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AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

and

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AGRICULTURAL RESEARCH CENTER
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and

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CORVALLIS, OR 97801

NOTICE OF RELEASE OF CARA (wheat)

The Agricultural Research Service of the United States Department of Agriculture, the Washington Agricultural Experiment Station, and the Oregon Agricultural Experiment Station announce the release of Cara club wheat.

Cara club wheat was developed by the USDA-ARS with assistance from the Washington Agricultural Experiment Station and the Oregon Agricultural Experiment Station. Cara was tested under experimental numbers ARS97135 and ARS97135-9 and is derived from a population with the cross number 92X102. It was released in February of 2007 because of its combination of yield potential, and resistance to multiple diseases including resistance to stripe rust (causal agent *Puccinia striiformis* Westend fm sp. *Tritici*), powdery mildew (causal agent: *Erysiphe graminis* DC. f. sp. *tritici* Em. Marchal) and strawbreaker foot rot ((causal agent *Tapesia yellundae* Wallwork & Spooner = *Pseudocercospora herpotrichoides* (Fron) Deighton) with the quality characteristics desired for the club wheat market class. Cara is derived from a combination of Dr. C. J. Peterson and Dr. R.E. Allan's germplasm and was released because its diverse pedigree broadened the genetic base of the club wheat cultivars currently in production. The recommended Area of Adaptation for Cara is the intermediate to high rainfall regions of the Palouse, especially wetter areas where foot rot, stripe rust, and powdery mildew are problems. Due to its very stiff straw strength and powdery mildew resistance, Cara is the club wheat with the best performance under irrigation.

The Pedigree of Cara is: WA7752//WA6581/WA7217.

The pedigree of WA7752 (sister line to Coda or PI 594372) is Tres (CItr 17917) /Madsen (PI 511673)//Tres=Tres/WA7163 (PI 511673)//Tres. The pedigree of WA6581 (PI486428) is Omar (CItr 13072)/1834. 1834 (PI 367167) was collected in Afghanistan. The pedigree of WA7217 (PI 561035) is VPM/Moisson951//2*Barbee (CItr 17417). The cross was made by RE Allan in

1992 with the objective of incorporating resistance to multiple diseases with end use quality suitable for the club wheat export market.

The original cross was made in 1992 and advanced without selection to the F2. 60 heads were collected from the F2 bulk population and planted as F3 head rows at Spillman Farm in Pullman WA. Those head rows were selected visually for agronomic characteristics (height and maturity) and resistance to stripe rust. Head rows selected in the F3 were grown in the F4 generation in yield plots (37.5 square meters) and selected for agronomic characteristics, disease resistance, grain yield and test weight. The selected line, ARS97-135 was grown in yield plots in replicated preliminary nurseries in the F5 generation at Spillman Farm, Pullman WA. Those nurseries were evaluated for all of the above traits, plus resistance to strawbreaker foot rot and for end use quality characteristics. Evaluation for all of the above listed traits was continued throughout the rest of the development of the cultivar. 16 heads were selected from one of those preliminary nursery plots and used for purification based on visual characteristics. ARS97-135 was grown for three years at Spillman Farm, WA, Walla Walla WA, and Lind WA in replicated plots in the ARS advanced yield trials. It was then grown for three years in those locations, plus Pendleton OR, Moro OR, Hermiston OR, and Lexington OR, as well as Harrington WA in the ARS Elite yield trials. ARS97-135 was replaced by its purified selection ARS97-135-9 and grown for three more years in the WA state variety testing Shadow trials at multiple locations in WA. It was then advanced to the WA State Soft winter wheat variety extension trials in 2007.

Cara was grown in the USDA-ARS breeding trials conducted in 32 location-years in Washington, Idaho, and Oregon from 2002-2005. Performance in 9 locations in WA, Idaho and Oregon was evaluated in 2006 (Tables 1, 2, and 2a). Two tailed paired T-tests were conducted between ARS97135-9 and checks using Satterthwaite's method for pooled variances when variances are unequal. Cara was significantly later and shorter (prob. < 0.05) from Tubbs for heading date, and height, respectively. Cara has a maturity equal to Chukar and Coda, slightly earlier than Eltan and Finch. Cara has a height equal to that of Stephens, slightly less than other check cultivars. For test weight, Cara is significantly (prob. < 0.05) lower than Coda, Eltan, Finch, Madsen and Tubbs but not different than Bruehl and Chukar. Cara does not differ from check cultivars, Bruehl, Chukar, and Finch for grain yield.

The end use quality of Cara was evaluated on grain samples from a total of 33 nurseries grown over 8 years by the USDA-ARS Western Wheat Quality Laboratory.

The end use quality of Cara was determined to improve the quality of the Pacific Northwest Wheat Crop. Cara was equal to other soft club wheat check cultivars Moro, Rely Hiller, Coda, Bruehl, and Edwin in grain protein content. The grain texture of Cara was significantly (P=0.05) harder than checks when Udy, single kernel and break flour yield were all considered but the milling score of Cara was better than Coda and Rely and equal to Bruehl and Chukar. Cara was slightly better in cookie spread as compared to Bruehl and Coda and equal to Chukar.

Resistance to stripe rust was evaluated by X.Chen in greenhouse and field nurseries over four years, from 2002 to 2006. Cara was highly resistant to stripe rust in all field tests and also in all seedling tests. Because these lines were resistant to all tested races, it is not clear whether they have any adult plant (HTAP) resistance but because these lines were developed from very complex crosses, the resistance may be due to combinations of several possible genes including

Yr17 from Madsen or VPM, Yr10 from P1178383, Yr6 and Yr20 from Fielder, YrTr1 and YrTr2 from Tres. None of these genes alone provides effective resistance to the selected races which, in combination cover all possible virulences identified so far.

Cara is resistant to strawbreaker foot rot. Based on analysis with the Ep-D1b isozyme, Cara carries the Pch1 gene for foot rot resistance, derived from VPM. In 2005, lodging in the presence of severe foot rot was 1.67 as compared with 1.33 for Tubbs, 3.67 for Chukar which also carry the Pch1 gene and 9 for ARS99123, a USDA-ARS breeding line that does not carry the gene. Similarly in 2006, and 2007, lodging of Cara was rated at 1 (standing) while that of Eltan was rated as 5 in an inoculated single row nursery with three replications.

Cara has resistance to powdery mildew. Based on observations at Moses Lake, St John, and Pullman in 2005, Cara was rated 2-3 on a the 1-9 scale of Lipps and Madden where susceptible entries were rated 7-9. Resistance to powdery mildew has also been observed in the greenhouse at the WSU Wheat Plant Growth Facility. Powdery mildew races present in the Pacific Northwest field and greenhouses are unknown.

The winter hardiness of Cara has been evaluated in artificial freeze tests conducted at the WSU wheat plant growth center in two replications over three years from 2005-2007. Cara has winter hardiness equal to that of other club wheats such as Chukar, Bruehl, and Coda, not as good as Edwin and Masami but better than Stephens.

Cara is an awnless, white chaffed, club wheat with white kernels. Samples of grain sent for grading to the Federal Grain Inspection Service were rated as soft white club or western white in both 2005 and 2006. Cara has weaknesses equal to those of other club wheats. It is not as winter hardy, nor does it have test weight equal to recently released soft white winter wheat cultivars.

Seed Source, Status and Availability: 1500 heads were snapped from a purification plot grown at Spillman Farm in 2005 and given to Washington State Crop improvement Association increased as F14 head rows in 2006. Because of off-types in the 2007 breeder seed production, 1500 heads were again snapped in 2007 and grown as F16 head rows in 2008 for a second breeder seed production. Cara will be sold as Foundation, Registered and Certified seed. Plant Variety Protection will not be applied for. Small amounts (5g) of seed are available from the breeder for research purposes.

Breeding team: Kim Garland Campbell, Robert E. Allan, James Anderson, Lynn M. Little, John Pritchett, Nathan Blake, Xianming Chen, Craig Morris, Dave Wood, Doug Engle, John Burns.

Signatures:

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9/29/08
Date

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10/7/08
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10/15/08
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CARA SOFT WHITE WINTER CLUB WHEAT
USDA-ARS WHEAT GENETICS, QUALITY, PHYSIOLOGY AND DISEASE RESEARCH
UNIT,
PULLMAN WA

Cara club wheat was developed by the USDA-ARS with assistance from the Washington Agricultural Experiment Station and the Oregon Agricultural Experiment Station. Cara was released because of its combination of competitive grain yield potential, excellent club wheat end use quality, and excellent standability and resistance to stripe rust. The Pedigree of Cara is: WA7752/WA6581/WA7217

Agronomic Characteristics

- Competitive grain yield potential
(similar to Bruehl and Chukar over multiple locations)
- Very stiff straw
- Heading date slightly earlier than Bruehl, Eltan and Chukar
- Height, slightly shorter than Chukar, Bruehl, and Tubbs 06
- Winter survival equal to Chukar and Coda.
- Emergence similar to Chukar and Coda, not as good as Bruehl.
- Awnless, white chaff, white club kernels.

Highly resistant to
stripe rust

strawbreaker foot rot - carries the *Pch1* gene for foot rot resistance

Also resistant to powdery mildew

Cara does not have resistance to snow mold.

Excellent club end use quality characteristics

- Very high milling quality
- Good club baking quality
- Consistently grades club
- Test weight equal to other clubs (Chukar and Bruehl)
- Very small kernel size
(recommend increased seeding rate of 10% if seeding by population)

Breeding team: Kim Garland Campbell, Robert E. Allan, James Anderson, Lynn M. Little, John Pritchett, Nathan Blake, Xianming Chen, Craig Morris, Dave Wood, Doug Engle, John Burns.

Table 2. Agronomic performance of ARS97135 compared to checks in USDA-ARS breeding nurseries, 2002-2005.

Year	Name	Heading Date (d from J. 1)			Height (in)			Yield (bu/a)			Test Weight (lb/bu)		
		Mean	S.Err.	N	Mean	S.Err.	N	Mean	S.Err.	N	Mean	S.Err.	N
2002	A97135-9	156	4.6	12	29	3.8	17	67	19	29	55.9	1.2	19
	BRUEHL	157	5.2	12	32	3.8	17	67	19	30	56.3	1.5	20
	CHUKAR	157	4.6	12	30	3.9	17	66	18	30	56.0	1.2	20
	CODA	156	4.6	13	32	3.3	17	66	17	30	59.0	1.6	20
	ELTAN	161	4.6	8	30	3.1	13	68	14	18	59.8	0.7	8
	FINCH	157	5.8	10	31	3.4	17	71	18	30	59.8	0.6	20
	MADSEN	156	5.8	13	30	2.8	17	66	16	29	58.5	1.1	19
2003	A97135-9	155	4.0	5	33	4.9	18	67	20	18	55.4	1.8	18
	BRUEHL	152	3.5	5	36	4.3	16	71	18	16	56.1	1.5	16
	CHUKAR	155	4.6	5	34	4.8	17	66	19	16	56.0	1.6	16
	ELTAN	152	4.0	5	35	4.3	16	65	19	15	58.0	1.3	16
	FINCH	152	4.0	5	34	4.6	17	75	18	17	58.3	1.4	17
	STEPHENS	149	6.4	5	33	3.9	17	78	20	17	57.2	2.0	17
	TUBBS	150	6.4	5	35	4.0	17	73	22	17	57.4	1.5	17
2004	ARS97135-9	155	5.8	5	34	3.8	18	86	19	15	57.2	1.4	18
	BRUEHL	157	6.4	5	35	2.7	18	81	18	15	56.0	1.8	15
	CHUKAR	155	5.8	5	36	3.8	18	90	18	15	57.5	1.0	18
	FINCH	157	6.4	5	34	3.8	18	84	16	15	58.6	1.8	18
	TUBBS	150	4.6	5	35	3.1	18	86	18	15	57.4	1.3	17
2005	ARS97135-9	151	5.2	11	35	4.0	12	64	15	19	58.2	0.7	19
	CHUKAR	151	5.2	11	36	4.3	12	60	15	19	58.0	0.7	19
	TUBBS	148	4.6	11	37	3.9	12	67	14	19	57.8	0.7	19

S.Err = Standard error of the mean, based on 3 replications per location year.

N= total number of observations in each mean.