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North Dakota
Hard Red Spring Wheat

Variety Trial Results for 2022 and Selection Guide

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Hard red spring (HRS) wheat was planted on 5.4 million acres in 2022, down slightly from 5.5 million in 2021. The average yield of HRS wheat was 52 bushels/acre (bu/a), up substantially from 34 bu/a in 2021. Low 2021 yields were caused by wide-spread and severe drought. The 2022 growing season started with late planting after spring blizzards and heavy rains delayed field work for many across the state.

SY Valda was the most popular HRS wheat variety in 2022, occupying 11.0% of the planted acreage, followed by SY Ingmar (9.4%), AP Murdock (8.8%), WB9590 (8.8%), WB9719 (4.1%), Shelly (3.9%), ND VitPro (3.0%), Elgin ND (3.0%), and Faller (2.9%). SY Valda, SY Ingmar, and AP Murdock were released by Syngenta/AgriPro. WB9590 and WB9719 were released by WestBred/Monsanto. Shelly is a University of Minnesota release and ND VitPro, Elgin and Faller are NDSU varieties.

Successful wheat production depends on numerous factors, including selecting the right variety for a particular area. The information included in this publication is meant to aid in selecting that variety or group of varieties. Characteristics to consider in selecting a variety may include yield potential, protein content when grown with proper fertility, straw strength, plant height, response to problematic pests (diseases, insects, etc.) and maturity. Every growing season differs; therefore, when selecting a variety, we recommend using data that summarize several years and locations. Choose the variety that, on average, performs the best at multiple locations near your farm during several years.

Selecting varieties with good milling and baking quality also is important to maintain market recognition and avoid discounts. Hard red spring wheat from the northern Great Plains is known around the world for its excellent end-use quality.

Millers and bakers consider many factors in determining the quality and value of wheat they purchase. Several key parameters are: high test weight (for optimum milling yield and flour color), high falling number (greater than 300 seconds indicates minimal sprout damage), high protein content (the majority of HRS wheat export markets want at least 14% protein) and excellent protein quality (for superior bread-making quality as indicated by traditional strong gluten proteins, high baking absorption and large bread loaf volume).

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Gluten strength and milling and baking quality ratings are provided for individual varieties based on the results from the NDSU field plot variety trials in multiple locations in 2021. The wheat protein data often are higher than obtained in actual production fields but can be used to compare relative differences among varieties.

The agronomic data presented in this publication are from replicated research plots using experimental designs that enable the use of statistical analysis. These analyses enable the reader to determine, at a predetermined level of confidence, if the differences observed among varieties are reliable or if they might be due to error inherent in the experimental process.

The LSD (least significant difference) values beneath the columns in the tables are derived from these statistical analyses and apply only to the numbers in the column in which they appear. If the difference between two varieties exceeds the LSD value, it means that with 95% or 90% confidence (LSD probability 0.05 or 0.10), the higher-yielding variety has a significant yield advantage. When the difference between two varieties is less than the LSD value, no significant difference was found between those two varieties under those growing conditions.

NS is used to indicate no significant difference for that trait among any of the varieties at the 95% or 90% level of confidence. The CV stands for coefficient of variation and is expressed as a percentage. The CV is a measure of variability in the trial. Large CVs mean a large amount of variation could not be attributed to differences in the varieties. Yield is reported at 13.5% moisture, while protein content is reported at 12% moisture content.

Presentation of data for the entries tested does not imply approval or endorsement by the authors or agencies conducting the test. North Dakota State University approves the reproduction of any table in the publication only if no portion is deleted, appropriate footnotes are given and the order of the data is not rearranged. Additional data from county sites are available from each Research Extension Center at *https://vt.ag.ndsu.edu/*.

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Table 1. North Dakota hard red spring wheat variety descriptions, agronomic traits, 2022.

Variety	Agent or Origin[1]	Year Released	Height (inches)[2]	Straw Strength[3]	Days to Head[4]	Reaction to Disease[5]				
						Stem Rust[6]	Leaf Rust	Tan Spot	Bact. Leaf Streak	Head Scab
AAC Brandon	Canada	2012	31	4	49	4	6	NA	6	5
AAC Starbuck	Canada	2018	32	4	49	NA	6	NA	6	5
AAC Wheatland	Canada	2018	31	4	49	NA	4	NA	7	5
AP Gunsmoke CL2	Syngenta/AgriPro	2021	30	6	48	3	3	4	8	3
AP Murdock	Syngenta/AgriPro	2019	28	4	49	3	5	4	6	6
AP Smith	Syngenta/AgriPro	2021	28	2	50	NA	3	3	5	4
Ascend-SD	**SD**	**2022**	**34**	**4**	**50**	**NA**	**4**	**NA**	**5**	**4**
Bolles	MN	2015	30	4	51	5	2	4	6	5
CAG-Justify	Champions Alliance Grp	2021	31	6	51	3	2	5	6	3
CAG-Reckless	Champions Alliance Grp	2021	32	5	49	4	2	6	6	4
CAG-Recoil	**Champions Alliance Grp**	**2022**	**29**	**3**	**55**	**NA**	**1**	**NA**	**3**	**4**
CP3099A	Croplan	2020	32	5	52	7	3	4	6	4
CP3188	Croplan	2020	30	7	49	8	2	6	7	4
CP3530	Croplan	2015	33	7	50	4	5	6	6	5
Dagmar[7]	MT	2019	30	6	47	3	7	4	7	7
Driver	SD	2019	31	4	50	4	1	7	7	3
Faller	ND	2007	32	6	50	5	7	7	5	4
Glenn	ND	2005	33	4	47	5	6	6	5	4
Lanning	MT	2017	30	3	50	6	7	4	8	6
LCS Ascent	**Limagrain**	**2022**	**30**	**4**	**46**	**NA**	**6**	**NA**	**6**	**4**
LCS Buster	Limagrain	2020	32	5	53	3	4	4	4	5
LCS Cannon	Limagrain	2018	29	4	45	3	7	5	7	6
LCS Dual	Limagrain	2020	30	4	48	NA	6	NA	7	5
LCS Hammer AX	**Limagrain**	**2022**	**29**	**4**	**47**	**NA**	**6**	**NA**	**7**	**5**
LCS Rebel	Limagrain	2017	33	6	46	6	7	3	5	5
LCS Trigger	Limagrain	2016	33	5	54	7	1	4	4	3
MN- Rothsay	**MN**	**2022**	**29**	**3**	**51**	**NA**	**6**	**NA**	**6**	**4**
MN-Torgy	MN	2020	31	4	50	3	3	3	4	3
MN-Washburn	MN	2019	30	3	51	3	1	6	6	5
MS Barracuda	Meridian Seeds	2018	28	4	45	4	NA	7	7	6
MS Charger	**Meridian Seeds**	**2022**	**29**	**7**	**47**	**NA**	**2**	**NA**	**7**	**4**
MS Cobra	Meridian Seeds	2022	29	4	48	3	2	4	8	5
MS Ranchero	Meridian Seeds	2020	32	5	53	6	4	5	6	6
ND Frohberg	ND	2020	33	5	49	3	5	8	5	5
ND Heron	**ND**	**2021**	**31**	**6**	**46**	**NA**	**7**	**NA**	**7**	**3**
ND VitPro	ND	2016	31	4	48	7	4	6	6	4
Shelly	MN	2016	29	4	51	3	6	3	8	5
SK Rush	Canada	2016	33	4	50	4	2	NA	7	4
SY 611CL2	Syngenta/AgriPro	2019	28	3	48	3	6	4	6	5
SY Ingmar	Syngenta/AgriPro	2014	29	3	50	3	3	6	6	5
SY Longmire[7]	Syngenta/AgriPro	2019	29	5	49	4	6	4	6	7
SY McCloud	Syngenta/AgriPro	2019	30	4	48	3	5	7	8	5
SY Valda	Syngenta/AgriPro	2015	29	5	49	4	2	7	6	5
TCG-Heartland	21st Century Genetics	2019	28	3	47	3	3	4	7	6
TCG-Spitfire	21st Century Genetics	2015	30	3	51	4	5	6	5	6
TCG-Wildcat	21st Century Genetics	2020	30	3	49	3	5	6	7	6
WB9590	WestBred	2017	27	3	48	3	3	8	8	6

[1]Refers to agent or developer: MN = University of Minnesota; MT = Montana State University; ND = North Dakota State University; SD = South Dakota State University; Canada = Agri-Food Canada. Bold varieties are those recently released, so data are limited and rating values may change.

[2]Height data averaged from multiple locations in 2022.

[3]Straw Strength = 1 to 9 scale, with 1 the strongest and 9 the weakest. These values are based on recent data and may change as more data become available.

[4]Days to Head = the number of days from planting to head emergence from the boot, averaged based on data from several locations in 2022.

[5]Disease reaction scores from 1 to 9, with 1 = resistant and 9 = very susceptible, NA = not available.

[6]Stem rust screening done with *Puccinia graminis* f. sp. *tritici* races TPMK, TMLK, RTQQ, QFCQ and QTHJ

[7]Solid stemmed or semisolid stem, imparting resistance to sawfly.

Table 2. Yield of hard red spring wheat varieties grown at five locations in eastern North Dakota, 2020-2022.

	Carrington		Casselton		Grand Forks		Langdon		Prosper		Average	
Variety	**2022**	**3 Yr.**	**2022**	**3 Yr.**	**2022**	**3 Yr.**	**2022**	**3 Yr.[1]**	**2022**	**2 Yr.**	**2022**	**3 Yr.**
	(bu/a)											
AAC Brandon	56.8	--	66.2	--	80.4	--	75.0	--	66.4	--	69.0	--
AAC Starbuck	60.7	--	69.5	--	77.5	--	80.1	--	55.9	--	68.7	--
AAC Wheatland	54.8	--	70.2	--	81.8	--	75.7	--	49.3	--	66.4	--
AP Gunsmoke CL2	57.7	54.0	72.9	--	86.1	--	80.6	--	50.8	73.5	69.6	--
AP Murdock	54.5	51.6	72.7	86.9	90.5	78.9	92.6	87.2	66.5	75.4	75.4	76.0
AP Smith	53.4	48.9	67.8	--	82.2	--	79.8	--	58.0	72.3	68.2	--
Ascend-SD	60.3	--	72.2	--	94.4	--	89.9	--	78.4	--	79.1	--
Bolles	46.1	45.7	74.4	77.0	83.1	69.7	71.0	70.5	42.0	61.7	63.3	64.9
CAG-Justify	60.7	--	74.7	--	78.8	--	92.6	--	50.3	70.9	71.4	--
CAG-Reckless	53.3	--	74.6	--	82.7	--	82.3	--	64.1	78.1	71.4	--
CAG-Recoil	53.2	--	62.3	--	95.1	--	85.5	--	75.3	--	74.3	--
CP3099A	59.7	--	83.7	--	87.8	--	81.8	--	57.9	78.2	74.2	--
CP3188	66.2	--	68.5	--	76.0	--	80.5	--	49.3	69.9	68.1	--
CP3530	58.7	54.4	71.9	85.3	86.5	77.6	86.7	82.7	63.9	70.3	73.5	74.1
Dagmar	62.8	56.0	68.4	80.8	89.3	75.6	68.7	--	54.7	68.3	68.8	--
Driver	58.3	56.6	77.5	86.7	87.5	78.9	81.9	--	51.6	73.6	71.4	--
Faller	59.4	56.7	71.0	82.8	81.5	77.2	85.7	83.3	69.9	80.5	73.5	76.1
Glenn	47.3	45.8	58.7	70.3	74.8	65.6	67.6	72.0	52.9	56.1	60.3	62.0
Lanning	49.2	47.5	67.9	81.7	78.5	69.7	60.5	--	60.2	71.1	63.3	--
LCS Ascent	51.4	--	79.9	--	90.5	--	85.0	--	57.1	--	72.8	--
LCS Buster	57.6	50.3	80.6	92.4	86.4	79.5	86.4	--	65.6	76.4	75.3	--
LCS Cannon	55.5	48.6	76.7	91.5	92.3	77.0	85.8	76.7	52.5	--	72.6	--
LCS Dual	65.9	--	76.4	--	88.7	--	73.1	--	46.2	--	70.1	--
LCS Hammer AX	63.2	--	76.7	--	87.8	--	79.5	--	63.6	--	74.2	--
LCS Rebel	64.4	55.4	76.9	82.0	78.9	76.3	76.7	77.8	64.3	76.7	72.2	73.6
LCS Trigger	58.6	55.4	80.7	90.6	91.2	85.3	93.5	87.1	81.3	87.4	81.1	81.2
MN-Rothsay	51.0	--	70.1	--	92.2	--	77.1	--	60.4	--	70.2	--
MN-Torgy	62.3	60.6	74.2	83.7	89.1	77.2	82.0	78.8	65.6	75.9	74.6	75.2
MN-Washburn	51.1	49.2	71.2	80.8	90.9	74.7	80.1	77.9	59.4	72.9	70.5	71.1
MS Barracuda	53.0	48.3	74.0	83.1	80.1	70.9	73.0	74.0	51.9	65.2	66.4	68.3
MS Charger	60.9	--	86.9	--	94.9	--	89.6	--	57.3	--	77.9	--
MS Cobra	60.6	--	76.4	--	78.3	--	67.5	--	47.9	66.8	66.2	--
MS Ranchero	55.6	55.4	66.2	82.4	80.2	75.3	76.1	--	50.4	62.3	65.7	--
ND Frohberg	54.9	48.2	72.2	82.3	79.4	69.8	77.4	77.2	62.0	73.7	69.2	70.3
ND Heron	48.5	42.8	66.7	80.5	79.1	69.5	68.0	71.1	56.5	70.1	63.8	66.8
ND VitPro	59.5	56.5	56.1	71.8	80.3	69.5	71.1	73.4	60.6	69.3	65.5	68.1
Shelly	65.0	59.0	78.3	--	86.1	73.5	76.0	71.9	46.5	--	70.4	--
SK Rush	46.9	--	60.5	--	74.8	--	75.5	--	59.4	--	63.4	--
SY 611CL2	57.3	48.8	67.1	81.4	82.2	72.9	81.6	80.9	58.5	76.2	69.3	72.0
SY Ingmar	50.4	46.6	66.5	77.9	81.9	72.6	75.3	77.8	50.1	67.5	64.8	68.5
SY Longmire	48.9	--	61.4	79.5	78.6	71.2	70.0	75.6	52.6	69.8	62.3	--
SY McCloud	52.2	50.5	75.9	84.2	84.8	71.7	75.4	76.5	54.4	71.2	68.5	70.8
SY Valda	55.2	53.9	71.8	85.8	93.9	77.6	86.1	81.7	62.6	77.2	73.9	75.2
TCG-Heartland	45.0	44.3	70.9	79.0	88.1	72.0	68.4	69.9	48.9	65.1	64.3	66.1
TCG-Spitfire	58.2	55.2	71.8	81.4	96.4	82.8	82.5	80.3	72.0	85.7	76.2	77.1
TCG-Wildcat	54.8	49.1	79.6	83.7	90.9	78.4	76.1	--	60.0	74.8	72.3	--
WB9590	56.7	--	78.9	--	97.4	--	74.4	--	50.3	68.5	71.5	--
Mean	56.3	51.6	71.9	82.4	85.3	74.9	78.6	77.5	59.2	72.2	70.1	71.4
CV%	9.9	--	4.4	--	6.5	--	7.7	--	12.1	--	8.2	--
LSD 0.05	7.8	--	5.8	--	6.2	--	8.4	--	8.1	--	7.1	--
LSD 0.10	6.6	--	4.5	--	5.2	--	7.1	--	6.8	--	6.0	--

[1]Langdon 3-year avg. includes 2019, 2020 and 2022.

Table 3. Yield of hard red spring wheat varieties grown at four locations in western North Dakota, 2020-2022.

	Hettinger		Mandan		Minot		Williston		Average	
Variety	**2022**	**3 Yr.**	**2022**	**3 Yr.**	**2022**	**3 Yr.**	**2022**	**3 Yr.**	**2022**	**3 Yr.**
	---(bu/a)---									
AAC Brandon	73.1	--	49.3	--	62.2	--	31.2	--	53.9	--
AAC Starbuck	76.1	--	51.6	--	52.4	--	33.3	--	53.4	--
AAC Wheatland	73.3	--	51.2	--	60.1	--	31.9	--	54.1	--
AP Gunsmoke CL2	78.8	50.5	66.4	43.8	57.7	--	34.8	--	59.4	--
AP Murdock	73.6	45.3	65.2	42.2	58.1	52.7	33.2	25.2	57.5	41.3
AP Smith	76.5	44.2	58.5	42.0	58.6	--	36.1	--	57.4	--
Ascend-SD	74.4	--	65.7	--	61.8	--	37.9	--	60.0	--
Bolles	70.3	43.1	56.5	38.5	61.5	55.4	31.6	24.3	55.0	40.3
CAG-Justify	82.4	--	67.2	--	66.7	--	33.8	--	62.5	--
CAG-Reckless	75.2	--	57.9	--	56.3	--	36.1	--	56.4	--
CAG-Recoil	76.4	--	66.6	--	66.9	--	37.7	--	61.9	--
CP3099A	76.8	--	62.8	--	68.7	--	34.6	--	60.7	--
CP3188	77.2	--	58.7	--	59.4	--	39.2	--	58.6	--
CP3530	76.0	48.0	58.4	41.1	55.5	56.8	33.4	--	55.8	--
Dagmar	82.6	51.7	57.7	39.0	60.9	53.7	30.7	26.9	58.0	42.8
Driver	76.9	50.4	57.0	43.7	63.0	--	32.1	26.6	57.3	--
Faller	79.2	50.8	61.2	44.3	72.0	64.6	31.1	28.0	60.9	46.9
Glenn	71.2	45.3	54.6	38.6	56.6	50.5	27.0	25.5	52.4	40.0
Lanning	77.3	48.9	56.0	41.9	63.4	55.9	34.6	28.9	57.8	43.9
LCS Ascent	80.9	--	54.9	--	65.1	--	33.9	--	58.7	--
LCS Buster	81.3	50.9	69.5	48.6	66.8	--	40.0	29.4	64.4	--
LCS Cannon	79.6	50.7	56.6	38.7	59.2	52.9	28.1	24.0	55.9	41.6
LCS Dual	80.2	--	55.1	--	72.7	--	32.8	--	60.2	--
LCS Hammer AX	77.6	--	62.8	--	60.4	--	36.8	--	59.4	--
LCS Rebel	78.2	51.0	58.5	40.8	61.0	56.5	34.9	28.4	58.2	44.2
LCS Trigger	77.1	50.3	70.4	47.6	66.7	64.9	36.5	29.2	62.7	48.0
MN-Rothsay	74.2	45.1	63.5	44.8	70.1	--	36.8	--	61.1	--
MN-Torgy	77.1	49.0	65.7	45.1	65.4	58.7	36.0	28.1	61.0	45.2
MN-Washburn	76.1	47.5	58.1	39.8	56.0	52.6	31.7	25.6	55.5	41.4
MS Barracuda	82.8	49.3	57.3	37.7	61.6	57.7	28.9	25.5	57.6	42.5
MS Charger	86.5	--	61.6	--	59.0	--	39.0	--	61.5	--
MS Cobra	77.7	--	62.1	--	55.2	--	32.9	--	57.0	--
MS Ranchero	78.2	51.0	64.3	46.8	52.1	--	33.3	27.0	57.0	--
ND Frohberg	73.7	47.3	57.9	40.6	58.0	53.0	34.4	26.5	56.0	41.9
ND Heron	74.3	48.0	54.2	37.7	55.9	55.3	30.5	--	53.7	--
ND VitPro	71.6	44.0	51.1	38.0	54.2	48.5	28.8	24.8	51.4	38.8
Shelly	78.9	--	60.9	--	63.8	56.8	32.1	--	58.9	--
SK Rush	76.1	--	57.0	--	50.4	--	36.3	--	54.9	--
SY 611CL2	81.4	50.3	60.7	41.7	56.5	57.4	36.4	29.6	58.7	44.8
SY Ingmar	65.1	42.0	54.3	38.6	53.5	48.8	36.8	28.6	52.4	39.5
SY Longmire	70.7	45.6	55.2	40.0	53.5	54.7	38.1	29.5	54.4	42.4
SY McCloud	76.9	47.9	59.8	39.6	66.7	53.7	34.6	26.3	59.5	41.9
SY Valda	74.8	48.1	60.8	44.6	57.4	51.4	35.4	26.9	57.1	42.7
TCG-Heartland	73.2	46.5	51.0	36.2	58.7	54.7	30.1	27.2	53.3	41.2
TCG-Spitfire	77.4	50.1	63.5	45.9	62.6	60.4	38.7	30.2	60.6	46.7
TCG-Wildcat	75.5	46.5	63.9	41.5	61.3	--	38.2	29.1	59.7	--
WB9590	77.6	--	57.2	--	59.0	--	30.6	--	56.1	--
Mean	76.6	47.8	59.4	41.6	60.9	55.3	34.5	27.3	57.7	42.8
CV%	3.1	--	6.5	--	8.7	--	7.1	--	6.4	--
LSD 0.05	2.8	--	4.5	--	8.6	--	4.0	--	5.1	--
LSD 0.10	2.2	--	3.5	--	7.2	--	3.3	--	4.3	--

Table 4. Protein at 12% moisture of hard red spring wheat varieties grown at nine locations in North Dakota, 2022.

Variety	Carrington	Casselton	Grand Forks	Langdon	Prosper	Hettinger	Mandan	Minot	Williston	State Avg.
	(%)									
AAC Brandon	13.9	14.5	16.1	15.0	16.9	13.2	12.3	14.7	13.7	14.5
AAC Starbuck	13.7	15.3	16.5	15.3	17.3	14.1	13.2	14.1	14.7	14.9
AAC Wheatland	12.9	14.8	16.3	15.5	17.1	13.1	12.0	13.8	13.9	14.4
AP Gunsmoke CL2	12.0	14.3	15.5	14.8	17.0	12.6	11.4	13.3	15.0	14.0
AP Murdock	12.1	13.4	14.0	13.7	15.2	12.7	11.4	13.0	13.4	13.2
AP Smith	12.5	14.1	15.0	14.7	15.4	13.1	12.1	13.4	14.6	13.9
Ascend-SD	12.4	14.2	16.0	14.1	16.4	13.1	10.8	12.7	13.7	13.7
Bolles	14.1	15.9	16.5	15.8	17.4	13.6	13.4	13.9	16.0	15.2
CAG-Justify	11.1	13.5	14.8	13.1	15.7	12.2	10.6	12.0	13.5	12.9
CAG-Reckless	13.0	14.3	15.6	14.3	15.6	12.7	11.3	13.8	13.7	13.8
CAG-Recoil	12.6	13.5	14.4	14.4	15.4	13.2	11.2	12.6	13.6	13.4
CP3099A	11.6	12.6	13.8	12.5	14.6	11.7	10.8	12.1	12.2	12.4
CP3188	11.2	13.0	14.1	13.0	15.1	11.9	10.7	12.0	11.8	12.5
CP3530	12.7	14.5	15.1	14.7	16.2	13.3	11.4	14.3	14.3	14.1
Dagmar	13.1	14.5	15.8	15.6	16.4	12.4	11.5	14.8	15.9	14.4
Driver	12.0	13.9	15.0	13.9	15.7	12.5	11.7	13.4	14.2	13.6
Faller	11.7	13.3	14.9	13.6	15.2	12.2	11.1	12.1	13.3	13.0
Glenn	12.5	14.9	16.0	15.0	16.9	13.9	11.8	14.6	15.4	14.6
Lanning	12.6	14.6	16.3	15.3	16.7	13.4	12.0	13.1	13.2	14.1
LCS Ascent	11.5	13.4	13.8	13.6	15.4	12.0	11.0	13.5	13.6	13.1
LCS Buster	10.9	12.0	12.9	12.5	13.1	11.6	9.7	11.5	12.0	11.8
LCS Cannon	12.4	13.5	14.8	14.6	16.3	12.4	11.5	13.8	15.8	13.9
LCS Dual	12.3	13.2	15.0	13.9	16.2	12.0	11.1	13.1	13.2	13.3
LCS Hammer AX	12.0	13.9	14.3	14.4	15.5	12.2	11.4	13.7	13.6	13.4
LCS Rebel	12.4	14.5	15.4	14.6	16.5	12.5	12.7	14.0	14.0	14.1
LCS Trigger	11.0	12.1	13.0	12.1	13.1	11.3	9.4	11.4	12.6	11.8
MN-Rothsay	12.0	13.9	14.8	14.6	15.1	12.5	11.0	13.0	13.3	13.4
MN-Torgy	13.2	14.3	15.6	14.7	15.8	12.4	11.2	13.1	13.1	13.7
MN-Washburn	12.8	13.7	15.8	14.1	16.6	12.9	11.6	14.1	13.9	13.9
MS Barracuda	13.4	14.6	15.7	15.0	17.1	12.1	11.8	14.5	14.7	14.3
MS Charger	10.2	12.3	13.9	12.5	15.1	11.1	10.6	12.7	12.1	12.3
MS Cobra	11.9	14.3	15.6	15.0	17.0	13.1	12.2	14.2	14.2	14.2
MS Ranchero	11.9	13.7	14.9	14.2	15.7	12.6	10.4	13.5	13.3	13.4
ND Frohberg	12.7	13.5	15.4	14.2	16.0	13.5	11.9	13.9	14.9	14.0
ND Heron	11.8	14.8	15.9	15.1	16.8	13.4	11.8	14.6	15.5	14.4
ND VitPro	13.0	15.1	16.1	14.8	16.5	14.4	12.3	14.1	15.1	14.6
Shelly	12.3	13.3	14.9	14.1	15.2	12.6	10.7	12.9	13.1	13.2
SK Rush	12.8	15.0	16.0	14.9	16.6	13.2	11.6	13.9	14.2	14.2
SY 611CL2	11.9	14.1	15.3	14.6	16.3	13.0	11.7	13.7	13.6	13.8
SY Ingmar	13.3	14.5	15.6	15.0	15.9	14.2	12.6	14.4	15.1	14.5
SY Longmire	13.5	14.1	15.0	15.2	15.9	12.8	12.0	13.5	14.5	14.1
SY McCloud	14.6	14.4	15.7	15.0	16.1	13.9	12.4	14.5	14.6	14.6
SY Valda	11.3	13.2	15.0	14.1	15.4	12.9	11.0	13.4	12.9	13.2
TCG-Heartland	13.5	15.0	15.8	15.4	16.5	14.3	12.0	14.2	15.4	14.7
TCG-Spitfire	12.8	13.4	14.1	13.6	14.5	13.2	11.4	12.8	13.1	13.2
TCG-Wildcat	13.3	14.0	15.4	15.2	15.5	13.7	11.6	13.9	13.9	14.0
WB9590	12.0	14.5	15.3	15.0	16.8	13.5	11.8	13.8	14.9	14.2
Mean	12.4	14.0	15.2	14.3	15.9	12.8	11.5	13.4	13.9	13.7
CV%	7.7	1.3	2.0	2.8	2.1	3.5	4.0	4.8	4.4	3.3
LSD 0.05	1.3	0.4	0.3	0.6	0.4	0.5	0.6	1.0	1.0	0.4
LSD 0.10	1.1	0.3	0.3	0.5	0.3	0.4	0.5	0.9	0.8	0.4

Table 5. Yield of organic hard red spring wheat varieties grown at two locations in North Dakota, 2020-2022.

	Carrington		Dickinson	Average
Variety	**2022**	**3 Yr.**	**2022**	**2022**
	(bu/a)			
Barlow	16.3	17.3	58.4	37.3
Bolles	16.2	16.8	48.8	32.5
Ceres	11.5	15.3	52.9	32.2
Dagmar	16.7	20.1	66.8	41.7
Dapps	17.5	15.7	54.9	36.2
Driver	19.0	--	51.9	35.4
Elgin-ND	19.6	19.9	52.8	36.2
FBC Dylan	14.6	17.5	59.2	36.9
Faller	20.5	21.0	59.9	40.2
Glenn	15.5	17.5	56.3	35.9
Lang-MN	19.1	20.3	62.1	40.6
Lanning	16.0	20.5	61.7	38.9
Linkert	19.9	--	55.2	37.5
MN Rothsay	14.8	--	--	--
MN Washburn	17.1	16.3	54.2	35.6
MN-Torgy	17.8	--	69.0	43.4
Mida	12.6	16.4	45.8	29.2
ND Frohberg	15.8	19.6	51.6	33.7
ND Heron	17.0	--	63.3	40.1
ND VitPro	17.5	16.8	62.2	39.8
Prosper	20.3	--	68.0	44.2
Red Fife	16.4	22.2	51.6	34.0
Shelly	17.2	17.5	59.6	38.4
Mean	16.9	18.3	57.5	37.3
CV%	9.6	--	14.1	--
LSD 0.05	2.7	--	11.5	--
LSD 0.10	2.2	--	9.6	--

Table 6. Quality data from 2018-2021. The Wheat Quality Index is a weighted average developed to summarize the relative milling and baking quality of lines in the trial. Data from across years are from 2018-2021 for all varieties which were tested in a minimum of two years (four locations per year) across North Dakota.

Variety	Test Weight[1]	Vitreous Kernels[2]	Wheat Protein[3]	Farinograph Absorption[4]	Flour Extraction[5]	Farinograph Stability[6]	Loaf Volume[7]	WQI RANK[8]
	lb/bu	%	12% m.b.	%	%	min	cm^3	
Bolles	61.3	80.1	16.8	65.4	64.6	22.8	980.9	1
WB9479	62.7	77.8	16.0	63.4	67.3	19.0	972.2	2
SY McCloud	63.1	75.7	15.4	67.0	67.0	11.2	978.2	3
Glenn	64.1	88.9	15.5	65.3	65.9	14.6	973.8	4
LCS Rebel	63.2	78.2	15.1	64.8	68.7	12.9	981.8	5
SY Longmire	62.4	77.2	15.1	65.1	67.5	12.4	1004.0	6
ND Frohberg	62.7	76.6	14.8	67.0	66.3	13.7	950.7	7
AAC Brandon	62.1	77.9	15.5	66.4	68.1	11.9	947.4	8
Dagmar	62.3	86.9	15.5	65.3	66.6	13.8	966.1	9
TCG-Heartland	63.1	75.6	15.5	64.3	67.9	15.0	946.5	10
ND VitPro	63.5	87.3	15.5	65.6	67.4	10.0	965.8	11
Lanning	61.4	83.3	15.4	64.3	66.4	11.3	1015.3	12
CP3530	61.7	68.8	14.7	64.8	68.3	11.3	995.4	13
SY Ingmar	62.7	78.7	15.2	63.7	67.7	13.3	974.5	14
MN-Rothsay	62.3	72.4	15.0	62.6	67.8	14.7	993.8	15
MN-Washburn	61.9	88.2	14.6	61.7	69.9	16.8	975.6	16
ND Heron	63.4	84.8	15.5	71.9	64.4	9.1	945.2	17
LCS Cannon	63.2	68.7	14.7	63.5	68.9	13.7	964.8	18
AP Murdock	61.7	62.3	14.8	65.1	67.6	13.6	949.5	19
Boost	61.4	80.6	15.2	65.7	66.8	10.2	953.3	20
WB9719	63.8	77.6	15.2	64.6	66.4	13.1	929.3	21
SY 611CL2	63.0	77.1	14.9	68.6	65.4	9.1	927.4	22
TCG-Spitfire	61.6	73.1	14.3	65.1	65.8	12.4	966.7	23
MS Ranchero	61.0	77.7	14.6	65.9	65.3	12.6	941.6	24
WB9590	62.4	76.4	15.5	63.9	67.3	13.8	915.4	25
MN-Torgy	62.5	70.3	15.1	62.9	66.2	15.3	938.4	26
TCG-Wildcat	62.9	78.4	14.9	64.5	67.3	8.9	946.9	27
Faller	61.7	69.9	14.4	64.6	68.4	10.3	931.7	28
Shelly	61.6	67.5	14.3	61.5	68.3	16.0	909.7	29
Driver	62.9	77.9	14.7	61.8	67.6	10.3	927.7	30
SY Valda	62.3	83.6	14.4	63.4	66.4	7.9	896.2	31
LCS Trigger	61.8	81.5	13.2	64.8	67.9	9.6	813.2	32
LCS Buster	60.1	68.0	13.2	58.6	68.9	15.1	864.3	33
Mean	62.0	77.6	15.0	64.4	67.1	12.6	958.7	

[1]Test weight - Expressed in pounds (lbs) per bushel. A high test weight is desirable. A 58 lb test weight is required for a grade of US No. 1.

[2]Vitreous kernels - Expressed as a percentage of seeds having a vitreous-colored endosperm. A high percentage is desirable.
US No. 1 DNS requires greater than 75% vitreous kernels.

[3]Wheat Protein - Measured by NIR at a 12% moisture basis. A high protein is desirable for baking quality.

[4]Farinograph Absorption - Measured by NIR at a 14% moisture basis. A measure of dough water absorption, expressed as percent. A high absorption is desirable.

[5]Flour Extraction - Percentage of milled flour recovered from cleaned and tempered wheat. A high flour extraction percentage is desirable.

[6]Farinograph Stability - A measure of dough strength expressed in minutes above the 500 Brabender unit line during mixing. A high stability is desirable.

[7]Loaf Volume - The volume of the pup loaf of bread, expressed in cubic centimeters. A high volume is desirable.

[8]Standardized means were used to calculate the Wheat Quality Index (WQI). The WQI is a weighted index calculated as: Test Weight (5%); Vitreous kernel (5%); Wheat Protein (10%); Flour Extraction (10%); Farinograph Absorption (23.3%); Farinograph Stability (23.3%) and Loaf Volume (23.3%). Adjusted means across locations were calculated for each trait using a mixed model. These means were standardized (mean=0 and standard deviation=1) to remove the effect of scale, which vary between traits.

Table 7. Quality data from 2021 from four locations across North Dakota. The Wheat Quality Index is a weighted average developed to summarize the relative milling and baking quality of lines in the trial. Data from 2021 are for all varieties which were tested in the 2022 trial. Data were collected from Carrington, Thompson, Hettinger, and Prosper, North Dakota.

Variety	Test Weight[1]	Vitreous Kernels[2]	Wheat Protein[3]	Farinograph Absorption[4]	Flour Extraction[5]	Farinograph Stability[6]	Loaf Volume[7]	WQI RANK[8]
	lb/bu	%	12% m.b.	%	%	min	cm^3	
CP3530	61.4	91.2	15.1	64.5	70.3	18.5	1046.1	1
MS Cobra	62.2	93.5	15.0	65.5	68.4	16.2	1064.5	2
SY Longmire	62.5	93.6	14.6	63.8	68.5	20.9	1043.9	3
SY McCloud	63.4	93.5	15.4	66.6	68.5	16.9	967.9	4
Lanning	61.6	93.6	15.1	63.5	69.3	18.3	1040.7	5
WB9479	62.9	92.7	15.9	63.2	68.1	23.1	971.2	6
Dagmar	62.4	93.7	15.3	64.8	66.8	20.5	970.1	7
MN-Washburn	62.3	94.3	14.6	61.0	70.0	25.1	999.4	8
TCG-Heartland	63.0	91.9	15.7	63.6	67.7	20.3	958.1	9
CAG-Reckless	62.5	91.0	15.0	64.5	65.8	19.5	997.2	10
LCS Rebel	63.2	94.0	15.1	63.5	68.8	18.8	961.4	11
AP Smith	61.8	90.0	14.9	62.4	66.9	22.6	1003.7	12
LCS Cannon	63.6	88.7	14.6	62.3	68.9	21.4	967.9	13
TCG Spitfire	61.3	91.7	14.6	64.7	67.0	17.1	982.0	14
Glenn	64.1	94.0	15.2	64.5	66.0	19.5	927.7	15
ND VitPro	63.3	94.2	15.5	64.8	67.0	14.5	945.1	16
Bolles	61.4	90.8	16.6	64.6	64.7	22.9	903.8	17
AP Murdock	61.5	88.1	14.8	63.6	67.9	18.2	955.9	18
SY 611CL2	63.0	93.5	14.7	67.5	65.4	14.0	948.3	19
ND Frohberg	62.7	92.4	14.8	66.1	66.0	18.9	889.7	20
MN-Rothsay	62.8	90.0	14.8	61.9	67.9	17.7	991.8	21
SY Ingmar	62.7	94.2	15.0	62.8	67.4	19.3	940.7	22
WB9590	62.7	90.6	15.2	63.5	67.3	19.1	920.1	23
MN-Torgy	62.9	92.8	14.9	61.8	67.1	20.9	961.4	24
Ascend-SD	61.4	94.2	15.0	63.1	66.2	15.0	1003.6	25
MS Ranchero	61.9	92.6	14.3	65.2	66.0	16.6	925.5	26
AP Gunsmoke CL2	61.5	92.3	15.4	61.5	67.7	18.6	945.1	27
TCG-Wildcat	62.7	93.8	14.7	63.3	67.7	12.7	945.1	28
ND Heron	63.6	93.7	15.5	71.5	63.8	12.0	886.4	29
Driver	63.1	91.3	14.4	60.6	68.8	15.0	951.6	30
Faller	61.6	89.6	14.4	64.0	68.3	14.7	870.2	31
CP3188	61.0	86.0	13.7	59.5	68.4	24.0	906.0	32
CAG-Justify	59.4	93.5	14.1	62.1	68.6	12.9	908.2	33
SY Valda	62.5	93.9	14.6	62.8	66.1	12.0	869.1	34
CP3099A	59.2	89.5	13.2	60.6	67.2	17.7	936.4	35
LCS Trigger	61.3	92.8	13.6	62.9	67.1	15.2	835.4	36
LCS Buster	60.2	85.3	13.0	56.6	69.0	20.2	834.3	37
Mean	62.0	92.1	14.8	63.3	67.5	17.9	955.6	

See footnotes below Table 6.

Acid Soil Management with Hard Red Spring Wheat

Ryan Buetow

No-till practices paired with heavy N use have lowered the soil pH on many acres in the northern Great Plains. Acid soil where the pH drops below 5.5 has an impact on nutrient availability, soil microbial activity, herbicide efficacy, stunted roots from aluminum (Al) toxicity and other plant/soil interactions. These areas can be improved from surface liming or lime incorporation; however, liming can be costly. For many producers facing this issue, especially those working rented land, there is a search for alternative options to reduce yield loss on acid ground. Research has been conducted in western North Dakota on adaptive management strategies for mitigating the symptoms of aluminum toxicity and soil acidity including variety selection, in-furrow fertilizer application and seed treatments. Variety selection showed a significant difference in yield (Table 1). Calcium in-furrow did not have an impact on yield (Table 2). Across HRS wheat varieties, a yield bump of 1.5 bushel in 2021 and 9.3 bushels in 2022 was shown from seed-placed P (0-45-0) applied at high rates (60 lb P_2O_5/ac) (Table 3). This mechanism doesn't appear to be as strong for HRS wheat as shown in similar durum trials. The data suggests use of tolerant HRS wheat varieties along with in-furrow P fertilizer can be used to alleviate symptoms of an acid soil. Ideally, producers should be applying tons of lime to bring the pH above 5.5 because the variety and fertilizer may fix the yield loss but does not fix issues with pesticide breakdown and carryover, soil microbiological activity, and nutrient tie-up, all issues caused by acid soil.

Table 1. HRSW variety across fertilizer treatments, Dickinson 2021 and 2022.

	Yield	
Variety	2021	2022
*SY Soren (susceptible check)	19.6b	47.5b
*Lanning (tolerant)	22.3a	65.4a
LSD (0.05)	1.2	3.2

*These are not the only susceptible and tolerant varieties. We continue to learn more each year about varietal tolerance of crop varieties. A truly tolerant variety will yield the same in low pH and neutral pH where susceptible varieties will go from yielding well in neutral pH to being severely stunted in acid conditions.

Table 2. Calcium fertilizer yields across other treatments, Dickinson 2021 and 2022.

	Yield	
Treatment	2021	2022
Control	21.4	54.3
Lime in furrow	20.3	56.3
Gypsum in furrow	20.8	57.4
Calcium nitrate in furrow	N/A	57.8
LSD (0.05)	ns	ns

Table 3. P fertilizer across HRSW varieties, Dickinson 2021 and 2022.

	Yield	
Treatment	2021	2022
Control	20.1b	51.8b
60 lbs additional P	21.6a	61.1a
LSD (0.05)	1.2	3.2

For more information on this and other topics, see www.ag.ndsu.edu

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