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 SIEGE HARD RED WINTER WHEAT

Siege (experimental name was NE12561) 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 2020 by the developing institutions. It was released primarily for its superior adaptation to rainfed wheat production systems in eastern Nebraska and possibly under similar higher management crop production practices as would be found with irrigation. NE12561 was licensed to NuPride Genetics and will be marketed as Siege Hard Red Winter Wheat. Siege genetically is a semi-dwarf wheat, containing the RhtB1b allele (formerly known as Rht1).

The pedigree of Siege is NI04420/NE00403. The pedigree of NI04420 is NE96644 (=ODESSKAYA P./CODY)//PAVON/*3 SCOUT 66 /3/WAHOO sib. The pedigree of NE00403 is PRONGHORN/ARLIN//ABILENE. The cross was made in 2006. The F_1 generation was grown in the greenhouse in 2007 and the F_2 to F_3 generations were advanced using the bulk breeding method in the field at Mead, NE in 2008 to 2009. In 2010, single F_3-derived F_4 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 2011. NE12561 was identified in 2012 as the experimental line, NE12561, and selected for further testing. There was no further selection made thereafter. This line seems to be narrowly adapted to eastern Nebraska and possibly irrigated or intensive management wheat production across Nebraska. It was selected using both phenotypic and genomic selection.

In the Nebraska Intrastate Nursery (NIN) (2014 to 2019, Table 1), Siege performed well across Nebraska in head-to-head comparisons for grain yield with the currently popular available wheat cultivars. Siege was significantly higher yielding than Goodstreak, Panhandle, Overland, and Scout 66, and not significantly lower yielding than Freeman, Ruth, and Robidoux. Test weight of Siege was good, not significantly higher than Ruth and Overland, but significantly higher than Goodstreak, Panhandle, Freeman, Robidoux, and Scout 66. Siege was two days earlier than Overland, one day earlier than Goodstreak and Panhandle and similar for anthesis date to Freeman, Ruth, Robidoux, and Scout 66. Siege was one to five inches shorter than Goodstreak, Panhandle, Ruth, Robidoux, Overland and Scout 66. It was similar in plant height to Freeman (Table 1). The coleoptile length of Siege is 4.7 cm, shorter than tall winter wheat cultivars Scout 66 (6.1 cm) and Goodstreak (5.6 cm), but similar to semi-dwarf wheat lines Overland (4.6 cm), Ruth (4.8 cm), and Freeman (4.5 cm). Siege has good straw strength for a semi-dwarf wheat, similar to Overland, but superior to Goodstreak, Panhandle, Freeman, Ruth,

Robidoux, and Scout 66. The winter hardiness of Siege is good and comparable to other winter wheat cultivars grown in Nebraska.

Siege was evaluated in the USDA-ARS coordinated Northern Regional Performance Nursery as NE12561 in 2015 (where it ranked 3rd out of 41 entries; 3rd in Nebraska, 25th in South Dakota, and 9th in North Dakota) and 2016 (where it ranked 21rd out of 32 entries; 11th in Nebraska, 27th in South Dakota, and 31th in North 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, and 2019. Using the three-year averages, Siege had a grain yield of 77.7 bu/a, compared to 76.0 bu/a for Overland, 76.7 bu/a for Freeman, 78.8 bu/a for Ruth, 56.9 bu/a for Scout 66 and 55.9 bu/a for Turkey Red. Generally, Siege is competitive in most of the rainfed production zones of Nebraska, but it performs best in eastern Nebraska (n=12 trials) when it yielded 95.8 bu/a compared to Ruth (90.4 bu/a), Freeman (89.0 bu/a), Overland (88.6 bu/a), Scout 66 (65.3 bu/a), and Turkey Red (63.2 bu/a). Siege (91.9 bu/a) is not the best irrigated wheat but does perform similarly to Robidoux (93.1 bu/a) and Wesley (94.0 bu/a) based on the three-year averages for the irrigated trials (n=3) in western Nebraska. Based upon these data, Siege is an early winter wheat that is adapted to all rainfed wheat production zones in NE but has performed especially well in eastern Nebraska and similar high yielding production systems.

Siege is resistant to wheat 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 is resistant at the seedling stage to stem rust races: QFCSC (the main race in the USA), QTHJC, MCCFC, RCRSC, RKQRC, TMPKC, TTTTF, GFMNC, QCCSM, TKTTF, TRTTF, and TTKSK (Ug99), but susceptible to variants of Ug99 races with *Sr24* virulence (TTKST and TTKTT). Stem rust reaction at the seedling stage was indicative of the presence of *Sr24*. It is moderately resistant to leaf rust (caused by *P. triticina* Eriks.) and is resistant at the seedling stage to races: TBBGS, MBDSD,TCRKG, PBLRG, and TBBGS, and but heterogeneous or susceptible to races: TNBGJ, MCTNB, KFBJG, TFBJQ, MJBJG, and TNRJ. It has the molecular marker Sr24#12 allele indicative of *Lr24/Sr24*. It exhibits dark coloration of the chaff and internodes that is often associated with presence of the adult plant resistance gene *Sr2*. It is moderately resistant to stripe rust (caused by *P. striiformis* Westendorp f. sp. *tritici*) in field nurseries in Nebraska and Kansas. Siege 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). Siege is susceptible to Fusarium head blight (caused by *Fusarium graminearum* Schwabe, data from greenhouse and field observations in Nebraska).

The milling and baking properties of Siege were determined for six 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 Siege (12.6%) was slightly higher than Overland (12.1%) for the corresponding years. The average flour extraction on the Buhler Laboratory Mill for Siege (72.5%) was slightly higher than Overland (71.9%). The flour ash content (0.40%) was similar to Overland (0.42%). Dough mixing properties of Siege were similar (mixtime peak was 3.63 minutes and mixtime tolerance was scored as 3.18 on a one to seven scale where seven is very tolerant) to Overland (mixtime peak of 3.56 minutes and mixtime tolerance scored as 3.46). Average baking absorption (63.3 %) was similar to Overland (63.0 %) for the corresponding years. The average loaf volume of Siege (961 cm^3) was higher

than Overland (918 cm^3). The scores for the exterior loaf appearance, internal crumb grain and texture were 5.1, 3.6, and 3.8 were similar to Overland (4.7, 3.7 and 3.6, respectively). The overall end-use quality characteristics for Siege (scored as 4.2, where 3 is fair, 4 is good and 6 is excellent) was slightly higher than Overland (4.0) and similar to many commonly grown wheat cultivars. Siege should be acceptable for the milling and baking industries.

In positioning Siege, based on performance data to date, it should be well-adapted in eastern Nebraska and competitive in most rainfed wheat production systems in Nebraska. Due to its straw strength it could be grown under irrigation with the understanding other cultivars have higher yield potential when well managed. Siege has a shorter coleoptile length similar to many other semi-dwarf wheat cultivars. Where adapted, Siege should be a replacement for Freeman and Overland (under rainfed production). Siege is genetically complementary to most wheat cultivars grown in Nebraska.

Siege 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. The flag leaf is erect and twisted at the boot stage. The foliage is green with a waxy bloom on the leaf sheath, the spike at anthesis and on the leaves. The leaves are glaborous. The spike is oblong (strap), and lax. The glume shoulder is rounded and medium to wide. The beak shape has an acuminate tip. At maturity, the spikes are predominantly erect with some inclined spikes. Kernels are red colored, hard textured, and mainly ovate in shape. The kernel has no collar, a brush of medium length, rounded cheeks, large germ, and a narrow and medium crease.

Siege 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 (up to 15 cm). Up to 1.0% of the variant plants may be encountered in subsequent generations. The Nebraska Crop Improvement Association provided technical assistance in describing the cultivar characteristics. The Nebraska Foundation Seed Division, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583 had foundation seed available to qualified certified seed enterprises in 2019 with the first sale of certified seed expected in 2020. The U.S. Department of Agriculture will not have commercial seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. Siege 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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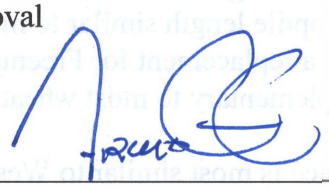
Approval



2/4/2020

Director, Nebraska Agricultural Experiment Station — date

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Acting Deputy Administrator, CPP
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Table 1. Head to head comparisons of Siege to popularly grown or new cultivars from trials in Nebraska beginning in 2013 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. Many traits had the same number of trials (N), but many had different numbers of trials among the lines.

	N	Antheis date Julian Days	Siege Antheis date Julian Days		N	Height (in)	Siege Height (in)		N	Lodging (1-9)	Siege Lodging (1-9)	
Goodstreak	22	142.33	141.14	**	55	39.93	34.39	***	5	6.13	1.50	**
Panhandle	16	144.53	143.22	**	48	39.8	34.48	***	5	6.25	1.50	***
Freeman	16	143.04	143.22	n.s.	48	34.6	34.48	n.s.	5	3.75	1.50	**
Ruth	16	144.18	143.22	n.s.	48	36.01	34.48	***	5	1.00	1.50	n.s.
Robidoux	16	143.76	143.22	n.s.	48	35.8	34.48	***	5	2.88	1.50	**
Overland	22	143.4	141.14	***	55	36.4	34.39	***	5	2.75	1.50	n.s.
Scout 66	16	143.94	143.22	n.s.	48	40.69	34.48	***	5	6.75	1.50	**

	N	Yield bu/a	Siege Yield bu/a		N	Test weight Lbs/bu	Siege Test weight Lbs/bu	
Goodstreak	56	53.28	61.08	***	15	58.68	59.7	*
Panhandle	51	53.47	60.52	***	11	56.77	58.31	***
Freeman	51	61.04	60.52	n.s.	12	56.72	58.48	***
Ruth	51	62.43	60.52	n.s.	12	58.1	58.48	n.s.
Robidoux	51	61.87	60.52	n.s.	12	57.99	58.48	*
Overland	56	58.78	61.08	*	12	58.26	58.48	n.s.
Scout 66	51	44.76	60.52	***	11	57.34	58.48	*

n.s., *, **, *** Not significantly different using head-to-head cultivar comparisons between Siege 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 Siege to Overland from 2013 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), water absorption (%), loaf volume (cubic centimeters, cc), and bread exterior score, crumb grain score, crumb texture score, 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 Values					
Sample ID	Year	Nursery	Flour Yield, %	Flour Protein %	Flour Ash %	Peak Time, min	Tolerance (1-7)	Water Absorption %	Loaf Volume cc	Bread Exterior (1-6)*	Crumb Grain (1-6)*	Crumb Texture (1-6)*	Overall (1-6)*
NE12561													
587	2013	NIN	72.4	13.5	0.39	3.29	3.44	63.9	944	5.1	4.3	4.9	4.8
635	2014	NIN	71.4	11.7	0.37	3.61	2.94	62.0	900	4.5	3.1	2.9	3.5
442	2015	NIN	73.2	13.8	0.46	2.76	1.31	65.0	1050	6.0	3.1	3.6	4.3
678	2016	NIN	71.6	12.7	0.40	4.80	2.94	64.3	900	4.5	3.3	3.4	3.7
533	2017	NIN	74.4	11.1	0.37	3.62	3.69	61.5	970	5.3	4.3	4.3	4.6
1007	2018	NIN	72.2	12.7	0.40	3.74	4.75	63.3	1004	5.5	3.5	3.6	4.2
Mean			**72.5**	**12.6**	**0.4**	**3.6**	**3.2**	**63.3**	**961.3**	**5.1**	**3.6**	**3.8**	**4.2**
OVERLAND (CHECK)													
547	2013	NIN	71.9	12.8	0.44	2.91	2.75	63.8	889	4.9	3.5	3.5	4.0
617	2014	NIN	72.6	12.0	0.38	4.51	4.06	62.0	934	4.8	3.4	3.1	3.8
434	2015	NIN	73.0	13.2	0.44	2.83	3.38	64.5	953	5.0	3.1	3.1	3.8
651	2016	NIN	71.3	10.2	0.37	3.66	3.00	61.0	890	4.5	4.0	4.0	4.2
554	2017	NIN	71.3	11.9	0.45	3.98	4.13	63.0	913	4.5	5.0	4.8	4.8
1000	2018	NIN	71.4	12.5	0.45	3.45	3.44	63.5	933	4.8	3.1	3.1	3.7
Mean			**71.9**	**12.1**	**0.4**	**3.6**	**3.5**	**63.0**	**918.3**	**4.7**	**3.7**	**3.6**	**4.0**
LSD (P < 0.05)			1.32	1.46	0.05	0.93	1.26	1.85	64.6	0.62	0.89	0.96	0.63

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

5.1,

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.