

**OREGON AGRICULTURAL EXPERIMENT STATION
OREGON STATE UNIVERSITY
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Proposed release of Full Pint spring 2-row barley

Description

Growth habit	spring
Spike type	2-row, semi-erect
Awn type	rough
Rachilla hair	long
Aleurone color	white
Disease resistance	Barley stripe rust, leaf rust, and scald

Pedigree and history

Full Pint (BCD-47) is a doubled haploid (DH) derived from a molecular marker-assisted selection program designed to pyramid multiple stripe rust resistance genes in a malting quality background. The initial parents were Orca and Harrington. We conducted one cycle of molecular marker-assisted backcrossing for the Orca stripe rust resistance QTL alleles on chromosomes 4 (4H) and 7 (5H). Orca is a stripe rust resistant two-row feed barley (Hayes et al., 2000) that was developed in the course of mapping stripe rust resistance QTL (Chen et al., 1994; Hayes et al, 1996). Harrington, the two-row North American malting quality standard, was the recurrent parent. Selected BC1 plants were crossed with D1-72, a germplasm line derived from the Shyri x Galena mapping population. Shyri is a stripe-rust resistant two-row feed barley developed by ICARDA/CIMMYT and released in Ecuador. Shyri has stripe rust resistance QTL alleles on chromosomes 2,3,5, and 6 (Toojinda et al., 2000). Galena is a proprietary two-row malting barley belonging to the Coors Brewing Company. One hundred and fifteen doubled haploids were produced from these crosses, using the *Hordeum bulbosum* technique to produce the "BCD rust resistance pyramid population" (Castro et al., 2000). "BCD" stands for "beavers conquer ducks". BCD-47 is line number 47 in this population.

Full Pint (a name approved by USDA variety naming authority) was released as a germplasm (BCD47, PI659444) along with a series of isogenic lines (the BISON) derived from BCD47/Baronesse, in 2011 (Verhoeven et al., 2011. Journal of Plant Registrations 5:135-140). Prior to the germplasm release, Full Pint had been tested as a potential malting variety in the American Malting Barley Association Pilot Scale testing program, but it was not advanced to Plant Scale. Full Pint was not released as a variety at that time based on the rationale that if it was not going to be released as an AMBA-approved malting variety there would be little demand for it as a feed barley. Higher yielding, higher stature feed varieties were, and are, available.

Agronomic performance and area of adaptation

BCD-47 was tested under both irrigated and dryland conditions in Oregon, Washington, and Idaho. It was entered in the Western Regional Spring Barley Nursery in 1999. BCD-47 is a semi-dwarf, lodging resistant, full-season selection that will perform well in irrigated environments. It is not suitable for dryland production. Agronomic performance data under plot conditions are presented in Tables 1 and 2.

Per the terms of the germplasm registration, seed has been distributed worldwide, without restriction. A local farmer, Scott Sayer (Brownsville, OR) increased seed with the goal of producing a lodging resistant, stripe rust resistant 2-row malt barley for craft brewers. Scott sold seed to other farmers. In 2013, Scott had ~ 100 acres, a farmer in central Oregon grew ~ 1 acre, and ~ 100 acres were grown in the Skagit Valley (WA) on multiple farms, in a program organized by Skagit Malting and Brewing Co. Yields of Full Pint in these commercial situations averaged 6,000 lbs/acre, the seed was plump and high test weight and the variety was resistant to lodging, stripe rust, leaf rust, and scald. Growers were satisfied and intend to replant in 2014.

Disease resistance

BCD-47 is resistant to barley stripe rust. It has been tested extensively in Mexico, South America, and the Pacific Northwest. Disease resistance data are summarized in Table 3. Our molecular analysis of the BCD population confirms that BCD-47 has the resistance QTL allele from Shyri on chromosome 5 (1H) and the resistance QTL alleles from Orca on chromosomes 4 (4H) and 7 (5H).

Malting quality

Available malting quality data for BCD-47, and its Harrington and Galena parents from the AMBA evaluation trials are presented in Tables 4 and 5. Compared to Harrington, BCD-47 has plumper and heavier grain. It is somewhat lower in extract, and higher in grain protein. It has a lower S/T ratio, higher diastatic power and alpha amylase activity, and lower wort beta glucan.

In a research project on barley contributions to beer flavor, Full Pint was used as a check variety and entered sensory assessment at Sierra Nevada Brewing (Chico, CA). The sensory panel gave it very high marks and commented on the unique and satisfying flavor. *“Full Pint is very fermentable and had a very nice extract... Full Pint wort also tasted very good, pre and post boiled. I picked up a very pleasant and strong fresh salted popcorn note. A very positive clean sweetness as well, with no harshness or astringency... The fermented Full Pint beer was clean, slightly estery, a bit tart and bready.”* This assessment sparked interest with other craft brewers.

In 2014, Scott Sayer sold Full Pint barley to Colorado Malting Company (Longmont, CO) and Briess Malting (Chilton, WI). Oskar Blues Brewery (Longmont, CO) produced all-Full Pint beers from the malt made by Colorado Malting and is keen on the flavor. Their brewmaster commented that the Full Pint malt contributed flavors to the beer he described as “salty caramel popcorn and agape nectar.” The Oskar Blues beers will go into limited national distribution. The Briess malt is destined for Sierra Nevada, New Glarus (WI) and potentially other craft brewers.

Seed availability

Full Pint seed will be available in all classes of certification (Foundation, Registered, and Certified) and Breeder's seed will be maintained (by the head row method) by the Oregon State University Barley Project.

References

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Table 1. BCD-47 compared to Baronesse and Harrington based on a summary generated in 2000. Numbers in parentheses refer to number of test environments. Data from California, Idaho, Oregon, Washington

Variety	Yield (lbs/acre)	Test weight (lbs/bu)	Height (inches)	Grain on 6/64 (%)	Lodging (%)	Heading (Julian days)
Baronesse (52)	4653	51.4	29	81	25	180
Harrington (37)	4227	50.5	32	83	30	173
BCD47 (52)	4097	51.5	24	85	16	181

Table 2. Yield and plant height of Baronesse and BCD47 across four environments, as reported by Verhoeven et al. 2011

Line	Fairfield MT	Aberdeen ID	Burley ID	Saskatoon SK, Canada	mean [†]	Aberdeen ID	Burley ID	mean [†]
	yield					height		
			kg ha ⁻¹				cm	
Baronesse	8032a [‡]	6387a	11121 a	4595 a	7524a	83.8a	88.6 a	86.4 a
BCD 47	5297c	6143a	11989 a	3388 b	6766a	64.8b	67.7 b	66.4 b
CV, %	8.7	6.3	9.1	6.4	9.5	2.9	3.5	3.3

[†] least square means from all locations

[‡] Least square means separation at p=0.05 after false discovery rate multitest adjustment. Letters indicate no significant difference between lines.

Table 3. Stripe rust severity (percent infection) on spring barley varieties. Data from Mexico

are averages of multiple observations per year. Years of testing are indicated in parentheses.

U.S. data are based on sites (number in parentheses) with significant stripe rust.

Variety	Mexico		U.S.	
	BSR (%)	Years	BSR (%)	Tests
Colter	90	(94-99)	89	(3)
Steptoe	83	(95-99)	78	(4)
Tango	20	(96-99)	3	(3)
Harrington	78	(96-99)	52	(3)
Baronesse	70	(96-99)	49	(5)
Orca	13	(91-95)	2	(4)
BCD-47	13	(96-99)	2	(2)

Table 4. Malting quality of BCD-47 compared to its malting parents, Harrington and Galena. Average of nine tests conducted in Oregon, Washington, and Idaho, 1997-1998. Malting quality data courtesy of CCRU.

Variety	Kernel Weight (mg)	Plump 6/64 (%)	Malt Extract (%)	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha- amylase (20°DU)	Beta-glucan (ppm)
Harrington	39.3	86.1	80.7	11.6	5.26	46.8	131	56.1	181
Galena	37.2	78.7	79.1	12.1	4.08	34.5	100	38.1	282
BCD-47	42.3	89.9	79.6	12.2	5.34	44.6	171	62.4	139

Table 5. Malting quality of BCD-47 compared to its malting parents, Harrington and Galena. Complete data, 1997-1998. Malting quality data courtesy of CCRU.

Variety or Selection	Location	Year	Kernel Weight (mg)	Plump 6/64 (%)	Malt Extract (%)	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)
Harrington	Pendleton	1997	43.1	96.8	82.0	10.0	5.15	52.2	108	58.3	72
	KFalls	1997	42.0	88.9	80.1	12.6	5.60	43.9	159	53.0	207
	Pullman	1997	40.7	95.6	81.4	10.8	5.49	52.7	107	53.4	267
	Moscow	1997	34.8	75.6	79.9	11.8	4.70	40.0	133	49.9	174
	Aberdeen	1997	42.6	93.0	80.5	11.3	4.93	43.5	133	60.8	227
	Pendleton	1998	30.3	58.9	82.4	9.6	5.02	55.8	104	56.5	47
	KFalls	1998	39.2	85.9	78.4	14.5	5.88	41.4	145	53.0	288
	Aberdeen	1998	41.8	94.2	81.1	12.5	5.31	44.7	157	63.5	164
	<i>average</i>		39.3	86.1	80.7	11.6	5.26	46.8	131	56.1	181
Galena	Pendleton	1997	37.9	83.8	79.7	11.6	4.58	40.6	96	42.0	138
	KFalls	1997	40.0	84.4	78.9	12.5	4.35	33.8	114	34.1	326
	Pullman	1997	38.4	94.1	80.9	11.0	4.88	45.1	82	44.1	283
	Moscow	1997	33.0	68.5	78.4	12.7	3.93	31.9	91	31.5	237
	Aberdeen	1997	39.5	86.9	78.9	11.6	4.04	34.8	102	37.3	464
	Pendleton	1998	28.2	28.1	79.0	10.2	3.76	37.3	79	35.3	64
	KFalls	1998	39.9	88.8	76.5	14.9	4.50	30.5	108	37.6	550
	Aberdeen	1998	40.6	94.7	80.5	12.3	2.62	22.0	129	42.5	197
	<i>average</i>		37.2	78.7	79.1	12.1	4.08	34.5	100	38.1	282
BCD-47	Pendleton	1997	44.3	96.4	81.1	10.3	5.42	52.0	130	67.3	105
	KFalls	1997	44.1	88.8	78.1	13.4	5.40	40.1	196	61.5	221
	Pullman	1997	40.9	93.8	80.6	11.6	5.50	49.5	140	64.3	165
	Moscow	1997	39.0	86.3	79.0	12.8	5.11	40.9	188	61.5	36
	Aberdeen	1997	42.7	92.2	79.2	12.5	5.19	42.5	170	58.3	194
	Pendleton	1998	36.7	70.6	81.2	9.9	4.62	48.1	140	56.5	6*
	KFalls	1998	47.1	96.3	77.9	14.7	6.03	40.2	186	57.6	164
	Aberdeen	1998	43.2	95.1	79.7	12.3	5.42	43.8	215	71.9	85
	<i>average</i>		42.3	89.9	79.6	12.2	5.34	44.6	171	62.4	139