

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

**and**

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

**RELEASE OF CAMELOT (NE01604) HARD RED WINTER WHEAT**

Camelot 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 2008 by the developing institutions. It was released primarily for its superior adaptation to rainfed wheat production systems in Nebraska and adjacent areas in the northern Great Plains. Camelot will be exclusively marketed by NuPride Genetics Network in keeping with their marketing plans.

Camelot was selected from the cross KS91H184/Arlin Sib//KS91HW29/3/NE91631/4/VBF0168 that was made in 1995. KS91H184 is an experimental line from Kansas and is selection from a random mating population involving CI17884 (Wells et al., 1982; as cited by Haley et al. 2005). The pedigree of KS91HW29 is 84WS164/2157. The pedigree of NE91631 is NE82761/Redland where the pedigree of NE82761 is CO725082 2\*/Roughrider where CO725082 was derived from IL21183/2643//Lancer/3/KS62. The line VBF0168 was originally developed by Pioneer Hi-Bred International, Inc. and given to Kansas State University, however the pedigree has been lost.

The F<sub>1</sub> generation was grown in the greenhouse in 1996 and the F<sub>2</sub> to F<sub>3</sub> generations were advanced using the bulk breeding method in the field at Mead, NE in 1997 to 1998. In 1999, single F<sub>3</sub>-derived F<sub>4</sub> rows were planted for the selection. There was no further selection thereafter. Camelot was identified in 2001 as the experimental line, NE01604, and selected for further testing.

Camelot was evaluated in Nebraska replicated yield nurseries starting in 2002, in the Northern Regional Performance Nursery in 2005 and 2006, and in Nebraska cultivar performance trials in 2005 to 2007. In the Nebraska cultivar performance trials, it is widely adapted and performs well throughout the state (Table 1) with better performance in western NE. In organic and irrigated trials, it performs well, though it tends to lodge more than popular irrigated cultivars such as Wesley and Agripro Jagalene. The average Nebraska rainfed yield of Camelot of 3855 kg ha<sup>-1</sup> (36 environments from 2005 to 2007) was greater than or similar to the yields of other popular cultivars such as Antelope (3467 kg ha<sup>-1</sup>), Infinity CL (33869 kg ha<sup>-1</sup>), Agripro Brand Jagalene (3541 kg ha<sup>-1</sup>), Millennium (3843 kg ha<sup>-1</sup>), Wahoo (3669 kg ha<sup>-1</sup>), and Wesley (3628 kg ha<sup>-1</sup>). The highest yielding cultivar in those years was NE01643 (Husker Genetics Brand Overland, 4119 kg ha<sup>-1</sup>). Though we have only two years (7 environments) of data, Camelot performed well in irrigated environments where its grain yield (6133 kg ha<sup>-1</sup>) is similar to the popular cultivars Wesley (6234 kg ha<sup>-1</sup>) and Agripro Jagalene (6187 kg ha<sup>-1</sup>). Camelot (3968 kg ha<sup>-1</sup>) has also performed well in organic production systems (2 environments) which was similar

to Wahoo (3968 kg ha<sup>-1</sup>) and slightly superior to Millennium (3833 kg ha<sup>-1</sup>) and Wesley (3800 kg ha<sup>-1</sup>). Camelot is broadly adapted to the Northern Great Plains as was evident by its performance in the Northern Regional Performance Nursery where it ranked 12<sup>th</sup> in 2005 (out of 32 lines tested) and 2006 (out of 30 lines tested) and consistently above the nursery mean (3858 kg ha<sup>-1</sup>).

Compared to the check cultivars in the Northern Regional Performance Nursery, Camelot (4222 kg ha<sup>-1</sup>) was higher yielding than Harding (3507 kg ha<sup>-1</sup>) and Nuplains (3719 kg ha<sup>-1</sup>).

Other measurements of performance from comparison trials show that Camelot is moderately late in maturity (143 d after Jan.1, data from 6 observations in eastern NE), about 1 d later flowering than 'Alliance', similar to Wesley, and 1 day earlier than NE01643 and Millennium. Camelot is a semi-dwarf wheat cultivar and contains the *RhtB1b* (formerly *Rht1*, data provided by Dr. Guihua Bai). The mature plant height of Camelot (87 cm) is 1.3 cm shorter than Millennium and 9.5 cm taller than Wesley (Table 1). Camelot has moderate straw strength (14% lodged), similar to Agripro Jagalene (12%), but less than Wesley (7%), Millennium (7%). The winter hardiness of Camelot (80%) is good to very good, slightly less than Nuplains (86%), similar to Nudakota (79%) and comparable to other winter wheat cultivars adapted and commonly grown in Nebraska.

Camelot is moderately resistant 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 (RCRS, QFCS, QTHJ, RKQQ, and TPMK). In greenhouse tests, it is moderately resistant to races QFCS, MCCF, RKQQ, TPMK and TTKS, but susceptible to race TTTT (data provided by Y. Jin at the USDA Cereal Disease Laboratory). It is moderately resistant to leaf rust (caused by *P. triticina* Eriks), stripe rust (caused by *P. striiformis* Westendorp f. sp. *tritici*, data obtained from field observations in the Great Plains), and Hessian fly (*Mayetiola destructor* Say, data provided by Ming-Shun Chen, USDA and Kansas State University). Camelot also is slightly more tolerant to Fusarium head blight (caused by *Fusarium spp.*, data obtained from misted screening nurseries in Nebraska and South Dakota) than many widely grown lines. It is moderately susceptible to wheat soilborne mosaic virus, and susceptible to barley yellow dwarf virus, and wheat streak mosaic virus (data obtained from the Northern Regional Performance Nursery, 2005-2006 and field observations in NE).

Camelot is a genetically intermediate in grain volume weight (71.9 kg hl<sup>-1</sup>), which is lower than Millennium (72.7 kg hl<sup>-1</sup>) and NE01643 (73.0 kg hl<sup>-1</sup>), similar to Scout 66 (71.6 kg hl<sup>-1</sup>), and higher than Wesley (69.7 kg hl<sup>-1</sup>). The milling and baking properties of Camelot were determined for four years by the Nebraska Wheat Quality Laboratory. In these tests, Millennium, an excellent milling and baking wheat, was used for comparison. The average wheat and flour protein content of Camelot (135 and 126 g kg<sup>-1</sup>) were similar to Millennium (139 and 123 g kg<sup>-1</sup>) for the corresponding years. The similar grain protein content was confirmed by the Nebraska cultivar performance trials where Camelot had 122 g protein kg<sup>-1</sup> compared to Millennium with a value of 120 g kg<sup>-1</sup>. The average flour extraction on the Buhler Laboratory Mill for Camelot (715 g kg<sup>-1</sup>) was slightly lower than Millennium (721 g kg<sup>-1</sup>). The flour ash content (44 g kg<sup>-1</sup>) was higher than Millennium (43 g kg<sup>-1</sup>). Dough mixing properties of Camelot were acceptable (mixtime peak was 3.7 minutes and mixtime tolerance was scored as 3.3) which was weaker than Millennium (mixtime peak of 4.0 minutes and mixtime tolerance scored as 3.4). Average baking absorption (618 H<sub>2</sub>O g kg<sup>-1</sup>) was slightly higher than Millennium (613 H<sub>2</sub>O g kg<sup>-1</sup>) for the corresponding years. The average loaf volume of Camelot (894 cm<sup>3</sup>) was lower than Millennium (915 cm<sup>3</sup>). The scores for the internal crumb grain and texture ranged from fair to very good, which was better than Millennium which ranged from fair plus to good. The overall end-use

quality characteristics for Camelot (scored as 4.3, where 5 is excellent) was better than Millennium (3.9) and similar to many commonly grown wheat cultivars. Camelot should be acceptable to the milling and baking industries.

In positioning Camelot, 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 northern Great Plains. Being a broadly adapted wheat line may explain its good agronomic performance in the Northern Regional Performance Nursery. Where it is adapted, Camelot should be a replacement for 2137, Wahoo, and Wesley (for rainfed production), though Wesley has better straw strength. Camelot is genetically complementary to Husker Genetic Brand Overland, Millennium, Infinity CL, and Antelope. It is non-complementary to Hatcher and 2137.

Camelot is an awned, ivory-glumed cultivar. Its field appearance is most similar to 2137. After heading, the canopy is moderately closed and nodding. The flag leaf is erect and twisted at the boot stage. The foliage is dark green with a light waxy bloom on the leaf sheath and spike at anthesis, but not on the leaves. The leaves are generally glabrous, but a few leaves have very short hairs parallel to the leaf veins. The spike is tapering to blocky, narrow, mid-long, and middense. The glume is long and narrow, and the glume shoulder is narrow and rounded to square. The beak is moderately long in length with an acuminate tip. The spike is predominantly inclined at maturity with some spikes nodding. Kernels are red colored, hard textured, and mainly ovate in shape. The kernel has no collar, a large brush of medium length, rounded cheeks, large germ, and a narrow and shallow crease.

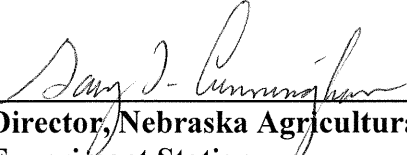
Camelot has been uniform and stable since 2005. Less than 0.5 % of the plants were rogued from the Breeder's seed increase in 2005. The rogued variant plants were taller in height (5 - 15 cm) or were awnless and/or with red chaff. Up to 1% (10:1000) variant plants may be encountered in subsequent generations. The Nebraska Crop Improvement Association and Mr. Roger Hammons 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 will have foundation seed available to qualified certified seed enterprises in 2008. The U.S. Department of Agriculture will not have seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. Camelot will be submitted for plant variety protection under P.L. 10577 with the certification option. A research and development fee will be assessed on all certified seed sales. Small quantities of seed for research purposes may be obtained from the Dr. P. S. Baenziger and the Department of Agronomy and Horticulture, University of Nebraska-Lincoln for at least 5 yr from the date of this release. Camelot was developed with partial financial support from the Nebraska Wheat Development, Utilization, and Marketing Board.

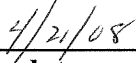
**Development team: P. S. Baenziger (breeder-inventor), R. A. Graybosch, D. D. Baltensperger, R. N. Klein, L. A. Nelson, Y. Jin, Stephen Wegulo, Ming-Shun Chen, Guihua Bai, and Lan Xu.**

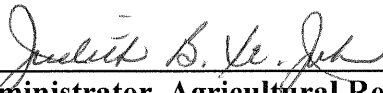
Haley, S. D. , J. S. Quick, J. J. Johnson, F. B. Peairs, J. A. Stormberger, S. R. Clayshulte, B. L. Clifford, J. B. Rudolph, B. W. Seabourn, O.K. Chung, Y. Jin, and J. Kolmer. 2005. Registration of 'Hatcher' Wheat. *Crop Sci.* 45:2654-2655.

Wells, D.G., R. S. Kota, H. S. Sandhu, W. S. Gardner, and K. F. Finney. 1982. Registration of one disomic substitution line and five translocation lines of winter wheat germplasm resistant to wheat streak mosaic virus. *Crop Sic.* 22: 1277.

**Approval**

  
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**Director, Nebraska Agricultural  
Experiment Station**

  
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**date**

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

  
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Table 1. Mean grain yield, grain volume weight, protein content, lodging and plant height in rainfed production systems by region in Nebraska and for all testing environments in Nebraska for 2005 to 2007.

Southeast Nebraska (9 environments)						
Brand	Variety	Grain Yield kg/h	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
----	Antelope(W)	4143	72.20	11.8	5.4	88.9
----	Arapahoe	4499	72.95	11.9	8.4	95.0
----	Infinity CL	4822	75.19	11.6	15.2	93.5
AGRIPRO	Jagalene	4223	73.95	11.6	7.1	87.1
----	Millennium	4667	74.70	11.7	2.6	93.7
----	NE01481	5057	74.45	11.2	5.8	93.7
----	Camelot	4795	75.44	11.9	7.4	93.0
----	NE02584	4916	77.81	11.7	3.9	87.1
----	Nuplains (W)	3820	72.33	11.5	0.9	81.5
Husker Genetics	Overland (NE01643)	5165	76.19	11.6	1.6	90.9
----	Scout66	3450	69.58	12.1	42.0	101.9
----	Wahoo	4378	70.21	11.4	10.2	91.9
----	Wesley	4391	71.95	11.7	1.0	83.6
Average all entries*		4388	73.39	11.7	8.4	90.0
LSD (0.05)**		752	3.91	0.4	17.9	6.6
Southcentral Nebraska (3 environments)						
Brand	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
----	Antelope(W)	3477	66.6	13.4	22.7	86.4
----	Arapahoe	3477	67.6	13.4	26.3	89.7
----	Infinity CL	3632	67.5	12.5	24.7	90.7
AGRIPRO	Jagalene	3497	66.7	12.5	19.3	84.6
----	Millennium	3833	68.3	12.8	12.0	94.0
----	NE01481	3410	64.3	12.4	26.7	91.4
----	Camelot	3699	66.2	13.3	25.0	92.2
----	NE02584	3948	69.2	12.8	19.7	85.6
----	Nuplains (W)	2690	66.6	13.4	11.7	83.1
Husker Genetics	Overland (NE01643)	4055	68.0	12.8	11.3	92.2
----	Scout66	2710	68.8	13.2	52.7	97.3
----	Wahoo	3410	66.3	13.0	16.7	89.7
----	Wesley	3679	64.1	12.5	11.0	83.8
Average all entries*		3490	67.2	12.9	21.3	88.5
LSD (0.05)**		612	3.3	0.5	22.1	6.5

West Central Nebraska (12 environments)

Brand	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
----	Antelope(W)	3416	72.20	12.5	8.3	79.5
----	Arapahoe	3497	71.20	12.6	8.8	87.1
----	Infinity CL	3907	72.95	12.2	9.3	85.1
AGRIPRO	Jagalene	3436	73.07	12.5	8.8	79.8
----	Millennium	3921	73.82	12.5	6.3	88.4
----	NE01481	3827	70.21	11.9	11.4	86.1
----	Camelot	3894	72.58	12.6	10.6	86.9
----	NE02584	3638	74.57	12.7	8.7	78.2
----	Nuplains (W)	2912	71.95	12.6	7.3	75.9
Husker Genetics	Overland (NE01643)	4075	73.57	12.2	7.6	85.6
----	Scout66	3080	73.82	12.5	36.9	99.1
----	Wahoo	3874	70.08	12.3	9.5	84.6
----	Wesley	3652	71.20	12.3	8.6	75.4
Average all entries*		3615	72.29	12.4	10.7	83.9
LSD (0.05)**		409	1.67	0.5	9.7	3.4

Western Nebraska (12 environments)

Brand	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
West						
----	Antelope(W)	2831	73.4	11.0		69.6
----	Arapahoe	2818	73.1	11.0		73.9
----	Infinity CL	3114	73.6	11.0		74.4
AGRIPRO	Jagalene	3006	74.8	10.5		68.6
----	Millennium	2952	73.9	11.0		75.4
----	NE01481	2919	73.4	10.6		72.9
----	Camelot	3033	73.3	10.9		74.2
	NE02584	3087	75.8	11.0		68.3
----	Nuplains (W)	2757	76.1	11.1		65.8
Husker Genetics	Overland (NE01643)	3181	74.4	10.5		74.7
----	Scout66	2724	73.9	10.6		84.8
----	Wahoo	3013	72.1	10.3		72.9
----	Wesley	2791	71.5	11.5		65.5
Average all entries *		2943	73.8	10.7		73.1
LSD (0.05)**		230	1.6	0.6		5.2

All environments (36)

	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
AGRIPRO	Antelope(W)	3467	71.11	12.2	12.1	81.1
	Arapahoe	3573	71.20	12.2	14.5	86.4
	Infinity CL	3869	72.29	11.8	16.4	85.9
	Jagalene	3541	72.14	11.8	11.7	80.0
	Millennium	3843	72.70	12.0	7.0	87.9
	NE01481	3803	70.61	11.5	14.6	86.0
	Camelot	3855	71.89	12.2	14.3	86.6
	NE02584	3897	74.35	12.1	10.8	79.8
	Nuplains (W)	3045	71.73	12.2	6.6	76.6
Husker Genetics	Overland (NE01643)	4119	73.04	11.8	6.8	85.9
	Scout66	2991	71.55	12.1	43.9	95.8
	Wahoo	3668	69.68	11.8	12.1	84.8
	Wesley	3628	69.68	12.0	6.9	77.1

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\* 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 2. Mean grain yield, gain volume weight, protein content, lodging and plant height in irrigated trials (7 environments) in Nebraska for 2006 to 2007. Note the average and the LSD are for all entries that were in the trial. As entries change from year to year, only data on representative common entries are presented.

Brand	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
----	Antelope(W)	6234	73.8	10.9	0.1	72.4
AGRIPRO	Jagalene	6187	74.9	10.8	0.8	74.7
----	Millennium	6133	74.2	10.7	4.7	81.8
----	NE01481	6100	73.7	10.5	8.6	82.6
----	Camelot	6086	75.7	11.0	6.8	74.2
----	Nuplains (W)	6026	73.4	10.7	3.1	82.0
Husker Genetics	Overland (NE01643)	5985	75.4	10.7	3.6	76.2
----	Wesley	5884	74.7	11.2	0.1	84.6
	Average all entries*	6191	74.5	10.8	2.9	77.0
	Lsd (0.05)**	N.S.	0.7	0.4	N.S.	4.3

\* 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 3. Mean grain yield, grain volume weight, protein content, lodging and plant height in organic trials (2 environments) in Nebraska for 2006 to 2007. Note the average and the LSD are for all entries that were in the trial. As entries change from year to year, only data on representative common entries are presented.

Brand	Variety	Grain Yield kg/ha	Bushel Weight kg/hl	Grain Protein %	Plant Lodging %	Plant Height cm
----	Antelope(W)	3901	70.0	11.4	18.25	78.7
----	Arapahoe	3699	69.6	12.6	19.16	85.1
----	Goodstreak	3396	71.0	12.3	20.83	95.3
----	Millennium	3833	71.7	11.4	16.68	87.6
----	Camelot	3968	68.7	12.4	16.65	88.9
----	NE02584	4035	73.3	11.8	16.04	80.0
Husker Genetics	Overland (NE01643)	4102	72.2	11.6	19.52	85.1
----	Wahoo	3968	68.2	11.2	18.40	83.8
----	Wesley	3800	68.1	11.8	17.40	76.2
	Average all entries*	3773	69.8	11.8	18.52	84.7
	LSD (0.05)**	N.S.	2.4	0.8	2.84	6.1

\* 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.