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 LCS VALIANT HARD RED WINTER WHEAT

LCS Valiant (experimental name was NE10478-1) is a hard red winter wheat (*Triticum aestivum* L.) cultivar developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS and released in 2019 by the developing institutions. It was released primarily for its superior adaptation to rainfed wheat production systems throughout Nebraska and in adjacent wheat producing states. The main interest in LCS Valiant is that it is one of the earliest flowering and maturing lines developed recently from our program. As such, it complements our later maturing lines and extends its area of adaptation into western Kansas. NE10478-1 has been licensed to Limagrain Cereal Seeds (LCS) because LCS Valiant has done well outside of Nebraska and needs a marketing partner for those regions. LCS Valiant is a semi-dwarf wheat, containing the *RhtB1b* allele (formerly known as *Rht1*).

The pedigree of NE10478-1 is that it was a selection for uniformity and grain yield from NE10478, which was derived from the cross NI03418/Camelot. The pedigree of NI03418 is W91-248/NE95544 (=MCVEY 78015/NE88521)//Thunderbird. The final cross of NE10478 was made in 2004. The F_1 generation was grown in the Yuma, AZ in 2005, and the F_2 to F_3 generations were advanced using the bulk breeding method in the field at Mead, NE in 2005-2006 to 2006-2007. In 2007-2008, single F_3-derived F_4 rows were planted for selection. There was no further selection in NE10478 other than to remove off-types thereafter. The $F_{3:5}$ was evaluated as a single four-row plot at Lincoln, NE and a single row at Mead, NE in 2008-2009. NE10478 was identified in 2009-2010 as the experimental line, NE10478, and selected for further testing in the advanced (2010-2011) and elite (2011-2015) yield trials. In the spring of 2011, 15 heads were selected from NE10478 to determine its level of uniformity. These heads were threshed and planted in the fall of 2011 as head rows and one head row was selected in 2012 and named NE10478-1. In 2012-13, seed of NE10478-1 was planted in a preliminary observation nursery in Lincoln, NE. In 2013-2014, the NE10478-1 and NE10478 were advanced to a replicated yield trial at Lincoln, NE. In the 2014-2015 growing season, NE10478-1 and NE10478 were grown in the elite yield trial (Nebraska Intrastate Nursery [NIN]) and it was determined that NE10478-1 was the more uniform and better line, hence it was tested in the elite yield trial thereafter and NE10478 was dropped from further consideration. In addition, to the Nebraska trials, it was shared with Limagrain Cereal Seeds in 2014-15 and was tested in their trials thereafter.

In the Nebraska Intrastate Nursery (NIN; 2015 to 2019, Table 1), LCS Valiant performed extremely well across Nebraska in head-to-head comparisons for grain yield with the currently available wheat cultivars. LCS Valiant was significantly higher yielding than Freeman,

Overland, Panhandle, and Goodstreak, and not significantly higher yielding than Ruth and Robidoux. Test weight of LCS Valiant was good, not significantly different from Goodstreak, Ruth, Robidoux, Overland, or Scout 66, but significantly higher than Panhandle and Freeman. LCS Valiant was also one to four days earlier and one to six inches shorter than the other cultivars (Table 1). The coleoptile length of LCS Valiant was 5.4 cm, shorter than tall winter wheat cultivars Scout 66 (6.1 cm) and Goodstreak (5.6 cm), but longer than semi-dwarf wheat lines Overland (4.6 cm), Ruth (4.8 cm), and Freeman (4.5 cm). LCS Valiant has good straw strength for a semi-dwarf wheat, similar to Freeman, Ruth, Robidoux, and Overland, but superior to Goodstreak, Panhandle, and Scout 66. The winter hardiness of LCS Valiant is good and comparable to other winter wheat cultivars grown in Nebraska.

LCS Valiant was evaluated in the USDA-ARS coordinated Southern Regional Performance Nursery as NE10478-1 in 2017 (where it ranked 9th out of 50 entries; 8th in Kansas, 12th in Colorado, 5th in Nebraska, and 11th in South Dakota) and 2018 (where it ranked 20th out of 50 entries; 8th in Kansas, 12th in Colorado, 7th in Nebraska, and 25th in South Dakota; data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932) and in the University of Nebraska Fall Sown Wheat Performance Trials in 2017, 2018 (state-wide), and 2019 (state-wide). Using the two-year averages (2018 and 2019), LCS Valiant had a grain yield of 81.0 bu/a, compared to 78.7 bu/a for Overland, 76.4 bu/a for Freeman, 76.8 bu/a for Ruth, 59.4 bu/a for Scout 66 and 61.2 bu/a for Turkey Red. Based upon these data, LCS Valiant is an early winter wheat that is adapted to all rainfed wheat production zones in NE and has performed well in adjacent states.

LCS Valiant is resistant to wheat soilborne wheat mosaic virus in field nurseries in Nebraska). It is moderately resistant to to moderately susceptible to stem rust (caused by *Puccinia graminis* Pers.: Pers. f. sp. *tritici* Eriks. & E. Henn.) in field nursery tests at St. Paul, MN and Manhattan, KS, and is resistant at the seedling stage to stem rust races: QFCSC (the main race in the USA) MCCFC, RCRSC, TMPKC, GFMNC, and QCCSM; but susceptible to stem rust races QTHJC, RKRQC, TTTTF, and races in the Ug99 race group) and moderately resistant to leaf rust (caused by *P. triticina* Eriks.) and is resistant at the seedling stage to races: TNBGJ, TNRJJ, TBBGS, TCRKG, KFBJG, MBDSD, and PBLRG; but heterogeneous or susceptible to races: MCTNB, MFJSB, and MJBGJ. It is very susceptible to stripe rust (caused by *P. striiformis* Westendorp f. sp. *tritici*) in field nurseries in Nebraska, and fungicide applications are recommended whenever this disease is present. LCS Valiant is moderately resistant or heterogeneous to Hessian fly (*Mayetiola destructor* Say). It is susceptible to wheat stem sawfly (*Cephus cintus* Norton), barley yellow dwarf virus, and wheat streak mosaic virus (data obtained from the USDA-ARS Southern Regional Performance Nursery and field observations in NE). LCS Valiant is moderately resistant to Fusarium head blight (caused by *Fusarium graminearum* Schwabe, data from greenhouse and field observations in Nebraska) similar to but slightly less resistant than Overland, but superior to most other commonly grown wheat cultivars.

The milling and baking properties of LCS Valiant were determined for four years by the Nebraska Wheat Quality Laboratory (Table 2). In these tests, Overland, a poorer milling and baking wheat, was used for comparison. The average flour protein content of LCS Valiant (12.2%) was similar to Overland (12.0%) for the corresponding years. The average flour extraction on the Buhler Laboratory Mill for LCS Valiant (73.1%) was higher than Overland (71.7 %). The flour ash content (0.41%) was similar to Overland (0.43 %). Dough mixing properties of LCS Valiant were superior (mixtime peak was 4.68 minutes and mixtime tolerance

was scored as 4.23 on a one to seven scale where seven is very tolerant) and stronger than Overland (mixtime peak of 3.48 minutes and mixtime tolerance scored as 3.48). Average baking absorption (62.9 %) was similar to Overland (63.0 %) for the corresponding year. The average loaf volume of LCS Valiant (959 cm^3) was higher than Overland (922 cm^3). The scores for the external loaf appearance, internal crumb grain and texture were 4.9, 4.0, and 4.3 which were higher than Overland (4.7, 3.8, and 3.8, respectively). The overall baking score for LCS Valiant (scored as 4.4, where 3 is fair, 4 is good and 6 is excellent) was higher than Overland (4.1) and similar to many commonly grown wheat cultivars. LCS Valiant should be acceptable to good for the milling and baking industries.

In positioning LCS Valiant, based on performance data to date, it should be well-adapted to most rainfed wheat production systems in Nebraska and in adjacent areas of the Great Plains where early, semi-dwarf wheat cultivars are preferred. However, LCS Valiant has a longer coleoptile length than many other semi-dwarf wheat cultivars, though shorter than Goodstreak (a tall wheat with a long coleoptile). LCS Valiant is not recommended for irrigated wheat production due to its not having comparable yield potential to the best available irrigated wheat cultivars (data not shown). Where adapted, LCS Valiant should be a replacement for Camelot (under rainfed production). LCS Valiant is genetically complementary to most wheat cultivars grown in Nebraska with the exception of Camelot and Ruth, as LCS Valiant and Ruth both have Camelot as the last parent.

LCS Valiant is an awned, white-glumed cultivar. Its field appearance is most similar to Wesley, but can be easily distinguished from Wesley because Wesley has bronze chaff. After heading, the canopy is moderately closed and heads are erect to inclined. The flag leaf is erect and twisted at the boot stage. The foliage is green with little waxy bloom on the leaf sheath, the spike at anthesis and on the leaves. The leaves are glaborous. The spike is tapering, and middense. The glume shoulder is oblique and medium-wide. The beak shape has an acuminate tip. The spike is predominantly inclined at maturity with some erect spikes. Kernels are red colored, hard textured, and mainly ovate in shape. The kernel has no collar, a brush of long length, rounded cheeks, large germ, and a narrow and shallow crease.

LCS Valiant has been uniform and stable since 2017. Less than 1% of the plants were rogued from the Breeder's seed increased in 2017-2019. The rogued variant plants were taller in height (5 – 10 cm) or had glume variations. Up to 1.5% of the variant plants may be encountered in subsequent generations. The Nebraska Crop Improvement Association provided technical assistance in describing the cultivar characteristics. Limagrain Cereal Seeds had foundation seed available to qualified certified seed enterprises in 2018 with the first sale of certified seed in 2019. The U.S. Department of Agriculture will not have commercial seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. LCS Valiant will be submitted for plant variety protection under P.L. 10577 with the certification option. A fee will be assessed on all certified seed sales. 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 will be deposited in the USDA-ARS National Small Grains Collection, Aberdeen, ID, and this seed is freely available to interested researchers.

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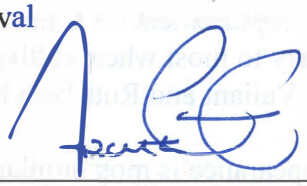
Approval



2/4/2020

Director, Nebraska Agricultural Experiment Station — date

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Acting Deputy Administrator, CPP — date
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Table 1. Head to head comparisons of LSC Valiant to popularly grown or new cultivars from trials in Nebraska beginning in 2012 until 2019. Data on anthesis date, plant height, lodging (using a 1 to 9 scale with 1 being no plants lodged and 9 being 90% or more of the plant being lodged), grain yield, and grain volume weight were from trials at up to eight rainfed locations (Mead, Lincoln, Clay Center, North Platte, McCook, Grant, Sidney, and Alliance) in Nebraska and not every cultivar was grown in the same trial across the state. Note most traits had the same number of trials (N), but test weight had different numbers of trials among the lines.

	Antheis date Julian Days		Height in		Lodging (1-9)		Yield bu/a		N	Test wt Lbs/bu	Test wt Lbs/bu	
Line	N=14		N=41		N=4		N=44			Line	Valiant	
Valiant	141.65		34.14		2.00		63.17				58.06	
Goodstreak	143.86	***	40.12	***	6.75	**	51.04	***	11	57.51	58.04	n.s.
Panhandle	143.98	***	40.05	***	5.61	**	52.22	***	11	56.77	58.24	***
Freeman	142.35	*	34.99	***	3.88	*	60.99	*	12	56.72	58.06	**
Ruth	143.60	***	36.35	***	0.75	n.s	61.93	n.s	12	58.10	58.06	n.s.
Robidoux	143.04	***	36.15	***	2.25	n.s	61.63	n.s.	12	57.99	58.06	n.s.
Overland	145.22	***	36.67	***	3.38	n.s	57.13	***	12	58.26	58.06	n.s.
Scout 66	143.33	***	40.72	***	6.63	*	44.36	***	12	57.34	57.99	n.s.

n.s., *, **, *** Not significantly different using head-to-head cultivar comparisons between LCS Valiant and the other tested cultivars at the P= 0.05 probability level, significantly different at the P=0.05 probability level, significantly different at the P=0.01 probability level, and significantly different at the P=0.001 probability level.

Table 2. Comparison of LCS Valiant to Overland from 2015 to 2018 for flour yield, flour protein content (%), ash content (%), Mixograph peak mixing time in minutes (min), Mixograph tolerance (using a score of 1 being very intolerant to 7 being very tolerant to overmixing), loaf volume (cubic centimeters, cc), and crumb grain score, crumb texture score (crumb tex.), and overall baking score (Overall) (using a 1 to 6 scaring system) 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 H_20 1000 g^{-1} flour basis.

			Milling	Flour		Mixograph		Baking					
Sample ID	Year	Nursery	Flour Yield, %	Flour Protein %	Flour Ash %	Peak Time min	Tolerance (1-7)	Water Absoprtion %	Loaf Volume cc	Bread Exterior (1-6)*	Crumb Grain (1-6)*	Crumb Texture (1-6)*	Overall (1-6)*
LCS Valiant													
	2015	NIN	74.1	14.2	0.41	3.47	4.19	65.0	1050.0	6.0	3.5	3.5	4.3
	2016	NIN	73.2	10.9	0.39	5.19	3.75	62.0	900.0	4.3	4.0	4.3	4.2
	2017	NIN	71.8	10.8	0.39	4.24	4.44	61.5	962.5	5.0	4.8	5.3	5.0
	2018	NIN	73.5	12.7	0.44	5.83	4.56	63.0	925.0	4.5	3.8	4.0	4.1
Mean			***73.1***	***12.2***	***0.41***	***4.68***	***4.23***	***62.9***	***959.4***	***4.9***	***4.0***	***4.3***	***4.4***
OVERLAND (CHECK)													
	2015	NIN	73.0	13.2	0.44	2.83	3.38	64.5	952.5	5.0	3.1	3.1	3.8
	2016	NIN	71.3	10.2	0.37	3.66	3.00	61.0	890.0	4.5	4.0	4.0	4.2
	2017	NIN	71.3	11.9	0.45	3.98	4.13	63.0	912.5	4.5	5.0	4.8	4.8
	2018	NIN	71.4	12.5	0.45	3.45	3.44	63.5	932.5	4.8	3.1	3.1	3.7
Mean			***71.7***	***12.0***	***0.43***	***3.48***	***3.48***	***63.0***	***921.9***	***4.7***	***3.8***	***3.8***	***4.1***
LSD (p<0.05)			1.79	2.85	0.06	1.59	0.81	1.07	98.4	0.41	1.45	1.49	0.90

* Excellent (6), Very Good (5), Good (4), Fair (3), Poor (2), Very Poor (1)

Baenziger, P.S., D. R. Shelton, M.J. Shipman, and R. A. Graybosch. 2001. Breeding for end-use quality: reflection on the Nebraska experience. Euphytica 119:95-100.