

**NEBRASKA AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEBRASKA-LINCOLN
DEPARTMENT OF AGRONOMY AND HORTICULTURE**

and

**UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D. C.**

RELEASE OF NW13493 HARD WHITE WINTER WHEAT

NW13493 is a hard white winter wheat (*Triticum aestivum* L.) cultivar developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS and released in 2020 by the developing institutions. It was released primarily for its superior adaptation to rainfed wheat production systems throughout Nebraska and for having white kernels. NW13493 will be licensed to a milling company. NW13493 genetically is a semi-dwarf wheat, containing the *RhtB1b* allele (formerly known as *Rht1*).

NW13493 is a hard white winter wheat selected from the cross derived from the cross 'SD98W175-1'/'NW03666'. The pedigree of SD98W175-1 is 'KS84273BB-10'/'KSSB110-9'/'KS831374-141B'/'YE1110'/3/'KS82W418'/'SPN' and the pedigree of NW03666 is 'N94S097KS'/'NE93459'. The cross was made in 2007. The F₁ generation was grown in the greenhouse in 2008 and the F₂ to F₃ generations were advanced using the bulk breeding method in the field at Mead, NE in 2009 to 2010. In 2011, single F₃-derived F₄ rows were planted for selection at Lincoln, NE. The F_{3.5} was evaluated as a single four row plot at Lincoln, NE and a single row at Mead, NE in 2012. NW13493 was identified in 2013 as the experimental line, NW13493, and selected for further testing. The only selection thereafter was to remove contaminant red kernels. This line seems to be broadly adapted throughout Nebraska for rainfed production systems. It was selected using both phenotypic including for its white kernels and genomic selection.

NW13493 was evaluated in Nebraska replicated yield nurseries starting in 2013, in the USDA-ARS coordinated Southern Regional Performance Nursery in 2016 and 2017 and in the University of Nebraska Fall Sown Wheat Performance Trials in 2017 to 2020. In the Nebraska Intrastate Nursery (2015 to 2020, Table 1), NW13493 performed extremely well across Nebraska in head-to-head comparisons for grain yield with the currently popularly available wheat cultivars. It was significantly or non-significantly higher yielding than all of the comparative cultivars. These data are supported by the 2016 and 2017 USDA-ARS Southern Regional Performance Nursery where NW13493 ranked 16th and 11th region-wide of the 38 and 50 entries tested in those years (data available at <http://www.ars.usda.gov/Research/docs.htm?docid=11932>). In the last three years it has been tested in the Nebraska State Variety Trials across 39 environments (Table 2, full data available at <http://cropwatch.unl.edu/web/varietytest/wheat>). NW13493 was not significantly different from all currently popular winter wheat cultivars that were tested state-wide (e.g. Ruth, Freeman, and

LCS Valiant). Based upon these data, NW13493 is adapted to all rainfed wheat production areas in NE.

Other measurements of performance from comparison trials indicate that NW13493 is moderately late in maturity (143.4 d after Jan.1, data from 14 observations in eastern NE) which is very similar to Ruth (143.8 d after Jan.1), one day later than Freeman (142.6 d after Jan.1) and two days later than LCS Valiant (141.7 d compared to NW13493 with 143.5 d after Jan.1, n=15). NW13493 is a semi-dwarf wheat cultivar and contains the *RhtB1b* (formerly *Rht1*). The mature plant height of NW13493 is similar to shorter than Ruth, Robidoux, Overland, and Scout 66. NW13493 is taller than, Freeman, LCS Valiant, Siegf, Settler CL, and Wesley (Table 1). NW13493 has moderate straw strength for a semi-dwarf wheat with little lodging reported in the years it has been tested. The winter hardiness of NW13493 is good and comparable to other winter wheat cultivars grown in Nebraska.

NW13493 is resistant to *Soilborne wheat mosaic virus* in field nurseries in Nebraska It is moderately resistant to stem rust (caused by *Puccinia graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) in field nursery tests at St. Paul, MN and moderately resistant to moderate susceptible to stripe rust (caused by *P. striiformis* Westendorp f. sp. *tritici*) in field nurseries in Nebraska. In greenhouse seedling tests, it is resistant or segregating for resistance to stem rust races QFCSC, QTHJC, MCCFC, RCRSC, RKQQC, and TMPKC, but susceptible to race TTTTF (Table 3). It is moderately resistant to leaf rust (caused by *P. triticina* Eriks,) data obtained from field observations in the Great Plains). By molecular markers, it is believed to carry the Lr37/Sr38/Yr17 translocation. NW13493 is moderately resistant to Fusarium head blight (caused by *Fusarium graminearum*, data from greenhouse and field observations in Nebraska and Kansas) and moderately susceptible to DON accumulation. NW13493 is susceptible to Hessian fly (*Mayetiola destructor* Say,). It is moderately susceptible to *Barley yellow dwarf virus*, and susceptible to *Wheat streak mosaic virus* (data obtained from the USDA-ARS Northern Regional Performance Nursery and field observations in NE).

NW13493 has high grain volume weight (Tables 1 and 2), which is similar to most high grain volume weight wheats (Ruth and Siegf) and significantly higher than Overland, LCS Valiant, Robidoux, and Settler CL (higher grain volume weight cultivars); and Freeman and Wesley, and Scout 66 (lower grain volume weight cultivars). Freeman and Overland. The milling and baking properties of NW13493 were determined for five years by the Nebraska Wheat Quality Laboratory (Table 3). In these tests, Overland an acceptable milling and baking was used for comparison. The average flour protein content of NW13493 (12.2%) was slightly higher than Overland (11.8%). The result was confirmed with data from the Nebraska State Variety Trial (Table 2). The average flour extraction on the Buhler Laboratory Mill for NW13493 (71.8%) was similar to Overland (Table 4). The flour ash content (0.41%) was similar to Overland. Dough mixing properties of NW13493 were good (mixtime peak was 7.5 minutes and mixtime tolerance was scored as 4.5 on a one to 7 scale where 7 is very tolerant) and stronger than Overland. Average baking absorption (63.4%) was similar to Overland for the corresponding years. The average loaf volume of NW13493 (938 cm³) was similar Overland. The scores for the external appearance, internal crumb grain and texture were 4.7, 4.5 and 4.4., respectively, were higher than Overland. The overall end-use quality characteristics for NW13493 (scored as 4.5, where 3 is fair, 4 is good and 6 is excellent) was higher than Overland and similar to many commonly grown wheat cultivars. NW13493 should be acceptable to the milling and baking industries. NW13493 is a white wheat and when conditions were conducive

to sprouting, NW13493 retained its high falling number indicating it does not have a preharvest sprout problem.

In positioning NW13493, based on performance data to date, it should be well adapted to most rainfed wheat production systems throughout Nebraska and in adjacent areas of the Great Plains. NW13493 is not recommended for irrigated wheat production due to its not having similar straw strength and comparable yield potential to the best available irrigated wheat cultivars (data not shown). Where adapted, NW13493 should be a new white wheat with good end use quality. NW13493 is genetically complementary to virtually all wheat cultivars grown in Nebraska.

NW13493 is an awned, tan-glumed cultivar. Its field appearance is most similar to Wesley, but can be easily separated from Wesley because Wesley has bronze chaff. After heading, the canopy is moderately closed and erect to inclined. The flag leaf is erect and twisted at the boot stage. The foliage is green with a waxy bloom on the leaf sheath, spike at anthesis, and on the leaves. The leaves are glabrous. The spike is tapering, narrow, and lax. The glume is medium and wide, and the glume shoulder is wanting and narrow. The beak is obtuse. The spike is predominantly inclined at maturity with some recurved spikes. Kernels are white colored, hard textured, and mainly ovate in shape. The kernel has no collar, a brush of short length, rounded cheeks, midsize germ, and a narrow and deep crease.

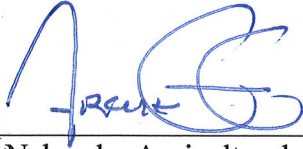
NW13493 has been uniform and stable since 2016. Less than 0.5 % of the plants were rogued from the Breeder's seed increase in 2016-19. The rogued variant plants were taller in height (5 - 15 cm) or were awnless and/or had red chaff. Up to 1% (10:1000) variant plants may be encountered in subsequent generations. As with all white wheat cultivars, there is a concern of red kernel contamination. In our fields up to 0.6% red kernels have been found and up to 2% could be encountered in subsequent generations. The Nebraska Foundation Seed Division, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583 will have foundation seed available to qualified certified seed enterprises in 2016 with the first sale of certified seed in 2021. The U.S. Department of Agriculture will not have commercial seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. NW13493 will be submitted for plant variety protection under P.L. 10577 with the certification option. Small quantities of seed for research purposes may be obtained from Dr. P. S. Baenziger and the Department of Agronomy and Horticulture, University of Nebraska-Lincoln for at least 5 years from the date of this release. In addition, a seed sample has been deposited in the USDA-ARS National Small Grains Collection, Aberdeen, ID, and this seed is freely available to interested researchers.

NW13493 was developed with partial financial support from the Nebraska Agricultural Experiment Station and the Nebraska Wheat Development, Utilization, and Marketing Board. Partial funding for P.S. Baenziger is from Hatch project NEB-22-328, USDA, NRICGP 2004-35300-1470, and 2007-51300-0375, USDA, CSREES NRICAP grant number 2006-55606-16629, USDA OREI 2007-51300-03785, AFRI/2011-68002-30029, NIFA/ 2017-67007-25931 and 2020-67013-30872 the CERES Trust Organic Research Initiative, and USDA under Agreement No. 59-0790-4-092 which is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the USDA. Cooperative investigations of the Nebraska Agric. Res. Div., Univ. of Nebraska, and USDA-ARS.

Development team: P. S. Baenziger (breeder-inventor), V. Belamkar, R. A. Graybosch, J. Boehm, Jr., D. Rose, M. Guttieri, Lan Xu, S. Wegulo, T. Regassa, A. Easterly, C. Creech, D. Santra, G Kruger, G. Hergert, R. Klein, Y. Jin, J. Kolmer, Ming-Shun Chen, Guihua Bai, J. Poland, I. S. Elbasyoni, G. Hein, and J. Bradshaw.

Acknowledgements: Critical technical support came from Greg Dorn, Mitch Montgomery, Marc Walter, and Julie Stephens. Jeff Noel and the Nebraska Foundation Seed Division used optical sorters to reduce the level of red kernel contamination in NW13493.

Approval



Director, Nebraska Agricultural
Experiment Station

1/15/2021

date

For _____
Administrator, Agricultural Research Service
United States Department of Agriculture
Washington, D. C.

date

Table 1. Head to head comparisons of NW13493 to popularly grown or new cultivars from trials in Nebraska beginning in 2015 until 2020. Data on grain yield, grain volume weight, and plant height were from trials at up to eight rainfed locations (Mead, Lincoln, Clay Center, North Platte, McCook, Grant, Sidney, and Alliance) in Nebraska in each year (total environments in the comparison is N) and not every cultivar was grown in the same trial across the state.

	Grain Yield		Grain Volume Weight			Height						
	N	Line	NW13493	Line	N	Line	NW13493					
		bu/a	lbs/bu			in						
Freeman	53	58.78	61.65	**	17	56.79	59.21	42	34.28	35	**	
LCS Valiant	56	61.77	62.26	n.s.	19	58.44	59.12	**	44	33.26	34.95	**
Ruth	53	60.34	61.65	n.s.	17	58.67	59.21	n.s.	42	35.73	35	**
Siege	56	58.39	62.26	**	19	59.43	59.12	n.s.	44	34.2	34.95	**
Robidoux	56	60.14	62.26	n.s.	18	58.69	59.41	**	44	35.42	34.95	*
Overland	44	57.08	63.68	**	14	59.13	59.67	*	37	36.87	35.64	**
Scout 66	53	43.66	61.65	**	15	57.93	59.61	**	42	40.02	35	**
Settler CL	27	51.21	62.32	**	9	58.81	60.39	**	24	36.45	37.33	*
Wesley	27	50.96	62.32	**	8	55.61	59.28	**	24	35.36	37.33	**

** Significantly different at the P=0.01 probability level.

Table 2. Grain yield by region and averaged across the state, and state average for grain volume weight, grain protein content, and plant height for Nebraska from 2018 to 2020 representing 39 location-years of data from rainfed environments.

Cultivar	South East	South Central	West Central	West	State Avg.	State Avg.	State Avg.	State Avg.	State Avg.
	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Yield (bu/a)	Bushel Weight lbs/bu	Grain Protein %	Bushel Weight lbs/bu	Plant Height (in)
	Three Year Averages								
NW13493	86.8	80.1	67	51.6	68.09	57.84	12.87	57.84	32.29
Freeman	81	73.4	66	56	67.24	55.69	12.56	55.69	31.72
Ruth	86.7	73.4	65.8	57.1	69.21	57.31	12.81	57.31	33.19
LCS Valiant	88.7	77.5	70.3	54.3	70.36	57.85	13.14	57.85	31.72
Scout 66	62.6	53.7	54.4	42.2	52.34	57.19	13.41	57.19	38.21
Turkey	62.7	59.6	55.1	41.4	52.70	57.10	14.24	57.10	38.84
Average of all entries	81.9	73.9	66.7	53.9	66.99	57.14	12.96	57.14	32.85
L.S.D. (0.05)	9.3	7.3	4.4	4.3	5.97				

† This value is the average of all the values for the traits for the entries that were in the trial and includes values for many experimental lines not shown in the table.

‡ The L.S.D. (least significant difference $p < 0.05$) was calculated from the analysis of variance using all of the values of the entries that were in the trial including many experimental lines not shown in the table.

Table 3. Seedling stem rust reaction scores of NW13493 hard white winter wheat and other check cultivars evaluated in the 2016 and 2017 Northern Regional Performance Nursery (NRPN)† at the USDA-ARS Cereal Disease Laboratory, St. Paul, MN or Kenya‡.

Nursery	Line/selection	QFCSC	QTHJC	MCCFC	RCRSC	RKQQC	TPMKC	TTTTF	Adult plant field response	
									St. Paul, MN	Kenya
2016 NRPN	Kharkof	4/2	4	4	4	4	4	4	40MSMR	30S
2016 NRPN	Scout 66	4	4	4	4	4/3/;	4	4	30MSMR	10SMS
2016 NRPN	TAM107	2	2/2-	4/2	2	2-	4/2	4/2	30MR/30SMS	20MSMR
2016 NRPN	Jagalene	2-;	22-; "Z"	2-; "Z"	22-;	2-;/;	2	2	TR	70S
2016 NRPN	NW13493	;	;1-1	;	-	-	;	31;	TR	30S
2017 NRPN	Kharkof	2+3/4	-	4	3	3+	4	4	30MS	50S
2017 NRPN	Scout 66	2+3	2+;	3	1+3	3	4	3+	30MS	40S
2017 NRPN	TAM107	2-/0;	2	2-/4	2	;1/2/3+	4;/2	2	20MR/30S	50SMS
2017 NRPN	Jagalene	;2-	-	;1-	;2	;2	2	2	0	80S
2017 NRPN	NW13493	;	;	0;	0	;1	;	4	0	60S

†Complete data set can be found at <http://www.ars.usda.gov/Research/docs.htm?docid=11932> (accessed November 23, 2020). Seedling infection type: 0 = immune response, no sign of infection, 1 = small uredinia surrounded by necrosis; 2 = small uredinia surrounded by chlorosis; 3 = moderate size uredinia without necrosis or chlorosis; 4 = large uredinia without necrosis or chlorosis; + = uredinia larger than normal; - = uredinia smaller than normal; semicolon (;) = hypersensitive chlorotic or necrotic flecks; S = seedlings with scores of 3 or higher.

‡ Adult plant infection response evaluation from a field stem rust nursery at St. Paul, MN inoculated with a composite of races QFCSC, QTHJC, RCRSC, RKQQC, MCCFC, and TPMKC; and from Njoro, Kenya with race TTKST being predominant where R=resistance, MR=moderately resistant, MS=moderately susceptible, and S=susceptible.

Table 4. Comparison of NW13493 to Overland from 2014 to 2018 for flour yield, bran score, mill type scores, mill type scores, flour protein content, ash content, Mixograph water absorption (water abs.), Mixograph mixing time (MTime), Mixograph tolerance (MTol.), loaf volume, and external appearance (Ext. score), crumb grain score, crumb texture score, and overall baking score (Overall) as determined by the Wheat Quality Laboratory at the University of Nebraska (Baenziger et al., 2001). All reported values were measured at a 140 g H₂O 1000 g⁻¹ flour basis.

Sample ID	Year	Milling			Flour		Mixograph			Baking				
		Flour Yield, %	Bran Score†	Mill Type Score†	Protein (%)	Ash (%)	Water Abs (%)	MTime (min)	Mtol.‡	Loaf Vol (cc)	Ext. Score§	Crumb Grain Score§	Crumb Texture Score§	Overall§
2014	72.6	3.5	3.5	3.5	13.5	0.357	64.8	4.4	4.0	946.3	4.6	3.5	3.5	3.9
2015	71.8	3.5	4.5	4.5	12.3	0.445	63.0	7.1	4.3	1007.5	5.5	5.5	5.3	5.4
2016	70.5	3.5	4.5	4.5	11.8	0.392	63.0	9.3	4.5	927.5	4.5	4.8	4.8	4.7
2017	73.2	4.5	4.5	4.5	11.1	0.400	62.0	6.7	4.4	910.0	4.5	4.5	4.3	4.4
2018	71.1	3.5	3.5	3.5	12.3	0.434	64.0	9.8	5.3	900.0	4.5	4.0	4.0	4.2
Mean	71.8a	3.7a	4.1	12.2a	0.41a	63.4a	7.5a	4.5a	938a	4.7a	4.5a	4.4a	4.5a	4.5a
OVERLAND (CHECK)														
2014	72.6	3.5	4.5	4.5	11.6	0.382	62.0	4.5	4.1	933.8	4.8	3.4	3.1	3.8
2015	73.0	3.5	4.5	4.5	13.2	0.438	64.5	2.8	3.4	952.5	5.0	3.1	3.1	3.8
2016	71.3	3.5	4.5	4.5	10.1	0.374	61.0	3.7	3.0	890.0	4.5	4.0	4.0	4.2
2017	71.3	4.5	4.5	4.5	11.9	0.446	63.0	4.0	4.1	912.5	4.5	5.0	4.8	4.8
2018	71.4	3.5	3.5	3.5	12.5	0.451	63.5	3.5	3.4	932.5	4.8	3.1	3.1	3.7
Mean	71.9a	3.7a	4.3	11.8a	0.42a	62.8a	3.7b	3.6b	924a	4.7a	3.7a	3.6a	3.6a	4.0a †

use a 1 to 5 scale with 5 being very good and 1 being very poor

† Scores use a 0 to 7 scale with 7 being very tolerant.

§ Scores use a 0 to 6 scale with 6 being excellent

* Means followed by the same letter are not significantly different at the p=0.05 level.