

# 2016 Wheat, Barley, and Oat Variety Performance in Minnesota

## - Preliminary Report

Higher hopes in early spring of a greater upward pricing potential for corn relative to other commodities, a wetter and slightly later spring, and lack of contracts offered for both barley and oats resulted in a decline in Minnesota's small grain acreage across the board. Spring wheat, oat, and barley declined by 11%, 25%, and 30% respectively when compared to 2015 acreages. The 2016 growing season was also markedly different from 2015, with temperatures at or above normal for much of the growing season but especially during the critical grain fill period and excess precipitation during the latter part of the growing season in many parts of the state. Nonetheless, the average grain yield for spring wheat was estimated at 59 bu/acre, the second highest ever recorded while the state's average winter wheat yield was estimated at 56 bu/acre, a new state record. The state's averages for barley and oats were 66 and 68 bu/acre, respectively.

Planting started in earnest in the second week of April with nearly a quarter of the spring wheat having been seeded by April 17<sup>th</sup>. This was about a week behind last year's pace but on-par with the 5-year average. The pace of planting slowed in the second half of April as showers combined with excess soil moisture in especially the northern half of the Red River Valley yielded only a few days suitable for field work. By May 1<sup>st</sup>, nearly two thirds of the spring wheat, half of the barley and 80% of the oat acreage had been seeded. A pace well behind 2015's pace but still slightly ahead of the 5-year average. The development of the crop initially followed much the same pattern as planting progress; slower than 2015's pace but ahead of the 5 year average. This gap in crop development was closed by the end of June as average temperatures started trending above normal from mid-June on. It was especially the higher night time temperatures that accelerated the crop development. This trend continued through much of the month of July and by the end of July the spring wheat crop had surpassed both the 5-year average as well as last year's pace. Harvest therefore started earlier than last year and by the first week of August nearly half of the wheat, barley, and oats had already been harvested. Unfortunately untimely rains in the northern half of the Red River Valley resulted in a scenario much like the 2015 harvest with spring wheat and barley left standing well past harvest ripeness before finally being able to get harvested. USDA's July 1 and August 1 yield forecasts mirrored the differences between the 2015 and 2016 seasons. Whereas in 2015 USDA initially estimated the average spring wheat yield to be 62 bu/acre on July 1<sup>st</sup> it adjusted this number upwards to 64 bushels by August 1<sup>st</sup>. In contrast, this year the USDA estimated the average spring wheat yield to be 63 bu/acre on July 1<sup>st</sup> only to downgrade it to 60 bu/acre by August 1<sup>st</sup>.

Disease and pest problems in 2016 yielded a few surprises. First, wheat stem saw fly was confirmed in a few fields immediately following harvest as the lodged grain had caught some growers by surprise. Although not a new pest to Minnesota, wheat stem saw fly has not been an economic pest problem in recent memory. Fusarium root and crown rot were prevalent in some areas. Conditions were conducive for this disease early in the season and in a few cases growers experienced seedling death and areas of poor stand establishment in the worst affected areas. More noticeable, however, were the white heads late in the season that are indicative of latent infections. Incidences and severity of stripe rust, leaf rust and crown rust were generally low across the state. Tan spot and Septoria leaf blotch were most prevalent but losses were likely minimal as producers have largely adopted a dual timing fungicide program. Bacterial leaf streak, BLS, was again prevalent in many areas, especially those which had experienced hail damage and more episodes of windier, stormier weather. In many cases the disease was severe on flag leaves and thus likely having an impact on grain yield. The higher dew points and overall wetter conditions resulted in damages by Fusarium head blight (FHB) to be substantial in the northern half of the Red River Valley. Not only was this because conditions were conducive to FHB development, but also because the persistent episodes of rain made it impossible for growers to apply fungicide at the crucial time for control and producers are being discounted for the presence of DON in the harvested grain.

The quality of the wheat, barley and oats is average to slightly above average. Preliminary reports from US Wheat Associates indicate that grain protein is equal to the 2015 crop with lower test weight, but 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 2016 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. No other distinction or classification is used to group varieties. Seed of tested varieties can be eligible for certification, and use of certified seed is encouraged. However, certification does not imply a recommendation. Registered and certified seed is available from seed dealers or from growers listed in the 'Minnesota Crop Improvement Association 2017 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 (2016) and multiple year (2014-2016) 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.

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## SPRING WHEAT

*James Anderson, Jochum Wiersma, Susan Reynolds, Lance Miller, Chris Olson, Ruth Dill-Macky, James Kolmer, Matt Rouse, and Yue Jin*

The severe lodging encountered in 2015 was the underlying reason why acreage of Linkert nearly doubled to almost 28% of the acreage. Simultaneously Faller and Prosper's acreage precipitously dropped by half to just over 16% of the acreage. Three public varieties, namely Boost, Shelly, and Surpass, in addition to LCS Prime were released in 2016 and their single and multi-year data has been added to the tables. First-time entrants in the 2016 trials were Dyna-Gro Ambush, LCS Anchor, HRS 3616 (Croplan Genetics), TCG-Cornerstone, TCG-Spitfire, and TCG-Wildfire. Testing of Barlow, MS Stingray, and Samson was discontinued.

The results of the variety performance evaluations are summarized in Tables 1 through 7. The average yield across the seven southern testing locations was 78 bu/acre in 2016. This compares to an average of 81 bu/acre in 2015 and a three-year average of 79 bu/acre. The five northern locations averaged 86 bu/acre in 2016 compared to 91 bu/acre last year and 88 bu/acre for the three-year average.

Tables 4, 5, and 6 present the relative grain yield of tested varieties in 1, 2, and 3-year comparisons. LCS HRS 3419, HRS 3530, LCS Albany, LCS Nitro, SY Valda, and Shelly 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.

The varietal characteristics are presented in Tables 1, 2, and 3. Table 3 summarizes all the disease reactions for individual varieties. 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. Table 7 provides insight of how varieties respond to the use of fungicides. In Lamberton, Morris, Crookston, and Roseau the State Variety Trials are grown in duplicate. The duplicate trial is treated with fungicides at Feekes 5, 9, and 10.51 to eliminate, to the extent possible, any fungal pathogens that potentially can reduce grain yield and quality. Averaged across varieties, the use of fungicide increased grain yield by 6 bu/acre in the northern locations and 7 bu/acre in southern locations in 2016, relatively small differences compared to previous years. Individual varieties may have very different responses to fungicide, depending on their level of susceptibility to and intensity of fungal diseases. Use the information in Tables 3 and 7 to gain an understanding of how individual varieties should be managed to reduce the yield losses caused by fungal pathogens such as tan spot, leaf and stripe rust, and FHB. For example, WB9507 yielded a third more when protected with fungicide, largely due to its high susceptibility to stripe rust.

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 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, Focus, Forefront, LCS Breakaway, Prevail, SY Ingmar, and SY Rowyn offer the best resistance while varieties like HRS 3419, LCS Albany, LCS Nitro, RB07, WB-Mayville, and WB9507 have a rating of 6, indicating that they are the most consistently affected by the disease.

Variety selection for 2017 is a balance between yield potential, disease responses, and grain quality. As the past growing season demonstrated in the most northern tier of Minnesota counties, vigilance against FHB remains paramount as economic losses can quickly add up with varieties rated 6 or higher. Forefront, and Rollag provide the best resistance against FHB. Forefront has good adaptation to southern locations and both Forefront and Rollag are competitive varieties for the northern locations. Bolles, Boost, Faller, Focus, HRS3530, LCS Albany,

LCS Iguacu, LCS Prime, Norden, Prevail, RB07, Shelly, Surpass, SY Ingmar, SY Rowyn, SY Valda, and WB9507 are all varieties with 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, and Ed Schiefelbein*

The results of the state yield trials are summarized in Table 8. The average yield across the four testing locations (Crookston, Morris, St. Paul, and Roseau) was 95 bu/acre in 2016. This is 21 bushels lower than the state average in 2015. The highest yields were in Crookston and the lowest in Roseau.

The yield data in Table 8 were collected from advanced yield trials that contain the important varieties for the region planted in five locations in the state. Yield data is presented as percent of the mean of the varieties listed in the table. The mean of the varieties is presented in bushels per acre. Innovation, ND Genesis and Rasmusson were the highest yielding varieties followed by ABI Balster and Lacey based on the 3 year state averages (Table 8). Pinnacle is the most lodging resistant line and Robust and Quest are the least (Table 9). The two-rowed varieties Conlon, ND Genesis and Pinnacle had the plumpest grain while Celebration was the thinnest. Grain proteins for the six-rowed varieties ran from 13.0% (Rasmusson) to 13.9% (Robust). While the two-rowed varieties had 11.1% (ND Genesis) to 13.1% (Conlon) protein.

Table 10 describes the reaction of the currently grown varieties to the six 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. Bacterial Leaf Streak (BLS) cannot be controlled by fungicides and there are only minimal differences in resistance among the current varieties. Conlon and Celebration have the best net blotch resistance while Quest and Conlon have the best FHB resistance among the varieties presented. Pinnacle appeared to be hit particularly hard with net blotch this year so a timely fungicide application is particularly important for this variety.

## **OATS**

*Tyler Tiede, Jochum Wiersma, Ruth Dill-Macky, and Dimitri von Ruckert*

The results of the variety performance evaluations are summarized in Tables 11 through 14. The oat performance evaluations were grown in 10 Minnesota locations, including Waseca, LeCenter, Lamberton, St. Paul, Kimball, Morris, Fergus Falls, Crookston, Stephen, and Roseau in 2016. The greatest challenge during this past growing season in both the oat performance evaluations and

commercial production was again lodging. Consequently, data from the trials in St. Paul, Fergus Falls, Morris, and Roseau were not included in the results. The performance evaluations were treated with a fungicide when the flag leaf was fully extended (Feekes 9). The average yield across the testing locations was 133 bushels per acre in 2016. This compares to an average of 170 bushels per acre in 2014 and a three-year average of 144 bushels per acre. While Hayden, the 2015 release from SDSU, surpassed Deon for yield in 2016, the later remained the top yielding variety across the state in the multi-year comparisons (Table 14).

Relative maturity, measured as the number of days to heading, plant height, and resistance to lodging have been converted to a 1-9 scale to allow for easier interpretation of the data (Table 11). Differences among varieties for all three characteristics are generally much less in the southern half of the state or when seeding is delayed. In the northern half of the state the differences among varieties widen as is also the case when seeding is early. Earlier varieties tend to perform relatively better in the southern parts of the state, while later maturing varieties usually have a yield advantage in the north. Varieties with lodging scores greater than 4 should be chosen with caution as lodging problems reduce yield, quality, and harvestability. This is especially important if your soils are highly fertile. The extensive lodging encountered across the state will increase the emphasis on straw strength in the variety selection process for next year. Deon provides some of the best straw strength available in oats, but when conditions are favorable even Deon will encounter substantial lodging.

Quality traits are also presented on a 1-9 scale (Table 12). Groat percentage is an important consideration for grain production (perhaps as important as grain yield) regardless whether the crop is intended for food or feed. It is defined as the percentage of germ, bran, and endosperm in proportion to the whole seed on a weight basis (Table 12).

The disease ratings are based on inoculated screening nurseries for crown rust and smut on the University of Minnesota's St. Paul campus and for Barley yellow dwarf (or red leaf of oats) on the University of Illinois' Champaign Urbana campus (Table 13). Consider most oat varieties to be moderately to very susceptible to crown rust. Other fungal pathogens that commonly cause yield losses in oats in Minnesota are stem rust of oats and Septoria leaf blotch. No ratings are presented on these disease due to insufficient data at this time. The use of a fungicide at Feekes 9 is warranted if crown rust is present in the lower canopy and the variety has a crown rust rating of 4 or higher. A fungicide application at Feekes 9 will also provide excellent protection against Septoria leaf blotch but will likely be too early to protect against stem rust. Even when a fungicide application is made at Feekes 9, expect some yield losses

due to crown rust with the most susceptible cultivars if conditions for crown rust remain favorable during the grain fill period. Therefore, selecting a less susceptible cultivars like Deon and Ron is still prudent. Seed treatment should be used for smut-susceptible varieties. Varieties susceptible to Barley yellow dwarf (a rating of 6 or higher) should be avoided in the southern half of the state or when planting is delayed as viruliferous aphids are more likely to arrive early enough in the crops development to cause economic damages.

Descriptions of oat varieties covered by the U.S. Plant Variety Protection Act include a PVP designation. When PVP is followed by the notation (94), seed of that variety may not be sold by a grower, not even to a relative or neighbor, without the express permission of the variety's developer/owner. If the PVP application is pending, consider the variety as having PVP (94) protection. Using oats for cover crop does not exempt the buyer from the legal obligation to purchase only certified or registered classes of seed. Proper selection of oat varieties requires consideration of the anticipated growing conditions, the pests that might be encountered in a specific production situation, the purpose for growing the crop and its eventual usage. Specific growing situations will dictate the priority and emphasis given to each trait included in the tables.

Tables on pages 57 - 67

**Table 1.** Origin and agronomic characteristics of hard red spring wheat varieties in Minnesota in single-year (2016) and multiple-year comparisons.

| Variety         | Origin <sup>1</sup>                    |               | Days to              | Height              | Straw                 |
|-----------------|--|---------------|----------------------|---------------------|-----------------------|
|                 |  | PVP Status    | Heading <sup>2</sup> | Inches <sup>2</sup> | Strength <sup>3</sup> |
| Bolles          | 2015 MN                                | PVP (pending) | 62.1                 | 32.3                | 4                     |
| Boost           | 2016 SDSU                              | PVP (pending) | 62.7                 | 29.6                | 5                     |
| Chevelle        | 2014 Meridian Seeds                    | PVP (94)      | 58.9                 | 30.6                | 4                     |
| Dyna-Gro Ambush | 2016 Dyna-Gro                          | PVP (pending) | 58.4                 | 31.8                | 5                     |
| Elgin-ND        | 2013 NDSU                              | PVP (94)      | 59.8                 | 35.9                | 6                     |
| Faller          | 2007 NDSU                              | PVP (94)      | 61.6                 | 32.9                | 5                     |
| Focus           | 2015 SDSU                              | PVP (pending) | 55.6                 | 36.4                | 7                     |
| Forefront       | 2012 SDSU                              | PVP (94)      | 57.6                 | 37.2                | 6                     |
| Glenn           | 2005 NDSU                              | PVP (94)      | 57.7                 | 35.3                | 5                     |
| HRS 3361        | 2013 CROPLAN by WinField               | PVP (94)      | 60.3                 | 31.3                | 3                     |
| HRS 3419        | 2014 CROPLAN by WinField               | PVP (pending) | 63.8                 | 31.7                | 3                     |
| HRS 3504        | 2015 CROPLAN by WinField               | PVP (pending) | 62.4                 | 28.7                | 3                     |
| HRS 3530        | 2015 CROPLAN by WinField               | PVP (pending) | 61.8                 | 35.0                | 5                     |
| HRS 3616        | 2016 CROPLAN by WinField               | PVP (pending) | 60.2                 | 31.4                | 4                     |
| LCS Albany      | 2009 Limagrain Cereal Seeds            | PVP (94)      | 63.4                 | 30.3                | 5                     |
| LCS Anchor      | 2016 Limagrain Cereal Seeds            | PVP (pending) | 58.0                 | 28.9                | 5                     |
| LCS Breakaway   | 2012 Limagrain Cereal Seeds            | PVP (94)      | 59.8                 | 30.2                | 4                     |
| LCS Iguacu      | 2014 Limagrain Cereal Seeds            | PVP (94)      | 62.3                 | 31.0                | 4                     |
| LCS Nitro       | 2015 Limagrain Cereal Seeds            | PVP (94)      | 62.3                 | 31.1                | 5                     |
| LCS Prime       | 2016 Limagrain Cereal Seeds            | PVP (pending) | 58.1                 | 32.5                | 5                     |
| Linkert         | 2013 MN                                | PVP (94)      | 59.9                 | 29.3                | 2                     |
| Norden          | 2012 MN                                | PVP (94)      | 60.3                 | 30.5                | 3                     |
| Prevail         | 2014 SDSU                              | PVP (94)      | 57.9                 | 32.8                | 4                     |
| Prosper         | 2011 NDSU                              | PVP (94)      | 61.6                 | 33.5                | 6                     |
| RB07            | 2007 MN                                | PVP (94)      | 59.0                 | 31.7                | 5                     |
| Rollag          | 2011 MN                                | PVP (94)      | 59.2                 | 29.9                | 3                     |
| Shelly          | 2016 MN                                | PVP (pending) | 62.0                 | 30.6                | 5                     |
| Surpass         | 2016 SDSU                              | PVP (pending) | 57.0                 | 33.7                | 7                     |
| SY Ingmar       | 2014 AgriPro/Syngenta                  | PVP (94)      | 60.5                 | 31.0                | 4                     |
| SY Rowyn        | 2013 AgriPro/Syngenta                  | PVP (94)      | 59.3                 | 30.5                | 5                     |
| SY Soren        | 2011 AgriPro/Syngenta                  | PVP (94)      | 59.6                 | 29.7                | 4                     |
| SY Valda        | 2015 AgriPro/Syngenta                  | PVP (94)      | 60.1                 | 30.7                | 4                     |
| TCG-Cornerstone | 2016 21 <sup>st</sup> Century Genetics | PVP (pending) | 60.5                 | 29.1                | 3                     |
| TCG-Spitfire    | 2016 21 <sup>st</sup> Century Genetics | PVP (pending) | 63.5                 | 30.1                | 3                     |
| TCG-Wildfire    | 2016 21 <sup>st</sup> Century Genetics | PVP (pending) | 60.7                 | 33.6                | 4                     |
| WB-Mayville     | 2011 WestBred                          | PVP (94)      | 58.8                 | 28.8                | 3                     |
| WB9507          | 2013 Westbred                          | PVP (94)      | 59.8                 | 33.3                | 5                     |
| WB9653          | 2015 Westbred                          | PVP (94)      | 61.8                 | 29.1                | 4                     |
| Mean            |  |               | 60.2                 | 31.6                |                       |

<sup>1</sup> Abbreviations: MN = Minnesota Agricultural Experiment Station; NDSU = North Dakota State University Research foundation; SDSU = South Dakota Agricultural Experiment Station. <sup>2</sup> 2016 data. <sup>3</sup> 1-9 scale in which 1 is the strongest straw and 9 is the weakest. Based on 2014-2016 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 (2016) and multiple-year comparisons.

| Variety          | Test Weight (Lb/Bu) |      | Protein (%) <sup>1</sup> |      | Baking Quality <sup>2</sup> | Pre-Harvest Sprouting <sup>3</sup> |
|------------------|---------------------|------|--------------------------|------|-----------------------------|------------------------------------|
|                  | 2016                | 2 yr | 2016                     | 2 yr |                             |                                    |
| Bolles           | 58.3                | 59.4 | 15.8                     | 15.9 | 1                           | 1                                  |
| Boost            | 58.7                | 59.0 | 14.6                     | 14.8 | 3                           | 4                                  |
| Chevelle         | 59.1                | 60.2 | 12.9                     | 13.2 | –                           | 3                                  |
| Dyna-Gro Ambush  | 60.2                | –    | 14.7                     | –    | –                           | –                                  |
| Elgin-ND         | 58.9                | 59.6 | 14.4                     | 14.6 | 3                           | 2                                  |
| Faller           | 58.6                | 59.6 | 13.2                     | 13.4 | 5                           | 1                                  |
| Focus            | 60.1                | 61.3 | 15.1                     | 15.0 | 3                           | 4                                  |
| Forefront        | 59.8                | 60.6 | 14.7                     | 14.6 | 5                           | 3                                  |
| Glenn            | 61.0                | 62.0 | 14.8                     | 15.0 | 1                           | 1                                  |
| HRS 3361         | 58.6                | 59.4 | 13.8                     | 13.9 | 3                           | 2                                  |
| HRS 3419         | 58.5                | 58.8 | 12.9                     | 13.2 | 6                           | 4                                  |
| HRS 3504         | 58.9                | 58.9 | 13.3                     | 13.7 | –                           | 1                                  |
| HRS 3530         | 59.5                | 60.2 | 14.4                     | 14.4 | –                           | 2                                  |
| HRS 3616         | 58.8                | –    | 15.0                     | –    | –                           | –                                  |
| LCS Albany       | 59.3                | 59.9 | 13.3                     | 13.3 | 6                           | 4                                  |
| LCS Anchor       | 58.5                | –    | 14.9                     | –    | –                           | –                                  |
| LCS Breakaway    | 59.5                | 60.6 | 14.9                     | 14.8 | 5                           | 2                                  |
| LCS Iguacu       | 60.1                | 60.7 | 12.5                     | 12.9 | 7                           | 2                                  |
| LCS Nitro        | 58.7                | 59.6 | 13.1                     | 13.2 | 4                           | 4                                  |
| LCS Prime        | 58.0                | 59.4 | 12.9                     | 13.2 | –                           | 2                                  |
| Linkert          | 59.6                | 60.4 | 14.9                     | 15.0 | 1                           | 2                                  |
| Norden           | 60.2                | 61.3 | 13.9                     | 14.0 | 4                           | 1                                  |
| Prevail          | 59.5                | 60.3 | 14.1                     | 14.1 | 4                           | 4                                  |
| Prosper          | 58.9                | 59.9 | 13.4                     | 13.6 | 5                           | 2                                  |
| RB07             | 58.6                | 59.8 | 14.5                     | 14.5 | 3                           | 2                                  |
| Rollag           | 59.9                | 60.8 | 14.7                     | 14.8 | 6                           | 1                                  |
| Shelly           | 59.4                | 60.1 | 13.4                     | 13.8 | 5                           | 1                                  |
| Surpass          | 58.8                | 59.6 | 14.5                     | 14.6 | –                           | 2                                  |
| SY Ingmar        | 59.9                | 60.7 | 14.3                     | 14.7 | 2                           | 2                                  |
| SY Rowyn         | 59.7                | 60.3 | 13.7                     | 13.8 | 3                           | 3                                  |
| SY Soren         | 59.1                | 59.5 | 14.6                     | 14.7 | 4                           | 2                                  |
| SY Valda         | 59.6                | 60.2 | 13.7                     | 13.8 | –                           | 3                                  |
| TCG-Cornerstone  | 58.9                | –    | 14.6                     | –    | –                           | –                                  |
| TCG-Spitfire     | 57.7                | –    | 13.5                     | –    | –                           | –                                  |
| TCG-Wildfire     | 58.9                | –    | 14.3                     | –    | –                           | –                                  |
| WB-Mayville      | 58.9                | 59.7 | 14.7                     | 14.6 | 3                           | 3                                  |
| WB9507           | 58.1                | 58.8 | 13.4                     | 13.5 | 3                           | 4                                  |
| WB9653           | 59.0                | 59.6 | 13.3                     | 13.5 | –                           | 1                                  |
| Mean             | 59.3                | 60.7 | 14.1                     | 14.2 |                             |                                    |
| No. Environments | 9                   | 11   | 9                        | 11   |                             |                                    |

<sup>1</sup> 12% moisture basis. <sup>2</sup> 2014-2015 crop years. <sup>3</sup> 1-9 scale in which 1 is best and 9 is worst. Values of 1-3 should be considered as resistant.

**Table 3.** Disease reactions<sup>1</sup> of hard red spring wheat varieties in Minnesota in multiple-year comparisons.

| Variety         | Leaf Rust | Stripe Rust <sup>2</sup> | Stem Rust <sup>3</sup> | Bacterial Leaf Streak <sup>4</sup> | Other Leaf Diseases <sup>5</sup> | Scab |
|-----------------|-----------|--------------------------|------------------------|------------------------------------|----------------------------------|------|
| Bolles          | 1         | 1                        | 2                      | 4                                  | 4                                | 4    |
| Boost           | 2         | 2                        | 3                      | 2                                  | 7                                | 4    |
| Chevelle        | –         | 1                        | 1                      | –                                  | 6                                | 5    |
| Dyna-Gro Ambush | –         | –                        | –                      | –                                  | 4                                | –    |
| Elgin-ND        | 2         | 2                        | 2                      | 5                                  | 5                                | 5    |
| Faller          | 5         | 5                        | 2                      | 4                                  | 4                                | 4    |
| Focus           | 3         | 3                        | 3                      | 3                                  | 7                                | 4    |
| Forefront       | 2         | 2                        | 4                      | 3                                  | 4                                | 3    |
| Glenn           | 5         | 1                        | 1                      | 4                                  | 5                                | 3    |
| HRS 3361        | 3         | 3                        | 3                      | 4                                  | 4                                | 5    |
| HRS 3419        | 4         | 1                        | 1                      | 6                                  | 3                                | 5    |
| HRS 3504        | –         | 2                        | 2                      | –                                  | 4                                | 6    |
| HRS 3530        | –         | 3                        | 1                      | –                                  | 4                                | 4    |
| HRS 3616        | –         | –                        | –                      | –                                  | 5                                | –    |
| LCS Albany      | 2         | 3                        | 3                      | 6                                  | 5                                | 4    |
| LCS Anchor      | –         | –                        | –                      | –                                  | 6                                | –    |
| LCS Breakaway   | 3         | 2                        | 2                      | 3                                  | 5                                | 5    |
| LCS Iguacu      | 4         | 5                        | 2                      | 4                                  | 4                                | 4    |
| LCS Nitro       | 4         | 2                        | 2                      | 6                                  | 6                                | 5    |
| LCS Prime       | –         | 4                        | 2                      | –                                  | 6                                | 4    |
| Linkert         | 4         | 1                        | 1                      | 4                                  | 4                                | 5    |
| Norden          | 2         | 1                        | 1                      | 4                                  | 4                                | 4    |
| Prevail         | 2         | 1                        | 5                      | 2                                  | 6                                | 4    |
| Prosper         | 5         | 5                        | 2                      | 4                                  | 4                                | 5    |
| RB07            | 2         | 2                        | 2                      | 6                                  | 6                                | 4    |
| Rollag          | 4         | 1                        | 2                      | 4                                  | 5                                | 3    |
| Shelly          | 4         | 1                        | 2                      | 4                                  | 4                                | 4    |
| Surpass         | –         | 2                        | 5                      | –                                  | 5                                | 4    |
| SY Ingmar       | 3         | 2                        | 1                      | 3                                  | 5                                | 4    |
| SY Rowyn        | 3         | 1                        | 1                      | 2                                  | 6                                | 4    |
| SY Soren        | 2         | 2                        | 1                      | 4                                  | 4                                | 5    |
| SY Valda        | –         | 2                        | 1                      | –                                  | 4                                | 4    |
| TCG-Cornerstone | –         | –                        | –                      | –                                  | 5                                | –    |
| TCG-Spitfire    | –         | –                        | –                      | –                                  | 4                                | –    |
| TCG-Wildfire    | –         | –                        | –                      | –                                  | 4                                | –    |
| WB-Mayville     | 3         | 3                        | 2                      | 6                                  | 7                                | 7    |
| WB9507          | 8         | 8                        | 3                      | 6                                  | 3                                | 4    |
| WB9653          | –         | 2                        | 2                      | –                                  | 4                                | 5    |

<sup>1</sup> 1-9 scale where 1=most resistant, 9=most susceptible. <sup>2</sup> Based on natural infections in 2015 at Kimball, Lamberton, and Waseca. <sup>3</sup> Stem rust levels have been very low in production fields in recent years, even on susceptible varieties. <sup>4</sup> 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. <sup>5</sup> Combined rating of tan spot and septoria.

**Table 4** Relative grain yield of hard red spring wheat varieties in northern Minnesota locations in single-year (2016) and multiple-year comparisons (2014-2016).

| Variety         | Crookston |        |        | Fergus Falls |        |        | Hallock |        |        |
|-----------------|-----------|--------|--------|--------------|--------|--------|---------|--------|--------|
|                 | 2016      | 2-Year | 3-Year | 2016         | 2-Year | 3-Year | 2016    | 2-Year | 3-Year |
| Bolles          | 95        | 94     | 96     | 98           | 97     | 99     | 89      | 92     | 92     |
| Boost           | 97        | 92     | 92     | 98           | 94     | 97     | 86      | 93     | 93     |
| Chevelle        | 103       | 103    | –      | 106          | 102    | –      | 99      | 96     | –      |
| Dyna-Gro Ambush | 105       | –      | –      | 100          | –      | –      | 106     | –      | –      |
| Elgin-ND        | 89        | 94     | 95     | 95           | 96     | 97     | 89      | 87     | 93     |
| Faller          | 97        | 95     | 104    | 95           | 105    | 108    | 102     | 106    | 109    |
| Focus           | 89        | 94     | 94     | 100          | 96     | 95     | 105     | 100    | 100    |
| Forefront       | 94        | 98     | 99     | 89           | 91     | 97     | 97      | 100    | 101    |
| Glenn           | 88        | 89     | 87     | 97           | 94     | 90     | 99      | 94     | 95     |
| HRS 3361        | 106       | 103    | 101    | 101          | 103    | 104    | 97      | 96     | 97     |
| HRS 3419        | 108       | 111    | 109    | 95           | 101    | 109    | 109     | 112    | 110    |
| HRS 3504        | 102       | 102    | –      | 111          | 108    | –      | 108     | 102    | –      |
| HRS 3530        | 100       | 104    | –      | 95           | 103    | –      | 110     | 112    | –      |
| HRS 3616        | 100       | –      | –      | 105          | –      | –      | 97      | –      | –      |
| LCS Albany      | 111       | 107    | 110    | 105          | 108    | 110    | 103     | 106    | 106    |
| LCS Anchor      | 96        | –      | –      | 95           | –      | –      | 94      | –      | –      |
| LCS Breakaway   | 105       | 104    | 98     | 99           | 100    | 93     | 101     | 96     | 96     |
| LCS Iguacu      | 107       | 105    | 106    | 94           | 93     | 101    | 111     | 107    | 104    |
| LCS Nitro       | 104       | 104    | 103    | 102          | 103    | 109    | 104     | 101    | 100    |
| LCS Prime       | 96        | 92     | –      | 104          | 111    | –      | 93      | 101    | –      |
| Linkert         | 97        | 102    | 99     | 96           | 95     | 91     | 97      | 99     | 98     |
| Norden          | 103       | 101    | 99     | 100          | 99     | 98     | 98      | 97     | 98     |
| Prevail         | 96        | 99     | 98     | 97           | 98     | 104    | 105     | 103    | 102    |
| Prosper         | 100       | 100    | 105    | 99           | 104    | 107    | 102     | 106    | 108    |
| RB07            | 104       | 102    | 102    | 98           | 97     | 97     | 91      | 92     | 93     |
| Rollag          | 102       | 105    | 103    | 98           | 99     | 98     | 106     | 103    | 102    |
| Shelly          | 103       | 105    | 106    | 106          | 100    | 105    | 102     | 103    | 103    |
| Surpass         | 101       | 102    | –      | 98           | 100    | –      | 102     | 99     | –      |
| SY Ingmar       | 99        | 97     | 99     | 106          | 102    | 101    | 106     | 102    | 100    |
| SY Rowyn        | 100       | 101    | 104    | 101          | 104    | 106    | 101     | 102    | 102    |
| SY Soren        | 102       | 103    | 102    | 107          | 97     | 99     | 102     | 96     | 97     |
| SY Valda        | 108       | 108    | –      | 107          | 108    | –      | 119     | 118    | –      |
| TCG-Cornerstone | 96        | –      | –      | 99           | –      | –      | 89      | –      | –      |
| TCG-Spitfire    | 102       | –      | –      | 111          | –      | –      | 101     | –      | –      |
| TCG-Wildfire    | 101       | –      | –      | 97           | –      | –      | 91      | –      | –      |
| WB-Mayville     | 96        | 97     | 93     | 107          | 101    | 95     | 92      | 95     | 96     |
| WB9507          | 104       | 99     | 103    | 97           | 104    | 107    | 112     | 111    | 111    |
| WB9653          | 103       | 100    | –      | 110          | 109    | –      | 106     | 96     | –      |
|                 |           |        |        |              |        |        |         |        |        |
| Mean (Bu/Acre)  | 102.1     | 92.2   | 93.5   | 87.6         | 98.7   | 92.1   | 79.6    | 85.4   | 86.3   |
| LSD (0.10)      | 3.4       | 3.7    | 3.7    | 3.9          | 3.5    | 3.7    | 4.3     | 4.0    | 4.0    |



**Table 4 (continued)** Relative grain yield of hard red spring wheat varieties in northern Minnesota locations in single-year (2016) and multiple-year comparisons (2014-2016).

| Variety         | Oklee |        |        | Perley <sup>1</sup> | Roseau |        |        | Stephen <sup>1</sup> | Strathcona <sup>1</sup> |
|-----------------|-------|--------|--------|---------------------|--------|--------|--------|----------------------|-------------------------|
|                 | 2016  | 2-Year | 3-Year | 2-Year              | 2016   | 2-Year | 3-Year | 2-Year               | 2-Year                  |
| Bolles          | 97    | 98     | 100    | 97                  | 99     | 100    | 101    | 95                   | 103                     |
| Boost           | 93    | 98     | 96     | 94                  | 83     | 94     | 95     | 94                   | 84                      |
| Chevelle        | 103   | 104    | –      | –                   | 85     | 84     | –      | –                    | –                       |
| Dyna-Gro Ambush | 103   | –      | –      | –                   | 104    | –      | –      | –                    | –                       |
| Elgin-ND        | 106   | 104    | 101    | 93                  | 104    | 92     | 93     | 95                   | 94                      |
| Faller          | 103   | 101    | 104    | 104                 | 110    | 107    | 105    | 107                  | 105                     |
| Focus           | 96    | 99     | 96     | 97                  | 97     | 104    | 105    | 95                   | 94                      |
| Forefront       | 94    | 93     | 95     | 103                 | 105    | 99     | 100    | 98                   | 101                     |
| Glenn           | 93    | 96     | 97     | 92                  | 103    | 105    | 102    | 98                   | 100                     |
| HRS 3361        | 101   | 100    | 101    | 97                  | 105    | 97     | 100    | 93                   | 99                      |
| HRS 3419        | 108   | 109    | 110    | 106                 | 131    | 120    | 116    | 108                  | 111                     |
| HRS 3504        | 100   | 100    | –      | –                   | 93     | 94     | –      | –                    | –                       |
| HRS 3530        | 105   | 103    | –      | –                   | 114    | 107    | –      | –                    | –                       |
| HRS 3616        | 96    | –      | –      | –                   | 83     | –      | –      | –                    | –                       |
| LCS Albany      | 110   | 107    | 110    | 104                 | 120    | 110    | 108    | 106                  | 105                     |
| LCS Anchor      | 95    | –      | –      | –                   | 74     | –      | –      | –                    | –                       |
| LCS Breakaway   | 94    | 95     | 98     | 103                 | 92     | 98     | 97     | 101                  | 100                     |
| LCS Iguacu      | 101   | 100    | 105    | 107                 | 111    | 111    | 110    | 109                  | 106                     |
| LCS Nitro       | 102   | 102    | 103    | 101                 | 114    | 105    | 105    | 100                  | 106                     |
| LCS Prime       | 109   | 107    | –      | –                   | 105    | 107    | –      | –                    | –                       |
| Linkert         | 96    | 96     | 96     | 95                  | 85     | 94     | 97     | 101                  | 103                     |
| Norden          | 99    | 101    | 101    | 97                  | 84     | 101    | 97     | 99                   | 93                      |
| Prevail         | 98    | 97     | 98     | 101                 | 105    | 106    | 105    | 99                   | 101                     |
| Prosper         | 103   | 100    | 104    | 106                 | 119    | 111    | 109    | 105                  | 106                     |
| RB07            | 98    | 99     | 99     | 98                  | 83     | 88     | 92     | 99                   | 97                      |
| Rollag          | 95    | 94     | 95     | 100                 | 81     | 84     | 88     | 92                   | 97                      |
| Shelly          | 107   | 107    | 107    | 108                 | 119    | 111    | 107    | 98                   | 107                     |
| Surpass         | 103   | 101    | –      | –                   | 102    | 104    | –      | –                    | –                       |
| SY Ingmar       | 102   | 99     | 98     | 100                 | 99     | 101    | 98     | 101                  | 100                     |
| SY Rowyn        | 100   | 101    | 102    | 98                  | 103    | 96     | 97     | 100                  | 102                     |
| SY Soren        | 100   | 99     | 99     | 95                  | 86     | 100    | 102    | 99                   | 102                     |
| SY Valda        | 110   | 109    | –      | –                   | 121    | 108    | –      | –                    | –                       |
| TCG-Cornerstone | 92    | –      | –      | –                   | 91     | –      | –      | –                    | –                       |
| TCG-Spitfire    | 103   | –      | –      | –                   | 109    | –      | –      | –                    | –                       |
| TCG-Wildfire    | 105   | –      | –      | –                   | 100    | –      | –      | –                    | –                       |
| WB-Mayville     | 98    | 97     | 99     | 97                  | 86     | 91     | 96     | 94                   | 95                      |
| WB9507          | 90    | 93     | 98     | 106                 | 108    | 99     | 100    | 104                  | 103                     |
| WB9653          | 97    | 99     | –      | –                   | 96     | 95     | –      | –                    | –                       |
| Mean (Bu/Acre)  | 99.4  | 101.2  | 98.4   | 95.4                | 63.0   | 73.8   | 78.7   | 72.8                 | 77.6                    |
| LSD (0.10)      | 3.5   | 3.4    | 3.5    | 3.6                 | 5.5    | 4.7    | 4.4    | 4.7                  | 4.4                     |

<sup>1</sup> Data from 2016 sites at Perley (hail), Stephen and Strathcona (excessive water) were excluded from analyses. 2-year data for these locations is from 2014 and 2015.

**Table 5.** Relative grain yield of hard red spring wheat varieties in southern Minnesota locations in single-year (2016) and multiple-year comparisons (2014-2016).

| Variety         | Benson |        |        | Kimball |        |        | LeCenter |        |        |
|-----------------|--------|--------|--------|---------|--------|--------|----------|--------|--------|
|                 | 2016   | 2-Year | 3-Year | 2016    | 2-Year | 3-Year | 2016     | 2-Year | 3-Year |
| Bolles          | 92     | 95     | 95     | 98      | 98     | 98     | 104      | 95     | 89     |
| Boost           | 93     | 94     | 96     | 89      | 93     | 94     | 96       | 93     | 98     |
| Chevelle        | 108    | 111    | –      | 88      | 104    | –      | 96       | 100    | –      |
| Dyna-Gro Ambush | 94     | –      | –      | 100     | –      | –      | 100      | –      | –      |
| Elgin-ND        | 93     | 97     | 95     | 81      | 86     | 88     | 80       | 86     | 82     |
| Faller          | 101    | 101    | 104    | 95      | 90     | 96     | 99       | 102    | 105    |
| Focus           | 94     | 94     | 97     | 90      | 88     | 87     | 81       | 87     | 90     |
| Forefront       | 88     | 90     | 92     | 106     | 104    | 103    | 94       | 101    | 101    |
| Glenn           | 82     | 83     | 88     | 94      | 91     | 89     | 71       | 77     | 79     |
| HRS 3361        | 101    | 94     | 96     | 94      | 96     | 99     | 108      | 106    | 104    |
| HRS 3419        | 110    | 104    | 103    | 130     | 128    | 122    | 136      | 126    | 127    |
| HRS 3504        | 114    | 110    | –      | 101     | 102    | –      | 100      | 105    | –      |
| HRS 3530        | 115    | 114    | –      | 108     | 101    | –      | 106      | 107    | –      |
| HRS 3616        | 99     | –      | –      | 101     | –      | –      | 113      | –      | –      |
| LCS Albany      | 107    | 108    | 109    | 113     | 116    | 114    | 120      | 112    | 107    |
| LCS Anchor      | 93     | –      | –      | 108     | –      | –      | 77       | –      | –      |
| LCS Breakaway   | 92     | 94     | 96     | 110     | 99     | 98     | 89       | 93     | 93     |
| LCS Iguacu      | 98     | 99     | 101    | 117     | 109    | 108    | 120      | 108    | 110    |
| LCS Nitro       | 106    | 105    | 108    | 118     | 116    | 115    | 129      | 118    | 120    |
| LCS Prime       | 110    | 108    | –      | 94      | 102    | –      | 95       | 98     | –      |
| Linkert         | 93     | 92     | 92     | 114     | 103    | 101    | 87       | 96     | 94     |
| Norden          | 97     | 95     | 98     | 102     | 98     | 96     | 95       | 95     | 92     |
| Prevail         | 101    | 96     | 100    | 115     | 114    | 110    | 101      | 103    | 105    |
| Prosper         | 104    | 109    | 110    | 90      | 93     | 96     | 98       | 99     | 100    |
| RB07            | 99     | 99     | 98     | 96      | 99     | 98     | 88       | 88     | 89     |
| Rollag          | 95     | 96     | 98     | 97      | 98     | 98     | 91       | 91     | 88     |
| Shelly          | 105    | 107    | 107    | 92      | 103    | 104    | 109      | 99     | 93     |
| Surpass         | 97     | 99     | –      | 79      | 85     | –      | 76       | 88     | –      |
| SY Ingmar       | 109    | 105    | 108    | 125     | 115    | 111    | 115      | 111    | 114    |
| SY Rowyn        | 108    | 104    | 106    | 106     | 106    | 106    | 112      | 104    | 106    |
| SY Soren        | 101    | 97     | 98     | 110     | 103    | 101    | 109      | 97     | 95     |
| SY Valda        | 113    | 110    | –      | 98      | 101    | –      | 114      | 114    | –      |
| TCG-Cornerstone | 96     | –      | –      | 98      | –      | –      | 104      | –      | –      |
| TCG-Spitfire    | 95     | –      | –      | 103     | –      | –      | 100      | –      | –      |
| TCG-Wildfire    | 100    | –      | –      | 104     | –      | –      | 110      | –      | –      |
| WB-Mayville     | 100    | 95     | 97     | 108     | 99     | 95     | 104      | 105    | 104    |
| WB9507          | 100    | 104    | 104    | 97      | 94     | 99     | 118      | 115    | 115    |
| WB9653          | 108    | 109    | –      | 91      | 103    | –      | 101      | 105    | –      |
|                 |        |        |        |         |        |        |          |        |        |
| Mean (Bu/Acre)  | 113.0  | 109.2  | 109.9  | 64.6    | 81.1   | 84.1   | 78.4     | 82.9   | 74.3   |
| LSD (0.10)      | 3.6    | 8.0    | 6.5    | 19.9    | 12.5   | 9.3    | 14.6     | 14.6   | 12.0   |

**Table 5. (continued)** Relative grain yield of hard red spring wheat varieties in southern Minnesota locations in single-year (2016) and multiple-year comparisons (2014-2016).

| Variety         | Lamberton |        |        | Morris |        |        | St. Paul |        |        | Waseca |        |        |
|-----------------|-----------|--------|--------|--------|--------|--------|----------|--------|--------|--------|--------|--------|
|                 | 2016      | 2-Year | 3-Year | 2016   | 2-Year | 3-Year | 2016     | 2-Year | 3-Year | 2016   | 2-Year | 3-Year |
| Bolles          | 101       | 95     | 97     | 97     | 97     | 99     | 102      | 103    | 104    | 99     | 99     | 104    |
| Boost           | 106       | 97     | 99     | 101    | 97     | 103    | 103      | 98     | 99     | 102    | 106    | 106    |
| Chevelle        | 99        | 101    | –      | 109    | 109    | –      | 106      | 105    | –      | 107    | 101    | –      |
| Dyna-Gro Ambush | 102       | –      | –      | 107    | –      | –      | 97       | –      | –      | 93     | –      | –      |
| Elgin-ND        | 84        | 90     | 94     | 99     | 100    | 100    | 99       | 100    | 99     | 99     | 91     | 87     |
| Faller          | 109       | 109    | 108    | 88     | 92     | 97     | 76       | 89     | 95     | 92     | 98     | 98     |
| Focus           | 96        | 103    | 103    | 95     | 94     | 101    | 77       | 88     | 91     | 100    | 98     | 96     |
| Forefront       | 98        | 102    | 101    | 91     | 98     | 102    | 95       | 90     | 95     | 96     | 98     | 101    |
| Glenn           | 85        | 93     | 93     | 81     | 84     | 90     | 81       | 78     | 78     | 89     | 93     | 90     |
| HRS 3361        | 107       | 102    | 101    | 97     | 100    | 99     | 95       | 98     | 99     | 111    | 112    | 111    |
| HRS 3419        | 116       | 113    | 114    | 115    | 115    | 111    | 114      | 116    | 113    | 115    | 115    | 115    |
| HRS 3504        | 107       | 108    | –      | 115    | 115    | –      | 101      | 102    | –      | 112    | 107    | –      |
| HRS 3530        | 105       | 104    | –      | 104    | 97     | –      | 108      | 107    | –      | 119    | 126    | –      |
| HRS 3616        | 93        | –      | –      | 104    | –      | –      | 104      | –      | –      | 96     | –      | –      |
| LCS Albany      | 114       | 107    | 111    | 105    | 103    | 106    | 107      | 112    | 114    | 102    | 104    | 111    |
| LCS Anchor      | 75        | –      | –      | 86     | –      | –      | 91       | –      | –      | 83     | –      | –      |
| LCS Breakaway   | 89        | 90     | 91     | 99     | 93     | 94     | 105      | 102    | 96     | 91     | 94     | 91     |
| LCS Iguacu      | 103       | 101    | 102    | 98     | 98     | 99     | 112      | 116    | 116    | 103    | 92     | 95     |
| LCS Nitro       | 110       | 106    | 107    | 107    | 110    | 108    | 126      | 123    | 119    | 110    | 105    | 109    |
| LCS Prime       | 97        | 103    | –      | 100    | 95     | –      | 86       | 86     | –      | 86     | 82     | –      |
| Linkert         | 85        | 88     | 89     | 94     | 96     | 93     | 109      | 105    | 99     | 92     | 95     | 97     |
| Norden          | 96        | 97     | 98     | 99     | 100    | 97     | 105      | 103    | 101    | 88     | 93     | 98     |
| Prevail         | 105       | 103    | 101    | 89     | 95     | 102    | 99       | 103    | 105    | 117    | 118    | 120    |
| Prosper         | 109       | 105    | 105    | 95     | 92     | 100    | 86       | 94     | 98     | 96     | 99     | 104    |
| RB07            | 89        | 93     | 97     | 95     | 95     | 94     | 96       | 98     | 94     | 81     | 89     | 87     |
| Rollag          | 84        | 89     | 91     | 98     | 101    | 98     | 94       | 94     | 94     | 75     | 79     | 80     |
| Shelly          | 112       | 109    | 109    | 118    | 115    | 107    | 115      | 115    | 113    | 114    | 112    | 112    |
| Surpass         | 101       | 100    | –      | 104    | 102    | –      | 79       | 78     | –      | 112    | 108    | –      |
| SY Ingmar       | 110       | 105    | 104    | 106    | 100    | 103    | 113      | 100    | 100    | 105    | 94     | 94     |
| SY Rowyn        | 109       | 107    | 106    | 108    | 110    | 113    | 111      | 106    | 104    | 113    | 107    | 110    |
| SY Soren        | 89        | 90     | 96     | 102    | 93     | 97     | 113      | 106    | 103    | 112    | 98     | 97     |
| SY Valda        | 111       | 110    | –      | 113    | 112    | –      | 103      | 106    | –      | 105    | 102    | –      |
| TCG-Cornerstone | 93        | –      | –      | 94     | –      | –      | 105      | –      | –      | 93     | –      | –      |
| TCG-Spitfire    | 99        | –      | –      | 102    | –      | –      | 103      | –      | –      | 89     | –      | –      |
| TCG-Wildfire    | 103       | –      | –      | 103    | –      | –      | 99       | –      | –      | 98     | –      | –      |
| WB-Mayville     | 100       | 96     | 93     | 98     | 105    | 97     | 105      | 106    | 103    | 94     | 99     | 95     |
| WB9507          | 107       | 100    | 102    | 76     | 80     | 89     | 87       | 103    | 106    | 112    | 101    | 106    |
| WB9653          | 106       | 106    | –      | 109    | 115    | –      | 102      | 106    | –      | 110    | 110    | –      |
|                 |           |        |        |        |        |        |          |        |        |        |        |        |
| Mean (Bu/Acre)  | 72.0      | 84.4   | 83.3   | 78.3   | 71.6   | 74.7   | 65.7     | 76.7   | 74.1   | 74.2   | 61.5   | 53.6   |
| LSD (0.10)      | 9.2       | 8.6    | 7.1    | 10.1   | 10.2   | 11.4   | 12.3     | 11.6   | 11.6   | 11.1   | 15.9   | 14.2   |



**Table 6.** Relative grain yield of hard red spring wheat varieties in Minnesota in single-year (2016) and multiple-year comparisons (2014-2016).

| Variety          | State |        |        | North |        |        | South |        |        |
|------------------|-------|--------|--------|-------|--------|--------|-------|--------|--------|
|                  | 2016  | 2-Year | 3-Year | 2016  | 2-Year | 3-Year | 2016  | 2-Year | 3-Year |
| Bolles           | 97    | 97     | 98     | 95    | 97     | 98     | 99    | 97     | 98     |
| Boost            | 96    | 94     | 96     | 92    | 92     | 94     | 98    | 96     | 99     |
| Chevelle         | 102   | 101    | –      | 100   | 98     | –      | 103   | 105    | –      |
| Dyna-Gro Ambush  | 101   | –      | –      | 104   | –      | –      | 99    | –      | –      |
| Elgin-ND         | 93    | 93     | 94     | 96    | 94     | 96     | 91    | 93     | 93     |
| Faller           | 98    | 100    | 103    | 101   | 103    | 106    | 95    | 98     | 101    |
| Focus            | 94    | 96     | 96     | 97    | 98     | 97     | 91    | 93     | 95     |
| Forefront        | 95    | 97     | 99     | 95    | 96     | 99     | 95    | 97     | 99     |
| Glenn            | 88    | 91     | 91     | 95    | 95     | 95     | 83    | 86     | 87     |
| HRS 3361         | 102   | 100    | 100    | 102   | 99     | 100    | 102   | 101    | 101    |
| HRS 3419         | 115   | 113    | 112    | 109   | 110    | 110    | 119   | 116    | 115    |
| HRS 3504         | 106   | 104    | –      | 103   | 102    | –      | 108   | 107    | –      |
| HRS 3530         | 107   | 108    | –      | 104   | 107    | –      | 110   | 108    | –      |
| HRS 3616         | 99    | –      | –      | 97    | –      | –      | 102   | –      | –      |
| LCS Albany       | 109   | 108    | 109    | 109   | 106    | 108    | 109   | 109    | 110    |
| LCS Anchor       | 90    | –      | –      | 92    | –      | –      | 88    | –      | –      |
| LCS Breakaway    | 97    | 98     | 96     | 99    | 100    | 98     | 96    | 95     | 95     |
| LCS Iguacu       | 106   | 104    | 105    | 104   | 104    | 106    | 107   | 104    | 105    |
| LCS Nitro        | 110   | 107    | 108    | 105   | 103    | 104    | 114   | 112    | 112    |
| LCS Prime        | 99    | 101    | –      | 101   | 104    | –      | 96    | 98     | –      |
| Linkert          | 95    | 97     | 96     | 95    | 98     | 97     | 95    | 96     | 95     |
| Norden           | 98    | 98     | 98     | 98    | 98     | 98     | 97    | 97     | 97     |
| Prevail          | 102   | 102    | 103    | 100   | 100    | 101    | 103   | 104    | 105    |
| Prosper          | 100   | 102    | 104    | 104   | 104    | 106    | 98    | 99     | 102    |
| RB07             | 94    | 95     | 96     | 96    | 96     | 97     | 92    | 95     | 95     |
| Rollag           | 94    | 95     | 95     | 97    | 97     | 97     | 91    | 93     | 93     |
| Shelly           | 108   | 106    | 106    | 107   | 105    | 105    | 110   | 108    | 107    |
| Surpass          | 97    | 98     | –      | 101   | 103    | –      | 93    | 94     | –      |
| SY Ingmar        | 107   | 103    | 103    | 102   | 100    | 100    | 111   | 105    | 106    |
| SY Rowyn         | 106   | 104    | 104    | 101   | 101    | 102    | 110   | 106    | 107    |
| SY Soren         | 103   | 98     | 99     | 100   | 99     | 99     | 105   | 98     | 99     |
| SY Valda         | 110   | 109    | –      | 112   | 110    | –      | 109   | 108    | –      |
| TCG-Cornerstone  | 96    | –      | –      | 93    | –      | –      | 97    | –      | –      |
| TCG-Spitfire     | 101   | –      | –      | 105   | –      | –      | 98    | –      | –      |
| TCG-Wildfire     | 101   | –      | –      | 99    | –      | –      | 103   | –      | –      |
| WB-Mayville      | 99    | 98     | 97     | 97    | 96     | 96     | 101   | 101    | 98     |
| WB9507           | 100   | 101    | 104    | 102   | 102    | 104    | 100   | 100    | 103    |
| WB9653           | 104   | 104    | –      | 103   | 101    | –      | 104   | 107    | –      |
|                  |       |        |        |       |        |        |       |        |        |
| Mean (Bu/Acre)   | 81.5  | 85.0   | 83.3   | 86.2  | 89.4   | 87.5   | 78.0  | 81.0   | 79.0   |
| LSD (0.10)       | 4.8   | 3.4    | 2.5    | 6.0   | 4.4    | 2.9    | 6.8   | 4.9    | 3.9    |
| No. Environments | 12    | 27     | 42     | 5     | 13     | 21     | 7     | 14     | 21     |

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

| Variety          | NORTH |       |        |       |        |       | SOUTH |      |
|------------------|-------|-------|--------|-------|--------|-------|-------|------|
|                  | 2016  |       | 2-year |       | 3-year |       | 2016  |      |
|                  | Conv  | Int   | Conv   | Int   | Conv   | Int   | Conv  | Int  |
| Bolles           | 79.6  | 86.4  | 80.3   | 89.4  | 84.8   | 93.5  | 74.4  | 82.5 |
| Boost            | 75.8  | 78.0  | 76.9   | 86.8  | 80.5   | 92.8  | 77.6  | 79.2 |
| Chevelle         | 79.3  | 87.7  | 78.4   | 94.1  | –      | –     | 78.3  | 84.7 |
| Dyna-Gro Ambush  | 86.4  | 91.2  | –      | –     | –      | –     | 78.5  | 76.9 |
| Elgin-ND         | 78.2  | 83.4  | 77.2   | 86.9  | 81.3   | 92.1  | 69.2  | 75.0 |
| Faller           | 84.1  | 93.0  | 83.3   | 99.1  | 89.9   | 105.1 | 73.7  | 87.6 |
| Focus            | 76.0  | 80.5  | 81.8   | 88.5  | 85.1   | 93.6  | 71.7  | 82.9 |
| Forefront        | 80.8  | 87.7  | 81.4   | 85.4  | 85.5   | 92.3  | 70.6  | 74.4 |
| Glenn            | 77.2  | 80.8  | 79.5   | 84.9  | 80.7   | 89.8  | 62.1  | 68.7 |
| HRS 3361         | 87.1  | 91.3  | 83.5   | 91.6  | 86.7   | 97.7  | 76.6  | 86.6 |
| HRS 3419         | 96.5  | 100.7 | 95.6   | 99.5  | 96.8   | 105.7 | 86.9  | 88.7 |
| HRS 3504         | 81.5  | 82.9  | 81.5   | 92.7  | –      | –     | 83.3  | 90.1 |
| HRS 3530         | 87.3  | 89.7  | 87.4   | 94.5  | –      | –     | 78.5  | 90.4 |
| HRS 3616         | 77.1  | 83.9  | –      | –     | –      | –     | 74.2  | 81.4 |
| LCS Albany       | 94.4  | 98.9  | 90.1   | 100.0 | 93.7   | 103.7 | 82.3  | 86.7 |
| LCS Anchor       | 72.3  | 75.4  | –      | –     | –      | –     | 60.7  | 69.7 |
| LCS Breakaway    | 82.4  | 86.3  | 84.3   | 93.4  | 83.9   | 97.1  | 71.2  | 75.6 |
| LCS Iguacu       | 89.8  | 92.4  | 89.3   | 92.6  | 92.8   | 99.1  | 75.6  | 87.2 |
| LCS Nitro        | 89.0  | 97.7  | 86.8   | 94.4  | 89.8   | 100.5 | 81.4  | 82.0 |
| LCS Prime        | 82.1  | 89.7  | 82.0   | 97.0  | –      | –     | 73.8  | 85.1 |
| Linkert          | 76.2  | 80.0  | 81.5   | 89.0  | 84.5   | 93.9  | 67.2  | 78.5 |
| Norden           | 79.1  | 80.2  | 83.8   | 87.2  | 84.4   | 92.5  | 73.3  | 76.3 |
| Prevail          | 82.0  | 86.2  | 84.9   | 93.9  | 87.3   | 97.0  | 72.8  | 84.4 |
| Prosper          | 88.6  | 89.3  | 86.9   | 93.7  | 91.9   | 101.0 | 76.5  | 87.4 |
| RB07             | 79.0  | 84.5  | 79.4   | 92.5  | 83.7   | 97.9  | 69.2  | 67.8 |
| Rollag           | 77.6  | 86.9  | 79.4   | 92.8  | 82.7   | 96.4  | 68.6  | 73.3 |
| Shelly           | 90.2  | 97.0  | 89.3   | 100.7 | 91.8   | 104.4 | 86.8  | 94.0 |
| Surpass          | 83.6  | 83.9  | 85.4   | 90.2  | –      | –     | 77.0  | 80.7 |
| SY Ingmar        | 81.7  | 90.7  | 81.9   | 95.4  | 84.8   | 98.0  | 81.2  | 87.3 |
| SY Rowyn         | 83.6  | 89.1  | 81.9   | 94.6  | 86.6   | 98.7  | 81.6  | 90.4 |
| SY Soren         | 79.1  | 88.7  | 84.3   | 92.9  | 87.6   | 97.7  | 71.8  | 81.2 |
| SY Valda         | 93.5  | 94.6  | 89.5   | 97.0  | –      | –     | 84.1  | 90.1 |
| TCG-Cornerstone  | 77.5  | 83.9  | –      | –     | –      | –     | 70.3  | 76.7 |
| TCG-Spitfire     | 86.2  | 91.0  | –      | –     | –      | –     | 75.7  | 80.6 |
| TCG-Wildfire     | 82.9  | 85.9  | –      | –     | –      | –     | 77.7  | 78.2 |
| WB-Mayville      | 76.2  | 89.5  | 78.3   | 95.6  | 81.3   | 98.7  | 74.6  | 83.8 |
| WB9507           | 87.0  | 96.7  | 82.4   | 99.6  | 87.5   | 103.2 | 68.2  | 92.6 |
| WB9653           | 82.7  | 84.6  | –      | –     | –      | –     | 80.7  | 94.1 |
| Mean (Bu/Acre)   | 82.5  | 87.7  | 83.0   | 92.5  | 86.0   | 97.2  | 75.2  | 82.4 |
| LSD (0.10)       | 9.9   | 12.5  | 7.1    | 7.9   | 5.5    | 5.8   | 8.1   | 6.8  |
| No. Environments | 2     | 2     | 4      | 4     | 6      | 6     | 2     | 2    |

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

| Variety          | SOUTH  |      |        |      | STATE |      |        |      |        |      |
|------------------|--------|------|--------|------|-------|------|--------|------|--------|------|
|                  | 2-year |      | 3-year |      | 2016  |      | 2-year |      | 3-year |      |
|                  | Conv   | Int  | Conv   | Int  | Conv  | Int  | Conv   | Int  | Conv   | Int  |
| Bolles           | 74.9   | 81.1 | 77.6   | 83.1 | 77.0  | 84.4 | 77.6   | 85.2 | 81.2   | 88.3 |
| Boost            | 75.5   | 80.1 | 79.8   | 83.1 | 76.7  | 78.6 | 76.2   | 83.4 | 80.2   | 87.9 |
| Chevelle         | 81.7   | 87.0 | –      | –    | 78.8  | 86.2 | 80.1   | 90.5 | –      | –    |
| Dyna-Gro Ambush  | –      | –    | –      | –    | 82.5  | 84.1 | –      | –    | –      | –    |
| Elgin-ND         | 73.8   | 78.6 | 76.7   | 81.2 | 73.7  | 79.2 | 75.5   | 82.8 | 79.0   | 86.7 |
| Faller           | 78.7   | 90.1 | 81.2   | 90.2 | 78.9  | 90.3 | 81.0   | 94.6 | 85.6   | 97.6 |
| Focus            | 76.9   | 82.5 | 80.4   | 84.1 | 73.9  | 81.7 | 79.4   | 85.5 | 82.8   | 88.9 |
| Forefront        | 77.9   | 80.1 | 80.0   | 81.6 | 75.7  | 81.1 | 79.7   | 82.8 | 82.8   | 87.0 |
| Glenn            | 69.4   | 72.1 | 72.4   | 76.6 | 69.7  | 74.8 | 74.4   | 78.5 | 76.6   | 83.2 |
| HRS 3361         | 79.2   | 83.0 | 79.2   | 83.3 | 81.8  | 89.0 | 81.4   | 87.3 | 83.0   | 90.5 |
| HRS 3419         | 89.0   | 92.7 | 88.9   | 93.1 | 91.7  | 94.7 | 92.3   | 96.1 | 92.9   | 99.4 |
| HRS 3504         | 86.9   | 90.5 | –      | –    | 82.4  | 86.5 | 84.2   | 91.6 | –      | –    |
| HRS 3530         | 78.6   | 89.2 | –      | –    | 82.9  | 90.1 | 83.0   | 91.9 | –      | –    |
| HRS 3616         | –      | –    | –      | –    | 75.6  | 82.6 | –      | –    | –      | –    |
| LCS Albany       | 82.1   | 91.1 | 85.6   | 89.7 | 88.3  | 92.8 | 86.1   | 95.6 | 89.7   | 96.7 |
| LCS Anchor       | –      | –    | –      | –    | 66.5  | 72.6 | –      | –    | –      | –    |
| LCS Breakaway    | 71.4   | 79.6 | 73.2   | 82.3 | 76.8  | 80.9 | 77.9   | 86.5 | 78.6   | 89.7 |
| LCS Iguacu       | 78.0   | 88.7 | 79.4   | 88.6 | 82.7  | 89.8 | 83.7   | 90.7 | 86.1   | 93.9 |
| LCS Nitro        | 84.0   | 83.8 | 84.9   | 87.9 | 85.2  | 89.8 | 85.4   | 89.1 | 87.4   | 94.2 |
| LCS Prime        | 77.2   | 90.8 | –      | –    | 78.0  | 87.4 | 79.6   | 93.9 | –      | –    |
| Linkert          | 71.5   | 79.9 | 72.0   | 79.4 | 71.7  | 79.3 | 76.5   | 84.4 | 78.3   | 86.7 |
| Norden           | 76.8   | 79.6 | 76.9   | 81.1 | 76.2  | 78.3 | 80.3   | 83.4 | 80.7   | 86.8 |
| Prevail          | 77.6   | 86.0 | 80.0   | 84.9 | 77.4  | 85.3 | 81.2   | 89.9 | 83.6   | 90.9 |
| Prosper          | 77.3   | 89.4 | 81.1   | 89.6 | 82.6  | 88.4 | 82.1   | 91.5 | 86.5   | 95.3 |
| RB07             | 73.3   | 77.6 | 75.6   | 79.7 | 74.1  | 76.1 | 76.4   | 85.0 | 79.7   | 88.8 |
| Rollag           | 73.5   | 77.0 | 74.4   | 77.9 | 73.1  | 80.1 | 76.5   | 84.9 | 78.6   | 87.2 |
| Shelly           | 87.2   | 91.8 | 85.6   | 89.8 | 88.5  | 95.5 | 88.2   | 96.2 | 88.7   | 97.1 |
| Surpass          | 78.7   | 83.7 | –      | –    | 80.3  | 82.3 | 82.1   | 86.9 | –      | –    |
| SY Ingmar        | 80.1   | 85.4 | 81.6   | 86.5 | 81.4  | 89.0 | 81.0   | 90.4 | 83.2   | 92.2 |
| SY Rowyn         | 84.7   | 88.7 | 86.3   | 89.7 | 82.6  | 89.8 | 83.3   | 91.6 | 86.5   | 94.2 |
| SY Soren         | 71.4   | 82.5 | 76.3   | 83.7 | 75.5  | 85.0 | 77.8   | 87.7 | 82.0   | 90.7 |
| SY Valda         | 86.8   | 91.6 | –      | –    | 88.8  | 92.3 | 88.2   | 94.3 | –      | –    |
| TCG-Cornerstone  | –      | –    | –      | –    | 73.9  | 80.3 | –      | –    | –      | –    |
| TCG-Spitfire     | –      | –    | –      | –    | 80.9  | 85.8 | –      | –    | –      | –    |
| TCG-Wildfire     | –      | –    | –      | –    | 80.3  | 82.1 | –      | –    | –      | –    |
| WB-Mayville      | 78.3   | 82.1 | 75.0   | 81.6 | 75.4  | 86.7 | 78.3   | 88.8 | 78.1   | 90.2 |
| WB9507           | 70.8   | 91.5 | 75.9   | 92.0 | 77.6  | 94.6 | 76.6   | 95.5 | 81.7   | 97.6 |
| WB9653           | –      | –    | –      | –    | 81.7  | 89.3 | –      | –    | –      | –    |
| Mean (Bu/Acre)   | 77.8   | 84.5 | 78.9   | 84.6 | 78.8  | 85.0 | 80.4   | 88.5 | 82.5   | 90.9 |
| LSD (0.10)       | 7.3    | 7.0  | 5.1    | 5.0  | 6.1   | 6.9  | 5.1    | 5.2  | 3.7    | 3.8  |
| No. Environments | 4      | 4    | 6      | 6    | 4     | 4    | 8      | 8    | 12     | 12   |