

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

**WYOMING AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF WYOMING
PLANT SCIENCE DEPARTMENT**

and

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

RELEASE OF NI04421 HARD RED WINTER WHEAT

NI04421 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 2010 by the developing institutions and the Wyoming Agricultural Experiment Station. NI04421 was released primarily for its superior performance under irrigation and rainfed conditions in western Nebraska. Additionally, in eastern Wyoming NI04421 has demonstrated superior performance under irrigated and limited irrigated conditions.

NI04421 was selected from the cross NE96644/Wahoo (sib) where the pedigree of NE96644 is Odesskaya P/ Cody//Pavon 76/*3 Scout 66. The cross was made in the spring of 1998. The F₁ generation was grown in the greenhouse in 1999 and the F₂ to F₃ generations were advanced using the bulk breeding method in the field at Mead, NE in 2000 to 2001. In 2001, single F₃-derived F₄ rows were planted for harvest and selection in 2002. Using visual selection for shorter plant height with good straw strength the row (later named NI04421) was identified as possibly having potential for rainfed and irrigated production. Harvested seed of this row was split, planted, and evaluated in 2003 in a single 4 row observation plot at Lincoln, NE and in a two row observation plot under irrigation near Gurley western NE. Based upon its performance in 2003 under irrigation, the line was advanced to the Irrigated-Rainfed Nursery which has one irrigated testing site in western NE and three rainfed sites (Hemmingford, North Platte, and Lincoln, NE) in 2004 with the belief that some irrigated wheat lines may perform well in eastern NE where there is higher rainfall and that it may be possible to develop lines that perform well under both irrigation and rainfed conditions. It was the 21st new entry in 2004 and was given the experimental line name of NI04421 where the NI recognizes that it came from our irrigation breeding program. Based upon its performance in 2004 under both irrigation and dryland production, NI04421 was continued in the Irrigated-Rainfed Nursery and in the intermediate rainfed nursery (grown in 6 environments in NE in 2005). From 2006 on, NI04421 was grown in both Irrigated-Rainfed Nursery and the Nebraska Intrastate Nursery (NIN, elite trial, 6 locations per year). Once the line was identified in 2004, the only selection thereafter was roguing to remove obvious off-types (plants that were too tall, bronze chaffed, awnless, etc.).

NI04421 was evaluated in Nebraska replicated yield nurseries from 2004 to 2009 in the irrigated rainfed nursery (Table 1), from 2007 to 2009 in the Nebraska Intrastate Nursery (Table

2), and from 2007 to 2009 in Nebraska State Variety Trials in rainfed (Table 3) and irrigated testing sites (Table 4). Across all nine Wyoming environments NI04421 averaged 85.6 bu/a, 11.1 % protein, 60.7 lbs/bu, and 24 inches in height. It exceed Wesley by 7.3 bu/a, 0.3% protein, 0.9 lb/bu, and 1 inch in height. Based upon accumulated data (Tables 1, 2, 3, and 4), NI04421 is superior in western rainfed (west of North Platte, where drought is common, see Tables 2 and 3) and irrigated production sites to many currently grown cultivars (Tables 1 and 4). It seems to have good drought tolerance and does best in irrigated environments in the drier areas (eastern WY, Table 4). Across all nine Wyoming environments NI04421 averaged 85.6 bu/a, 11.1 % protein, 60.7 lbs/bu, and 24 inches in height. It exceed Wesley by 7.3 bu/a, 0.3% protein, 0.9 lb/bu, and 1 inch in height. As opposed to some irrigated wheat cultivars that have excellent potential when conditions are optimal, NI04421 does best in high yielding irrigated environments where some stress tolerance is beneficial, but not as well in extremely high yielding irrigated environments.

Other measurements of performance from comparison trials show that NI04421 is moderately late in maturity (143.1 d after Jan.1, Table 1) which is very similar to Wesley (143.2 after Jan. 1), about 0.5 d later flowering than ‘Antelope’ (142.69 d after Jan. 1). NI04421 is a semi-dwarf wheat cultivar and contains *RhtB1b* (formerly *Rht1*, data provided by Dr. Guihua Bai). The mature plant height of NI0441 (33.3 in) is 1.6 in taller than Wesley and 2.2 in shorter than Millennium (Table 3). Using data from the 2007-2009 irrigated locations in Nebraska State Variety Trials where lodging tends to be the most severe (Table 4), NI04421 has moderate straw strength (7 % lodged), which is similar to Bond CL (7%) and less than Wesley (0%). The winter hardiness of NI04421 is good to very good and comparable to other winter wheat cultivars adapted and commonly grown in Nebraska.

NI04421 is moderately resistant to stripe rust (caused by *P. striiformis* Westendorp f. sp. *tritici*, data obtained from field observations in the Great Plains). It is moderately resistant to moderately susceptible to stem rust (caused by *Puccinia graminis* Pers.: Pers. f. sp. *tritici* Eriks & E. Henn.) in field nursery tests inoculated with a composite of stem rust races (data from the 2006 and 2007 Southern Regional Performance Nursery) and to wheat soilborne mosaic virus. In greenhouse tests, it has heterogeneous reactions (e.g. some plants are resistant and others are susceptible) to many races of stem rust (data provided by Y. Jin at the USDA Cereal Disease Laboratory). It is moderately susceptible to leaf rust (caused by *P. tritricina* Eriks, data from the 2006 and 2007 Southern Regional Performance Nursery).. NI04421 is susceptible to Hessian fly (*Mayetiola destructor* Say, data provided by Ming-Shun Chen, USDA and Kansas State University and wheat streak mosaic virus (data obtained from the Southern Regional Performance Nursery, 2006 and field observations in NE). It is susceptible to common bunt (syn. stinking smut, caused by *Tilletia* spp.) and seed treatments are recommended.

NI04421 is genetically lower for test weight in rain fed conditions (56.0lbs/bu, Table 3), but is similar to Wesley (56.0 lbs/bu) and lower than Millennium (58.3 lbs/bu). In irrigated trials, the test weight of NI04421 (60.3 lbs/bu) was greater than Bond CL (59.0 lbs/bu) and Wesley (59.8 lbs/bu), but less than TAM 111 (61.1 lbs/bu). The milling and baking properties of NI04421 were determined for four years by the Nebraska Wheat Quality Laboratory. In these tests, Wesley, an excellent milling and baking wheat, was used for comparison. The average wheat and flour protein content of NI04421 (14.6 and 11.8%) were similar to less than Wesley (14.7% and 12.6%) for the corresponding years. The slightly lower grain protein content was confirmed by the Nebraska cultivar performance trials where NI04221 had 11.6% compared to

Wesley with a value of 12.0%. The average flour extraction on the Buhler Laboratory Mill for NI04421 (72.3%) was lower than Wesley (74.1%). The flour ash content (0.435%) was lower than Wesley (0.464%). Dough mixing properties of NI04421 were strong (mixtime peak was 4.4 minutes and mixtime tolerance was scored as 4.8) which was similar to Wesley (mixtime peak of 4.2 minutes and mixtime tolerance scored as 4.7). Average baking absorption (60.8%) was slightly higher than Wesley (60.0%) for the corresponding years. The average loaf volume of NI04421 (813 ml) was lower than Wesley (861 ml). The scores for the internal crumb grain and texture ranged from 4.4 to 4.9, which are good, but were slightly less than Wesley which ranged from 4.5 to 5.3). The overall end-use quality characteristics for NI04421 are acceptable and similar to many commonly grown wheat cultivars which are well received by the milling and baking industries.

In positioning NI04421, based on performance data to date, it should be well adapted to most rainfed and irrigated wheat production systems in western Nebraska and eastern Wyoming. Where it is adapted, NI04421 should provide growers with an additional choice to Camelot, Millennium, Overland, and Wesley for their rainfed production systems and to Bond CL, TAM 111, NuDakota, and Wesley for their irrigated production systems. Because NI04421 has Wahoo as a parent, NI04421, Wahoo, and Millennium would be considered non-complementary. NI04421 is complementary to Bond CL, Settler CL, Infinity CL, TAM 111, NuDakota, Wesley, Alliance, Buckskin, Goodstreak, and Pronghorn.

NI04421 is an awned, ivory-glumed cultivar. After heading, the canopy is moderately closed and nodding. The flag leaf is recurved and twisted at the boot stage. The foliage is green with a light waxy bloom on the leaf sheath and spike at anthesis, but not on the leaves. The leaves are generally glabrous. The spike is tapering, narrow, mid-long, and middense. The glume is long and narrow, and the glume shoulder is wanting. The beak is moderately long in length with an acuminate tip. The spike is predominantly nodding at maturity with some spikes inclined. Kernels are red colored, hard textured, and mainly ovate in shape. The kernel has no to a very small collar, a mid-sized brush of medium length, rounded cheeks, large germ, and a narrow and shallow crease.

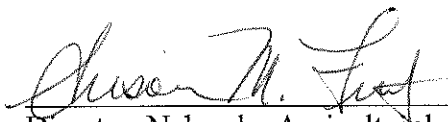
NI04421 has been uniform and stable since 2007. Less than 1 % of the plants were rogued from the Breeder's seed increase in 2007. The rogued variant plants were taller in height (8 - 15 cm), had larger beak length, or bronze chaff. Up to 2% (20:1000) variant plants may be encountered in subsequent generations. The Nebraska Crop Improvement Association provided technical assistance in describing the cultivar characteristics and accomplishing technology transfer. The Nebraska Foundation Seed Division, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583 has Foundation seed available to qualified certified seed enterprises in 2010. The U.S. Department of Agriculture will not have seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. NI04421 will be submitted for U.S. Plant Variety Protection under P. L. 10577 with the certification option. A research and development fee will be assessed on all certified seed sales. The Nebraska Foundation Seed Division, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583 will have foundation seed.

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Approval



Director, Nebraska Agricultural
Experiment Station

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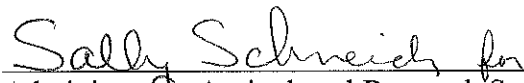
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Director, Wyoming Agricultural
Experiment Station

6-2-10

date

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Washington, D. C.

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Table 1. Data on flowering date, plant height, and grain yield from 2004 to 2009 from the Irrigated Rainfed Nursery grown at three rainfed locations (Lincoln, North Platte, and Hemingford) and one irrigated nursery (in western Nebraska) for a total of 23 environments for the lines that were in common all three years. The number in parentheses under the location is the number of environments (locations * years) when trials were harvested.

VARIETY	Flowering Date* (6)	Height (in) (18)	Lincoln bu/a (6)	N. Platte bu/a (6)	Alliance bu/a (6)	Rainfed Avg. bu/a (18)	Sidney Irr bu/a (5)	Average bu/a (23)
NI04421	143.1	33.80	78.64	73.63	68.57	73.62	101.97	79.78
WESLEY	143.2	31.92	71.22	54.86	60.69	62.26	104.98	71.54
Antelope	142.6	32.81	65.76	58.26	61.92	61.98	97.59	69.72

* Days after January 1.

Table 2. Data on grain yield from the Nebraska Intrastate Nursery from 2007 to 2009 at six locations in Nebraska for a total of 18 environments (locations * years) for the lines that were in common all three years.

Variety	Mead bu/a	Lincoln bu/a	Clay Cen. bu/a	N. Platte bu/a	Sidney bu/a	Alliance bu/a	St.Avg. bu/a	Rank
SETTLER CL	56.80	70.90	54.37	78.14	57.04	69.22	63.20	1
INE01481	57.18	77.80	49.46	80.58	61.76	55.26	62.21	2
CAMELOT	56.76	70.73	39.25	84.72	63.86	63.99	62.10	3
OVERLAND	54.27	71.51	50.96	77.71	61.75	60.57	62.00	4
NI04421	49.74	72.10	46.99	73.40	64.19	68.71	61.54	5
GOODSTREAK	62.63	68.29	38.24	79.69	61.44	64.43	61.16	6
Infinity CL	58.41	66.26	41.06	72.32	62.45	63.75	59.75	7
ALLIANCE	51.04	60.15	36.68	81.48	64.50	66.53	58.88	8
WESLEY	53.97	62.39	43.44	76.74	53.70	61.22	57.72	9
HARRY	53.88	60.23	36.96	71.97	61.58	67.36	57.33	10
MILLENNIUM	54.32	61.09	45.43	67.98	58.47	61.79	57.32	11
CHEYENNE	44.67	53.63	26.04	61.30	53.99	58.15	48.28	12
SCOUT66	43.06	46.76	21.08	57.75	52.40	53.66	44.78	13
Average	53.59	64.76	40.76	74.14	59.78	62.66	58.17	

Table 3. Data on grain yield by region, and test weight, grain protein content, lodging, and plant height from the rainfed locations in the Nebraska State Variety Trial from 2007 to 2009 in the southeast (SE; n=7), southcentral (SC, n=3), west central (WC, n=12), and western or panhandle (PH, n=14) from for the lines that were in common all three years.

Brand	Variety	SE		SC		WC		PH		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)	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Yield (bu/a)	Grain Protein (%)	Bushel Weight (lb/bu)	Grain Protein (%)	Lodging (%)	Plant Height (inches)
Three year averages															
NuPride	Camelot	58.7	46.0	70.2	54.9	57.5	57.5	57.5	57.5	12.0	57.0	12.0	4.8	34.8	
---	Infinity CL	62.2	46.3	66.0	54.0	57.1	57.1	57.1	57.1	11.7	58.2	11.7	8.6	34.3	
---	Millennium	62.0	54.0	67.5	51.5	58.8	58.8	58.8	58.8	12.0	58.3	12.0	3.9	35.9	
---	NE01481	63.2	49.3	69.9	51.9	58.6	58.6	58.6	58.6	11.5	57.1	11.5	8.0	35.3	
---	NI04421	51.6	46.3	66.4	56.5	55.2	55.2	55.2	55.2	11.6	56.0	11.6	6.5	33.3	
Husker Genetics	Overland	66.6	56.3	69.3	53.4	61.4	61.4	61.4	61.4	11.9	58.0	11.9	4.2	34.6	
---	Scout 66	41.6	33.0	53.3	46.8	43.7	43.7	43.7	43.7	12.0	53.2	12.0	24.6	38.3	
---	Settler CL	54.0	53.7	69.2	57.0	58.5	58.5	58.5	58.5	11.5	57.9	11.5	6.0	32.1	
---	Wesley	54.6	55.3	69.3	51.3	57.6	57.6	57.6	57.6	12.0	56.0	12.0	4.4	31.7	
Average all entries†		55.3	49.5	66.3	52.3	55.8	55.8	55.8	55.8	11.8	56.8	11.8	7.0	33.5	
Difference required for sign. 5%‡		6.8	8.4	5.8	3.3										

* Average over regions over years.

**Average over locations over years

† 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 LSD (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 4. Data on grain yield by location in western Nebraska/eastern Wyoming and adjacent areas in eastern Nebraska, and test weight, plant height, lodging, and protein content in the Nebraska State Variety Trial from 2006 to 2009 for a total of 14 environments for the lines that were in common all four years. The number in parentheses under the location is the number of environments (locations * years) when trials were harvested.

2006-2009

	Average Yield Bu/a (14)		Panhandle Yield Bu/a (4)		Laramie Yield Bu/a (3)		Chase Yield Bu/a (4)		Goshen Yield Bu/a (3)		Bushel weight lb/bu (14)		Plant height inches (14)		Plant lodging pct (11)		Grain protein pct (12)	
---	94.2	103.9	99.1	90.2	82.0	58.9	30.8	12.1	11.1									
---	93.8	101.7	104.8	85.7	83.2	60.0	30.1	9.8	11.0									
AGRIPRO	92.6	101.1	97.8	89.2	80.8	59.4	27.7	3.0	11.5									
---	89.7	96.7	99.1	89.2	71.5	59.5	28.5	1.1	11.7									
---	89.6	101.8	94.6	84.6	75.1	60.5	29.6	0.0	11.4									
Husker Genetics	88.5	94.1	100.4	84.9	73.9	59.9	31.6	7.8	11.4									
---	88.5	99.0	99.6	85.6	67.3	59.6	31.7	10.5	11.2									
---	87.7	98.5	91.0	85.7	72.8	59.9	31.2	9.2	11.7									
---	85.9	89.7	94.0	85.5	73.2	61.2	28.7	1.4	11.8									
---	85.7	94.5	93.8	85.9	65.6	60.5	29.5	1.1	11.5									
---	84.9	96.1	95.4	78.8	67.6	59.3	29.3	3.4	11.7									
Average	89.2	97.9	97.2	85.9	73.9	59.9	29.9	5.4	11.4									

Table 5. End-use quality data for NI04421 and Wesley (control sample) for 4 years of testing using composite samples from nurseries grown throughout Nebraska.

Sample ID	Year	Nursery	Milling			Protein (14% mb)		Ash, %			Water			Micrograph (14% mb)			Baking (14% mb)						Overall	
			Flour Yield, %	Brain Score	Short Score	Mill Type	in Wheat, %	in Flour, %	Ash, %	Abs, %	PT, min	Tol.	%TQ*	BA, min	Oxidant, ppm	Water Abs., %	MT, min	Loaf Vol. mL	SG ₁ g/mL	Exterior Score	Crumb Grain Score	Crumb Texture Score		
NI04421																								
883	2004	IRDR	71.1	3.5	3.5	3.5	13.8	12.7	0.41	60.0	4.9	5.0	157.4	0.0	62.0	7.2	920	0.172	4.5	4.5	4.5	4.5		
871	2006	NIN	72.2	3.5	3.5	1.5	15.7	11.6	0.467	60.0	4.7	5.0	171.2	0.0	60.0	7.5	818	0.172	4.3	4.3	4.8	4.6		
599	2007	NIN	71.1	1.0	4.0	3.5	13.1	12.0	0.415	60.0	3.6	4.8	171.2	0.0	62.0	6.4	800	0.181	4.5	4.5	5.0	4.8		
812	2008	NIN	73.7	3.5	3.5	4.5	15.0	11.9	0.423	60.0	4.8	4.5	157.2	0.0	60.5	6.5	820	0.176	4.8	4.5	5.0	4.8		
Mean			72.3	2.7	3.7	3.2	14.6	11.8	0.435	60.0	4.4	4.8	161.9	0.0	60.8	6.8	813	0.176	4.5	4.4	4.9	4.7		
Stdev			1.31	1.44	0.29	1.53	1.36	0.20	0.0280	0.00	0.66	0.25	8.03	0.00	1.04	0.63	10.9	0.0047	0.25	0.14	0.14	0.15		
Sterr			0.75	0.83	0.17	0.88	0.79	0.11	0.0762	0.00	0.38	0.14	4.64	0.00	0.60	0.36	6.3	0.0027	0.14	0.08	0.08	0.09		
WESLEY																								
887	2004	IRDR	73.6	3.5	3.5	4.0	15.1	13.9	0.427	60.0	5.3	5.0	173.0	0.0	62.0	8.0	1040	0.152	5	3.5	3.0	3.3		
845	2006	NIN	72.9	3.5	3.5	4.0	16.7	12.7	0.433	60.0	3.6	4.3	207.0	0.0	60.0	5.7	800	0.180	4.0	4.8	5.0	5.0		
612	2007	NIN	73.3	3.5	3.5	2.5	14.0	13.9	0.433	60.0	4.0	4.8	182.3	0.0	60.0	7.2	880	0.162	5.0	5.0	6.0	5.6		
799	2008	NIN	76.0	3.5	3.5	3.5	13.6	11.1	0.533	60.0	4.2	4.7	187.4	0.0	60.0	7.1	861	0.165	4.5	4.9	5.3	5.1		
Mean			74.1	3.5	3.5	3.3	14.7	12.6	0.464	60.0	4.2	4.7	187.4	0.0	60.0	7.1	861	0.165	4.5	4.9	5.3	5.1		
Stdev			1.68	0.00	0.00	0.76	1.68	1.37	0.0595	0.00	0.72	0.38	17.57	0.00	0.00	1.38	54.06	0.0142	0.50	0.14	0.58	0.42		
Sterr			0.97	0.00	0.00	0.44	0.97	0.79	0.0344	0.00	0.41	0.22	10.14	0.00	0.00	0.79	31.21	0.0082	0.29	0.08	0.33	0.24		

a. Super (7), Rating: Excellent (6), Very Good (5), Good (4), Fair (3), Poor (2), Very Poor (1), Fail (0)