro	58.9	-	15.5	-	-	-
ND-VitPro	61.0	61.6	15.5	15.3	3	1
Prevail	59.2	59.8	14.6	14.3	6	4
Prosper	59.4	60.2	14.3	13.7	5	2
Rollag	59.7	60.5	16.4	15.8	6	1
Shelly	59.5	60.5	14.7	14.2	5	1
Surpass	58.6	59.5	15.1	14.7	3	1
SY Ingmar	60.1	60.7	15.4	15.1	2	2
SY Rowyn	59.6	60.1	14.6	14.2	3	3
SY Soren	59.4	60.3	15.6	15.1	4	1
SY Valda	59.7	60.1	14.5	14.2	6	3
TCG-Climax	61.4	61.9	16.2	15.8	-	2
TCG-Glennville	59.7	-	16.1	-	-	-
TCG-Spitfire	59.1	59.7	14.2	14.0	3	3
WB-Mayville	59.3	60.3	16.0	15.4	3	3
WB9479	59.7	60.5	16.0	15.5	2	3
WB9590	59.1	59.9	15.5	15.0	3	2
WB9653	59.0	59.5	14.0	13.8	5	1
WB9719	61.4	-	14.5	-	-	-
Mean	59.6	60.2	15.1	14.8		
No. Environments	16	25	17	26		

¹ 12% moisture basis ² 2014 -2017 crop years ³ 1-9 scale in which 1 is best and 9 is worst. Values of 1-3 should be considered as resistant

Table 3. Disease reactions¹ of hard red spring wheat varieties in Minnesota in multiple-year comparisons (2012 - 2018).

Variety	Leaf Rust	Stripe Rust ²	Stem Rust ³	Bacterial Leaf Streak ⁴	Other Leaf Diseases ⁵	Fusarium Head Blight
	----- (1-9) -----					
Bolles	1	1	2	6	3	4
Boost	2	2	4	2	4	4
Chevelle	3	1	1	6	6	5
CP3419	4	1	1	6	3	4
CP3504	2	2	3	2	4	6
CP3530	3	3	1	4	4	4
CP3616	2	-	3	6	4	5
Dyna-Gro Ambush	2	-	2	5	4	4
Dyna-Gro Ballistic	-	-	-	3	4	-
Dyna-Gro Caliber	3	-	2	4	4	-
Faller	5	5	2	3	4	4
Forefront	2	2	5	4	6	3
Lang-MN	1	1	2	3	4	3
LCS Breakaway	3	2	2	5	5	5
LCS Cannon	-	-	-	6	6	-
LCS Rebel	5	-	2	3	4	-
LCS Trigger	-	-	-	3	4	-
Linkert	3	1	1	5	4	5
MS Barracuda	-	-	-	6	5	-
MS Camaro	-	-	-	7	5	-
ND-VitPro	3	-	1	3	4	3
Prevail	2	1	5	2	7	4
Prosper	5	5	2	4	4	5
Rollag	4	1	2	7	5	3
Shelly	3	1	2	6	3	4
Surpass	3	2	5	2	6	4
SY Ingmar	2	2	2	3	5	4
SY Rowyn	3	1	1	4	6	4
SY Soren	2	2	1	6	4	5
SY Valda	1	2	1	3	4	4
TCG-Climax	4	-	5	6	4	-
TCG-Glennville	-	-	-	6	5	-
TCG-Spitfire	5	-	3	3	4	5
WB-Mayville	3	3	3	7	7	7
WB9479	3	-	3	6	5	-
WB9590	3	-	3	7	6	-
WB9653	1	2	2	3	4	5
WB9719	-	-	-	3	2	-

¹ 1-9 scale where 1=most resistant, 9=most susceptible ² Based on natural infections in 2015 at Kimball, Lamberton, and Waseca ³ Stem rust levels have been very low in production fields in recent years, even on susceptible varieties ⁴ Bacterial leaf streak symptoms are highly variable from one environment to the next. The rating of newer entries may change by as much as one rating point as more data is collected
⁵ Combined rating of tan spot and Septoria spp

Table 4. Relative grain yield of hard red spring wheat varieties in northern Minnesota locations in single-year (2018)

Variety	Crookston			Fergus Falls			Hallock				
	2018	2 yr	3 yr	2018	2 yr	3 yr	2018	2 yr	3 yr		
	-----(% of mean)-----										
Bolles	96	98	97	93	90	92	88	90	89		
Boost	99	106	103	93	94	95	103	101	97		
Chevelle	102	106	105	102	106	106	110	109	106		
CP3419	96	106	107	102	105	101	105	102	104		
CP3504	111	115	111	101	104	107	106	108	108		
CP3530	95	101	102	103	105	102	99	101	104		
CP3616	90	93	96	96	98	100	100	100	99		
Dyna-Gro Ambush	91	96	100	98	97	98	101	102	103		
Dyna-Gro Ballistic	98	-	-	114	-	-	104	-	-		
Dyna-Gro Caliber	90	97	-	90	91	-	86	90	-		
Faller	102	112	107	107	109	105	104	109	107		
Forefront	90	95	95	90	87	87	101	96	96		
Lang-MN	99	97	96	100	99	98	97	101	98		
LCS Breakaway	98	89	96	100	105	103	104	101	101		
LCS Cannon	101	-	-	104	-	-	105	-	-		
LCS Rebel	99	103	-	97	98	-	99	102	-		
LCS Trigger	108	-	-	112	-	-	99	-	-		
Linkert	90	94	95	94	94	95	97	99	99		
MS Barracuda	98	-	-	100	-	-	101	-	-		
MS Camaro	97	-	-	99	-	-	96	-	-		
ND-VitPro	93	92	92	96	91	93	98	97	97		
Prevail	112	97	98	99	99	99	101	101	102		
Prosper	98	107	105	107	108	105	108	111	108		
Rollag	80	90	95	86	91	94	94	94	97		
Shelly	105	108	107	111	115	112	102	102	102		
Surpass	104	100	101	94	98	98	107	108	106		
SY Ingmar	100	94	96	100	99	101	100	97	100		
SY Rowyn	111	108	106	102	105	104	109	105	103		
SY Soren	97	101	102	98	98	101	98	99	99		
SY Valda	113	116	114	105	110	109	113	112	114		
TCG-Climax	101	106	-	104	101	-	87	87	-		
TCG-Glennville	89	-	-	90	-	-	88	-	-		
TCG-Spitfire	113	108	106	105	109	109	99	98	99		
WB-Mayville	88	86	91	99	99	101	95	96	94		
WB9479	107	105	-	96	95	-	94	93	-		
WB9590	112	106	-	111	107	-	101	101	-		
WB9653	111	106	105	101	104	106	108	111	109		
WB9719	114	-	-	102	-	-	101	-	-		
Mean (bu/acre)	65.6	86.3	90.9	98.5	93.8	91.8	98.6	96.8	91.2		
LSD (0.10)	11	13	9	7	7	6	11	7	6		

¹ Data from 2016 sites at Perley (hail), Stephen (excessive water) were excluded from analyses

and multiple-year comparisons (2016-2018).

Oklee			Perley ¹			Roseau			Stephen ¹		Strathcona ²
2018	2 yr	3 yr	2018	2 yr		2018	2 yr	3 yr	2018	2 yr	2018
-----(% of mean)-----											
90	97	97	91	97		96	99	98	86	93	92
103	102	99	104	99		100	102	97	94	96	96
105	106	105	104	107		101	101	96	110	109	106
115	118	115	100	105		108	114	117	103	107	99
107	107	104	115	109		100	106	102	105	103	107
96	95	99	105	106		97	103	105	96	107	99
92	94	95	86	94		89	94	91	100	98	99
107	106	105	96	99		99	96	97	104	101	103
104	-	-	109	-		108	-	-	107	-	101
97	93	-	84	86		84	87	-	91	92	97
108	108	107	107	110		110	112	111	103	105	93
95	98	97	100	99		102	102	102	96	97	97
94	95	98	95	92		107	103	104	96	94	92
92	94	94	93	99		94	92	91	100	97	92
102	-	-	104	-		100	-	-	107	-	112
99	102	-	110	101		98	99	-	101	100	95
108	-	-	119	-		113	-	-	111	-	102
90	92	94	94	95		92	94	91	90	89	100
102	-	-	90	-		103	-	-	101	-	111
91	-	-	82	-		80	-	-	99	-	102
98	93	96	105	97		93	93	94	91	90	92
105	103	102	112	101		100	100	100	104	100	100
109	110	108	113	110		112	112	113	111	111	100
89	92	93	91	95		86	87	85	95	97	94
104	105	106	96	103		105	108	110	108	110	102
96	97	100	118	107		102	101	101	104	103	94
98	101	102	93	95		91	90	92	96	97	103
102	107	105	101	106		100	102	102	100	103	101
94	95	97	83	89		93	95	92	91	95	103
114	115	114	107	108		102	104	108	113	113	101
96	102	-	100	93		91	94	-	90	93	89
91	-	-	80	-		85	-	-	87	-	97
105	109	107	102	102		99	101	102	105	105	100
97	95	96	98	96		92	92	90	97	99	101
98	100	-	82	92		96	96	-	102	104	99
110	105	-	95	100		100	94	-	106	110	102
105	104	102	113	107		106	110	106	111	106	107
106	-	-	95	-		104	-	-	96	-	102
97.5	88.3	91.8	74.9	95.1		89.7	95.0	85.0	98.1	102.1	93.4
9	8	7	15	9		9	7	8	15	7	7

² Strathcona was abandoned in 2016 and 2017 due to poor growing conditions

Table 5. Relative grain yield of hard red spring wheat varieties in southern Minnesota locations in single-year (2018)

Variety	Benson				Kimball				LeCenter		
	2018	2 yr	3 yr		2018	2 yr	3 yr		2018	2 yr	3 yr
	-----(% of mean)-----										
Bolles	92	84	87		96	99	99		66	80	89
Boost	99	92	93		74	91	91		106	100	99
Chevelle	98	89	97		88	93	92		91	102	101
CP3419	108	114	112		113	105	112		135	122	127
CP3504	102	108	111		99	96	98		99	104	103
CP3530	105	106	109		98	100	102		125	120	116
CP3616	106	91	94		81	94	96		79	91	99
Dyna-Gro Ambush	95	101	98		109	103	102		98	100	101
Dyna-Gro Ballistic	108	-	-		105	-	-		98	-	-
Dyna-Gro Caliber	81	92	-		98	96	-		85	88	-
Faller	114	109	106		111	104	102		105	98	99
Forefront	94	103	97		107	104	105		109	103	100
Lang-MN	109	102	100		107	106	104		99	94	93
LCS Breakaway	93	98	96		110	106	108		75	86	87
LCS Cannon	91	-	-		113	-	-		110	-	-
LCS Rebel	94	94	-		84	90	-		86	90	-
LCS Trigger	112	-	-		86	-	-		118	-	-
Linkert	88	94	93		102	97	102		86	95	92
MS Barracuda	92	-	-		105	-	-		110	-	-
MS Camaro	87	-	-		94	-	-		99	-	-
ND-VitPro	94	90	90		94	99	99		91	88	88
Prevail	107	106	104		112	109	111		108	104	103
Prosper	115	114	111		106	107	103		96	102	101
Rollag	90	95	95		96	97	97		64	87	89
Shelly	112	102	104		94	101	99		112	109	109
Surpass	93	102	100		97	103	97		84	88	84
SY Ingmar	102	99	103		102	95	104		104	105	109
SY Rowyn	94	102	105		80	89	95		92	96	102
SY Soren	93	90	94		102	107	108		92	101	104
SY Valda	117	117	116		106	103	102		97	111	112
TCG-Climax	96	93	-		103	99	-		111	94	-
TCG-Glennville	81	-	-		85	-	-		79	-	-
TCG-Spitfire	107	104	100		102	102	103		121	115	110
WB-Mayville	86	105	103		96	103	105		99	104	104
WB9479	95	103	-		109	105	-		103	97	-
WB9590	87	105	-		113	107	-		96	94	-
WB9653	102	107	107		84	92	92		76	97	99
WB9719	99	-	-		101	-	-		115	-	-
Mean (bu/acre)	77.6	85.9	94.9		68.3	81.3	75.5		57.5	73.0	74.6
LSD (0.1)	13	16	10		17	11	11		15	15	12

¹ 2018 Morris was discarded due to excessive rainfall and abnormally low grain yields. 2 yr. data is from 2016-2017.

and multiple-year comparisons (2016-2018).

Lamberton				Morris ¹		St. Paul				Waseca		
2018	2 yr	3 yr		2 yr		2018	2 yr	3 yr		2018	2 yr	3 yr
-----(% of mean)-----												
99	92	95		99		93	97	99		112	100	100
111	97	100		97		93	92	96		120	105	104
75	100	99		111		94	95	99		83	99	101
96	96	102		113		105	105	108		113	110	111
112	110	108		116		104	105	104		108	112	112
113	109	106		99		104	103	105		119	112	114
94	94	93		101		93	92	96		81	87	90
98	99	99		108		91	94	95		99	105	101
109	-	-		-		106	-	-		107	-	-
81	86	-		-		87	94	-		65	74	-
124	115	112		92		109	109	99		119	97	95
105	94	95		95		92	103	101		115	107	103
107	104	104		109		108	107	107		137	113	112
103	100	96		101		94	96	99		75	96	94
86	-	-		-		114	-	-		110	-	-
107	103	-		-		96	98	-		97	92	-
114	-	-		-		114	-	-		133	-	-
65	88	86		97		101	104	106		65	87	88
74	-	-		-		102	-	-		80	-	-
84	-	-		-		100	-	-		43	-	-
106	95	91		90		95	98	94		105	98	96
109	97	99		90		100	100	100		106	102	106
129	117	113		94		112	110	103		121	103	100
79	90	87		96		81	87	90		68	83	80
102	107	108		115		106	107	110		107	104	107
107	103	101		99		97	103	95		104	110	110
104	101	104		99		104	99	104		111	103	103
100	96	100		107		101	98	102		106	98	103
91	96	93		100		100	100	104		54	81	91
119	116	113		111		102	102	103		105	109	108
83	93	-		-		95	93	-		102	96	-
74	-	-		-		90	-	-		49	-	-
109	114	108		106		104	108	107		109	103	98
69	91	94		104		103	101	102		80	90	91
74	89	-				102	101	-		73	92	-
81	92	-		-		101	99	-		73	96	-
107	108	106		105		102	106	105		104	114	112
118	-	-		-		108	-	-		98	-	-
42.1	62.6	66.3		68.8		69.7	70.9	69.0		43.4	69.3	71.2
16	14	11		10		8	8	10		23	18	13

Table 6. Relative grain yield of hard red spring wheat varieties in Minnesota in single-year (2018) and multiple-year comparisons (2016-2018).

Variety	State			North			South				
	2018	2 yr	3 yr	2018	2 yr	3 yr	2018	2 yr	3 yr		
	-----(% of mean)-----										
Bolles	91	94	95	91	95	95	92	93	95		
Boost	98	98	97	100	100	98	97	96	97		
Chevelle	100	103	102	106	106	105	92	98	99		
CP3419	106	108	110	104	108	108	110	108	112		
CP3504	105	107	107	107	108	107	102	106	107		
CP3530	102	104	105	98	102	103	108	107	108		
CP3616	93	95	96	94	96	96	91	92	95		
Dyna-Gro Ambush	100	100	100	101	100	101	98	101	100		
Dyna-Gro Ballistic	106	-	-	104	-	-	107	-	-		
Dyna-Gro Caliber	88	90	-	90	91	-	85	89	-		
Faller	107	107	104	104	108	106	112	105	102		
Forefront	99	99	98	98	97	96	100	101	99		
Lang-MN	102	100	100	97	97	97	108	104	104		
LCS Breakaway	95	97	97	96	96	97	94	98	97		
LCS Cannon	104	-	-	104	-	-	104	-	-		
LCS Rebel	97	98	-	100	101	-	94	95	-		
LCS Trigger	110	-	-	108	-	-	111	-	-		
Linkert	91	95	95	93	94	94	89	95	95		
MS Barracuda	99	-	-	101	-	-	97	-	-		
MS Camaro	91	-	-	93	-	-	90	-	-		
ND-VitPro	96	94	94	95	93	94	96	94	93		
Prevail	105	101	101	104	100	100	105	102	103		
Prosper	109	109	106	107	109	108	111	108	104		
Rollag	87	92	92	90	93	94	82	90	90		
Shelly	105	106	107	103	107	107	107	106	107		
Surpass	100	101	100	103	102	102	95	100	98		
SY Ingmar	100	98	101	97	96	98	104	100	104		
SY Rowyn	100	102	103	103	105	104	96	98	102		
SY Soren	94	96	98	94	96	97	92	96	99		
SY Valda	108	110	110	109	111	111	107	109	109		
TCG-Climax	96	96	-	93	95	-	100	97	-		
TCG-Glennville	85	-	-	88	-	-	81	-	-		
TCG-Spitfire	105	106	104	103	104	104	108	107	104		
WB-Mayville	94	97	98	96	95	95	92	100	101		
WB9479	96	98	-	97	98	-	95	99	-		
WB9590	101	102	-	104	103	-	97	101	-		
WB9653	103	106	105	108	107	106	96	103	104		
WB9719	103	-	-	102	-	-	105	-	-		
Mean (bu/acre)	76.8	84.0	83.3	88.3	93.6	91.7	65.3	74.5	75.7		
LSD (0.1)	4	3	3	4	3	3	8	5	5		
No. Environments	14	27	39	8	14	19	6	13	20		

Table 7. Grain yield (bushel per acre) of hard red spring wheat varieties grown under conventional and intensive management.

	North								South	
	2018		2-year		3-year		2018			
	Conv	Int	Conv	Int	Conv	Int	Conv	Int		
Bolles	74.5	72.9	89.4	91.5	86.1	89.8	41.7	41.3		
Boost	77.2	81.7	94.1	97.8	88.0	91.2	46.6	49.2		
Chevelle	78.9	84.3	93.4	103.4	88.7	98.2	31.5	44.0		
CP3419	79.7	90.5	99.5	108.5	98.5	105.9	40.2	45.3		
CP3504	81.5	89.9	99.9	106.0	93.7	98.3	46.9	50.4		
CP3530	74.4	81.5	92.6	97.8	90.8	95.1	47.7	47.6		
CP3616	69.3	73.1	84.8	88.2	82.2	86.7	39.6	43.1		
Dyna-Gro Ambush	74.1	78.8	86.8	93.2	86.7	92.5	41.1	41.3		
Dyna-Gro Ballistic	80.4	87.3	-	-	-	-	45.8	50.8		
Dyna-Gro Caliber	67.3	71.5	83.1	85.6	-	-	34.1	35.0		
Faller	82.9	87.9	101.4	108.6	95.6	103.4	52.0	56.3		
Forefront	75.5	75.2	89.1	88.5	86.3	88.2	44.3	45.3		
Lang-MN	80.5	83.1	90.5	95.1	87.6	91.8	45.0	49.3		
LCS Breakaway	74.4	81.0	81.9	89.3	82.1	88.3	43.3	36.2		
LCS Cannon	78.1	81.7	-	-	-	-	36.4	39.3		
LCS Rebel	76.3	79.2	91.5	98.0	-	-	45.0	45.2		
LCS Trigger	86.0	94.9	-	-	-	-	48.0	54.9		
Linkert	70.7	76.0	85.0	90.3	82.0	86.8	27.2	37.7		
MS Barracuda	78.3	78.7	-	-	-	-	31.2	39.5		
MS Camaro	67.5	73.6	-	-	-	-	35.4	35.4		
ND-VitPro	72.2	73.5	84.1	85.4	82.0	85.0	44.7	47.1		
Prevail	81.6	85.7	89.5	92.5	87.0	90.4	45.8	53.9		
Prosper	82.2	86.0	99.3	109.4	95.8	102.7	54.5	57.8		
Rollag	64.8	69.8	80.2	84.6	79.3	85.4	33.4	39.4		
Shelly	81.6	82.9	98.0	101.1	95.4	99.7	43.0	47.1		
Surpass	79.8	81.6	91.3	96.0	88.7	92.0	45.0	46.1		
SY Ingmar	73.4	80.6	83.3	87.8	82.7	88.8	43.9	45.3		
SY Rowyn	81.5	85.3	95.1	99.4	91.3	95.9	42.1	43.7		
SY Soren	73.5	75.5	88.8	91.8	85.6	90.8	38.1	38.6		
SY Valda	83.1	87.7	99.7	104.6	97.6	101.2	50.2	49.0		
TCG-Climax	74.0	84.5	90.4	99.0	-	-	34.8	42.4		
TCG-Glennville	67.4	73.5	-	-	-	-	31.1	33.3		
TCG-Spitfire	81.7	86.2	94.5	98.5	91.7	96.0	46.0	50.7		
WB-Mayville	70.4	77.1	80.9	90.6	79.3	90.2	28.8	30.2		
WB9479	78.1	79.0	91.0	96.3	-	-	30.9	35.1		
WB9590	81.8	84.2	90.4	99.1	-	-	34.0	34.4		
WB9653	83.9	91.6	97.7	104.0	92.7	97.5	45.1	54.7		
WB9719	83.9	87.7	-	-	-	-	49.6	47.3		
Mean (bu/acre)	77.8	85.9	90.7	96.0	88.0	93.0	42.1	45.8		
LSD (0.1)	7.4	15.6	6.4	7.5	5.2	6.5	7.4	7.8		
No. Environments	2	2	4	4	6	6	1	1		

South (continued)					State							
2-year		3-year			2018		2-year		3-year			
Conv	Int	Conv	Int	Conv	Int	Conv	Int	Conv	Int	Conv	Int	
58.5	58.8	64.9	68.3	63.6	62.4	76.1	77.5	76.5	80.0			
58.9	63.7	66.4	69.9	67.0	70.9	79.0	83.2	78.2	81.5			
64.0	68.1	69.7	74.7	63.1	70.9	80.8	88.3	80.1	87.5			
61.6	67.4	71.7	75.9	66.6	75.4	83.3	90.9	86.3	92.3			
69.1	69.6	74.8	77.8	70.0	76.7	86.7	90.4	85.1	89.0			
63.7	69.8	69.7	78.0	65.5	70.2	80.2	85.8	81.2	87.3			
58.0	63.5	64.5	70.7	59.4	63.1	73.3	77.6	74.2	79.4			
62.8	65.9	69.1	70.3	63.1	66.3	76.5	81.5	78.7	82.4			
-	-	-	-	68.9	75.1	-	-	-	-			
53.0	53.8	-	-	56.2	59.4	70.2	71.9	-	-			
67.5	74.9	70.0	80.0	72.6	77.4	86.9	94.2	84.0	92.8			
59.1	63.6	63.7	67.9	65.1	65.3	76.2	77.8	76.1	79.0			
65.5	69.1	71.2	73.8	68.7	71.8	79.8	84.0	80.2	83.6			
62.2	63.3	65.8	68.2	64.0	66.1	73.5	78.2	74.7	79.2			
-	-	-	-	64.2	67.5	-	-	-	-			
61.8	65.2	-	-	65.9	67.9	78.8	84.0	-	-			
-	-	-	-	73.4	81.6	-	-	-	-			
56.7	61.4	60.9	68.2	56.2	63.2	72.9	77.9	72.4	78.4			
-	-	-	-	62.6	65.6	-	-	-	-			
-	-	-	-	56.8	60.9	-	-	-	-			
56.1	59.4	61.0	63.7	63.0	64.7	72.1	74.2	72.5	75.3			
58.1	66.1	64.0	73.4	69.7	75.1	76.1	81.1	76.5	82.7			
67.0	75.2	70.8	80.1	72.9	76.6	85.5	94.8	84.4	92.4			
56.0	57.9	61.0	64.0	54.3	59.7	69.8	73.1	71.0	75.7			
66.4	71.0	74.6	80.2	68.7	71.0	84.5	88.2	85.9	90.8			
61.4	62.1	67.6	69.5	68.2	69.8	78.5	81.5	79.1	81.8			
59.9	63.7	68.4	73.1	63.5	68.8	73.2	77.5	76.2	81.7			
60.9	64.1	69.2	74.6	68.4	71.4	80.4	84.3	81.2	86.3			
59.5	59.7	64.4	68.3	61.7	63.2	76.3	78.1	76.0	80.6			
69.7	72.1	75.5	79.3	72.1	74.8	86.9	90.7	87.6	91.3			
60.8	63.5	-	-	60.9	70.4	77.7	83.8	-	-			
-	-	-	-	55.3	60.1	-	-	-	-			
69.5	71.0	72.0	74.8	69.8	74.4	83.8	86.7	82.8	86.4			
60.1	61.1	65.9	70.2	56.5	61.5	72.0	77.9	73.2	81.1			
58.7	61.7	-	-	62.4	64.4	77.2	81.5	-	-			
61.0	64.4	-	-	65.9	67.6	77.8	84.2	-	-			
65.0	71.7	71.3	80.6	71.0	79.3	83.7	90.2	83.0	89.9			
-	-	-	-	72.5	74.2	-	-	-	-			
61.5	65.4	67.3	72.5	65.8	69.9	78.2	82.9	78.6	83.7			
7.5	6.8	5.5	5.1	6.1	6.3	4.8	5.1	3.8	4.2			
3	3	5	5	3	3	7	7	11	11			

Table 8. Origin and agronomic characteristics of barley varieties in multiple-year comparisons (2016-2018).

Variety	Origin ¹	Year of Release	Legal Status	Use	Days to Heading	Plant Height	Straw Strength ²	Plump	Protein
					(days)	(inches)	(1-9)	(%)	(%)
2-row									
ABI Balster	ABI	2014	PVP	Malt	58	32	5	87	13.8
ABI Growler	ABI	2015	PVP	Malt	58	33	5	90	13.0
Conlon	ND	1996	None	Malt	52	33	5	96	13.7
LCS Genie	LCS	2015	PVP(94)	Malt	61	30	3	92	13.2
LCS Odyssey	LCS	2016	PVP(94)	Malt	60	29	4	88	13.0
ND Genesis	ND	2015	PVP(94)	Malt	55	35	4	97	11.6
Pinnacle	ND	2007	PVP(94)	Malt	56	34	6	93	11.7
6-row									
Celebration	ABI	2008	PVP	Malt	55	38	6	84	14.3
Innovation	ABI	2010	PVP	Malt	53	34	4	87	14.1
Lacey	MN	2000	PVP(94)	Malt	54	34	5	92	13.8
Quest	MN	2010	PVP(94)	Malt	54	36	6	88	13.6
Rasmusson	MN	2008	PVP(94)	Malt	54	33	5	89	12.6
Robust	MN	1983	None	Malt	55	38	5	89	13.8
Tradition	MN	2003	PVP	Malt	55	37	4	91	14.2
No. Environments					11	10	6	5	5

¹ Abbreviations: ABI= Busch Agricultural Resources, MN = Minnesota Agricultural Experiment Station; ND = North Dakota State University Research Foundation.
² 1-9 scale in which 1=strongest straw, 9=weakest straw.

Table 9. Disease reactions of barley varieties in multiple year comparisons (2016-2018).

Variety	Fusarium Head Blight ¹	Net Blotch ¹	Spot Blotch ¹	Stem Rust ^{1,2}	Bacterial Leaf Streak ¹
	----- (1-9) -----				
2-row					
ABI Balster	4	-	3	3	3
ABI Growler	7	-	4	3	4
Conlon	4	3	3	2	5
LCS Genie	9	-	4	3	4
LCS Odyssey	7	-	5	3	4
ND Genesis	5	5	2	3	3
Pinnacle	5	9	3	4	4
6-row					
Celebration	6	3	3	3	4
Innovation	7	4	2	3	5
Lacey	8	6	1	4	5
Quest	5	5	2	3	4
Rasmusson	9	5	2	3	5
Robust	9	5	1	4	5
Tradition	8	4	1	3	5

¹ 1-9 scale where 1=most resistant, 9=most susceptible ² Reaction to the race QCCJ of the stem rust pathogen

Table 10. Relative grain yield of barley varieties at several locations in Minnesota in single-year (2018) and multiple-year comparisons (2016-2018).

Variety	Argyle	Crookston		Hallock		Oklee		Perley	Roseau		Stephen		Strathcona	
	2018 ¹	2018	3 yr	2018	3 yr	2018	3 yr	2018 ¹	2018	3 yr	2018	2 yr ²	2018	2 yr ²
-----(% of mean)-----														
2-row														
ABI Balster	100	96	92	102	102	105	101	97	102	100	101	96	99	98
ABI Growler	101	92	94	99	96	87	95	101	98	105	82	83	96	96
Conlon	46	95	100	98	96	99	88	103	96	90	89	94	97	93
LCS Genie	101	80	89	94	88	97	102	85	91	99	100	87	101	96
LCS Odyssey	85	88	87	91	97	83	95	100	96	110	97	95	94	96
ND Genesis	91	93	100	95	102	109	102	87	107	95	95	96	100	99
Pinnacle	91	120	93	102	102	105	106	95	104	95	110	96	90	97
6-row														
Celebration	121	94	99	100	100	98	101	110	96	98	101	101	92	95
Innovation	127	112	112	105	103	107	103	102	105	105	102	107	106	106
Lacey	98	111	110	100	105	104	100	98	98	96	97	108	101	105
Quest	120	113	110	103	101	102	99	104	103	98	103	105	100	100
Rasmusson	-	124	115	108	109	106	106	101	107	111	98	105	106	107
Robust	97	99	100	95	90	103	99	98	94	95	101	108	100	103
Tradition	113	107	106	96	102	91	99	111	96	99	99	105	104	101
Mean (bu/acre)	76	118	135	141	122	117	117	85	113	102	139	122	138	116
LSD (0.05)	22	11	8	8	7	18	9	17	15	10	20	12	14	10

¹Trial data is from 2018 only ² Trial data is from 2017 and 2018

Table 11. Relative grain yield of barley varieties in on-farm trials near Fergus Falls, Hallock, Oklee, Perley, Kimball and Strathcona, Minnesota in single-year (2018) and multiple-year comparisons (2016-2018).

Variety	Fergus Falls		Morris		New Ulm		St. Paul		
	2018	2 yr ¹	2018	3 yr	2018 ²		2018	3 yr	
	-----(% of mean)-----								
2-row									
ABI Balster	98	87	70	102		95		100	108
ABI Growler	80	81	48	85		98		95	105
Conlon	42	61	127	100		103		50	73
LCS Genie	105	94	28	74		78		49	83
LCS Odyssey	119	109	14	94		94		65	100
ND Genesis	108	83	154	113		111		114	121
Pinnacle	109	113	124	104		114		102	101
6-row									
Celebration	110	114	78	93		104		131	99
Innovation	89	92	153	119		100		99	99
Lacey	104	113	158	119		96		127	106
Quest	100	118	116	94		95		102	94
Rasmusson	124	125	144	111		100		129	112
Robust	79	94	136	100		84		122	96
Tradition	93	91	127	103		106		132	106
Mean (bu/acre)	94	78	28	59		57		86	94
LSD (0.05)	23	26	15	9		16		11	8

¹ Trial data is from 2016 and 2018

² Trial data is from 2018 only

Table 12. Relative grain yield of barley varieties in a single-year (2018) and multiple year comparisons (2016-2018).

Variety	State			North			South		
	2018	2 yr	3 yr	2018	2 yr	3 yr	2018	2 yr	3 yr
	-----(% of mean)-----								
2-row									
ABI Balster	99	99	99	100	99	98	95	100	101
ABI Growler	92	94	95	94	95	96	85	90	93
Conlon	86	87	89	92	91	93	66	71	80
LCS Genie	89	89	91	94	92	93	73	77	83
LCS Odyssey	90	95	97	92	95	96	85	95	100
ND Genesis	102	101	101	98	97	98	115	114	110
Pinnacle	104	102	100	103	101	98	109	107	105
6-row									
Celebration	103	101	101	100	101	101	112	104	102
Innovation	106	106	106	107	106	107	101	104	103
Lacey	104	105	105	101	103	104	115	113	110
Quest	104	102	102	105	104	103	101	97	100
Rasmusson	113	113	111	112	112	111	123	120	114
Robust	99	99	98	99	99	98	100	98	96
Tradition	103	103	103	101	102	103	112	106	102
Mean (bu/acre)	99	101	101	115	114	114	66	72	75
LSD (0.05)	5	4	4	6	4	4	8	7	7
No. Environments	12	20	27	8	14	18	4	6	9

Table 13. Origin and agronomic characteristics of oat varieties in Minnesota in multiple-year comparisons (2016-2018).

Variety	Origin	Year of Release	Legal Status	Seed Color	Days to Heading	Plant Height	Straw Strength ⁴	Test Weight	Groat ⁵	Grain Protein ⁶	Oil
					(days)	(inches)	(1-9)	(lbs/bu)	(%)	(%)	(%)
Antigo ¹	WI	2017	PVP (94)	Yellow	58	36	3	38	68	13.8	5.3
Badger	WI	2010	PVP (94)	Yellow	57	35	5	36	69	13.4	4.0
Betagene	WI	2015	PVP (94)	Yellow	62	38	5	35	72	13.3	4.3
CS Camden	Meridian Seeds	2013	PVP (94)	White	65	39	3	35	67	13.3	4.7
Deon	MN	2014	PVP (94)	Yellow	65	41	4	37	69	12.8	4.7
Goliath	SD	2013	PVP (94)	White	65	48	6	37	70	13.2	4.5
Hayden	SD	2015	PVP (94)	White	63	42	5	38	69	12.7	5.3
Horsepower	SD	2012	PVP (94)	White	61	36	4	36	69	12.8	4.6
MN Pearl	MN	2018	PVP (94)	White	63	41	3	36	71	12.9	6.3
Jury	ND	2012	PVP (94)	White	63	44	6	37	69	12.6	5.1
Natty	SD	2015	PVP (94)	White	59	42	5	38	72	13.8	3.5
Newburg	ND	2011	PVP (94)	White	64	44	7	35	68	12.4	4.9
Paul ^{2,3}	ND	1996	None	Hulless	-	42	9	-	-	17.0	7.5
Reins	IL	2016	PVP (94)	White	59	33	3	38	70	14.2	4.1
Ron	WI	2014	PVP (94)	Yellow	63	40	5	36	69	14.3	4.8
Saber	IL	2010	PVP (94)	Yellow	58	36	4	37	72	14.2	4.2
Saddle ²	SD	2018	PVP (94)	White	57	36	1	-	72	14.3	4.2
Shelby 427	SD	2011	PVP (94)	White	59	40	5	38	70	13.3	5.1
Streaker ³	SD	2016	PVP (94)	Hulless	60	41	6	-	-	17.5	6.6
Sumo ¹	SD	2017	PVP (94)	White	57	37	3	37	70	14.9	3.8

¹ Line tested in 2017 and 2018 ² Line tested in 2018 only ³ Hulless oat ⁴ 1-9 scale in which 1=strongest straw, 9=weakest straw
⁵ Trait measured in 2016 and 2017 only ⁶ Whole grain NIRS, trait measured in 2017 and 2018

Table 14. Disease characteristics of oat varieties.

Variety	Crown Rust, ³	BYDV ⁴	Loose Smut, ⁵
			(1-9)
Antigo ¹	2	7	2
Badger	6	5	1
Betagene	4	6	1
CS Camden	4	-	2
Deon	3	4	1
Goliath	6	2	3
Hayden	6	3	1
Horsepower	6	7	2
MN Pearl	5	6	1
Jury	5	5	2
Natty	5	4	2
Newburg	5	4	4
Paul ²	6	-	1
Reins	6	-	1
Ron	3	6	1
Saber	6	6	5
Saddle ²	4	-	2
Shelby 427	6	6	1
Streaker	5	-	1
Sumo ¹	5	-	1

¹ Line tested in 2017 and 2018 ² Line tested in 2018 only ³ 2017 and 2018, 1 = most resistant and 9 = most susceptible
⁴ 2016 and 2017, 1 = most resistant and 9 = most susceptible ⁵ 2016 thru 2018, 1 = most resistant and 9 = most susceptible

Table 15. Relative grain yield of oat varieties in Minnesota in single-year (2018) and multiple-year comparisons (2016-2018).

Variety	Waseca ³	LeCenter		Lamberton		Fergus Falls		Crookston ³
	2yr	2018	3yr	2018	3yr	2018	2yr	2yr
	-----(% mean)-----							
Antigo ¹	101	100	95	99	97	96	90	68
Badger	113	95	110	84	90	77	84	99
Betagene	114	93	102	112	109	100	94	108
CS Camden	108	119	119	127	119	120	119	100
Deon	109	91	105	120	123	106	103	105
Goliath	113	101	101	125	110	104	110	103
Hayden	108	120	113	106	108	116	117	117
Horsepower	84	92	96	88	89	105	111	103
MN Pearl	96	85	94	107	105	109	110	107
Jury	99	67	95	132	121	125	118	100
Natty	122	108	107	108	107	113	108	109
Newburg	90	111	109	104	104	115	117	105
Paul ^{2,3}	-	113	116	63	60	71	75	-
Reins	119	86	109	71	88	75	75	106
Ron	121	109	115	119	114	110	113	105
Saber	125	112	116	94	109	107	95	111
Saddle ²	81	105	105	95	103	85	97	-
Shelby 427	63	109	107	90	90	83	92	-
Streaker ³	73	99	69	70	79	96	65	87
Sumo ¹	91	86	69	87	87	84	83	68
Mean (Bu/Acre)	103	136	133	126	132	148	140	141
LSD (0.1)	16	30	24	14	11	23	15	21

¹ Line tested in 2018 only ² Hulless oat ³ Trial not reported in 2018 due to weather

Table 15 (continued)

Stephen		Roseau		State	
2018	3yr	2018	3yr	2018	3yr
-----(% mean)-----					
88	101	94	94	95	94
93	98	97	96	90	101
108	105	109	102	104	107
106	99	103	112	114	111
108	114	111	114	107	110
114	112	109	92	110	103
97	105	108	117	109	113
94	98	116	110	100	97
108	107	91	101	100	100
108	111	125	123	112	112
110	104	111	108	110	107
106	107	85	88	104	101
76	81	69	69	78	71
113	95	104	103	91	103
99	105	106	100	108	113
94	97	106	101	103	109
114	121	108	113	102	103
106	100	100	98	98	95
68	73	61	72	78	74
90	90	88	87	87	83
162	152	172	172	149	120
40	25	18	17	49	31