

Registration of 'Lyon', a Two-Row, Spring Feed Barley

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ABSTRACT

'Lyon' (Reg. No. CV-356, PI 673045), a spring, two-row, hulled feed barley (*Hordeum vulgare* L.) cultivar developed and tested as 05WA-316.K, was released in 2013 by Washington State University (WSU). Lyon was derived from the cross 'Baronesse'/'Spaulding' and selected through single-seed descent from F₂ to F₄ and pedigree breeding methods from F₅ to F₆. Lyon was tested in field trials in Pullman, WA, and in multi-environment trials at 8 to 10 locations per year by the WSU Variety Testing Program from 2009 to 2013. In these testing sites, Lyon had a mean grain yield (5699 kg ha⁻¹) that was higher than those of check cultivars 'Bob' and Baronesse. Across 37 station years in the Western Regional Spring Barley Nursery, Lyon had an average grain yield of 5284 kg ha⁻¹, which was higher than check cultivars 'Steptoe', 'Harrington', 'AC Metcalfe', and 'CDC Kindersley'. Lyon showed head emergence significantly earlier than Baronesse, Bob, and 'Lenetah' and was 3.3 cm shorter than Bob and 6.1 cm shorter than 'Champion'. Similar to Champion and Baronesse, Lyon is moderately susceptible to stripe rust (caused by *Puccinia striiformis* f. sp. *hordei* Eriks.). Lyon is intended as a high-yielding replacement to barley feed cultivars Bob, Baronesse, and Lenetah in the dryland cropping regions of eastern Washington that receive an average precipitation of 400 mm yr⁻¹ or higher.

'LYON' (Reg No. CV-356, PI 673045) is a spring, two-row, hulled feed barley (*Hordeum vulgare* L.) cultivar released in 2013 by Washington State University (WSU). Feed barley is the most important market class of barley grown in Washington State, comprising approximately 90% of the spring barley acreage. Lyon is a high-yielding cultivar with broad adaptation to the intermediate and high rainfall zones (400–500 mm, and >500 mm annual precipitation, respectively) in the dryland production systems of eastern Washington State. Lyon was evaluated across eastern Washington as the experimental designation 05WA-316.K in the WSU Variety Testing State Uniform Nursery. Lyon was released based on its broad adaptation, yield potential in high rainfall zones, and agronomic qualities suitable for a feed barley cultivar.

Lyon is a derivation from the cross of 'Baronesse'/'Spaulding'. The parentage of Baronesse (PI 568246) is 'Mentor'/'Minerva'/'Vada' mutant/4/'Carlsberg'/'Union'/'Opavsky'/'Salle'/'Ricardo'/'Oriol'/'6153P40. Baronesse is a rough-awned feed type, two-row, spring barley developed in Germany by the Nordsdaat Company in 1988 and marketed by the U.S. Westbred, LLC since 1992. The ancestry of Spaulding (PB1-95-2R-522) is 'Vanguard'/'Imber'/'Zephyr'/'3'/'Heavyweight'/'4'/'VD403582 developed by Plant Breeders 1 (Idaho) and the Genetic Marketing Group (Washington) and released in 2005. Baronesse is a barley cultivar with stable yields, high test weight, and good straw strength that has been widely grown in dryland cropping systems of Washington State. Spaulding is optimally adapted to irrigated systems in Idaho, and it has high test weight, below-average protein, and consistently plump kernels. Lyon shows the potential to equal or exceed the yields of all currently grown cultivars in the higher rainfall zones and would be an important contribution to Washington barley production. Lyon is named in honor of Steve Lyon, a grain farmer, mentor, and long-time researcher with Washington State University. Lyon will be released as a

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Abbreviations: IT, infection type; WRSBN, Western Regional Spring Barley Nursery; WSU, Washington State University.

nonexclusive, public barley cultivar intended specifically for the feed market class.

Methods

Parentage, Breeding History, and Line Selection

Lyon was developed using single-seed descent in a greenhouse facility followed by pedigree line development in nonirrigated headrows and plots at Spillman Agronomy Farm in Pullman, WA. The cross between Baroness and Spaulding (designated X03026) that produced Lyon occurred in July 2003. F₁ seed was grown in square pots (0.15 m by 0.15 m) in the greenhouses at WSU at daytime temperatures of 22°C and nighttime temperatures of 16°C. Subsequent F_{2,3} and F_{3,4} seed was produced under the same conditions. F₂ seed was harvested and planted in 72 cell flats. The resulting F₃ heads were individually harvested, and one seed per head from 300 heads was randomly selected and planted in cones as F₄ seed. Heads were then selected from the segregating population based on early maturity, short straw length, and desirable head type and size. These heads were individually threshed and planted as separate 1.5-m headrows at Spillman Farm in Pullman.

Evaluation in Replicated Yield Trials

A total of 94 rows were harvested from the initial Baroness/Spaulding cross and were planted in single 1.4-m by 6-m plots with 18-cm row spacing at a seeding rate of 108 kg ha⁻¹ (dimensions and seeding density remained the same for all subsequent testing) in a nonreplicated field trial with repeating check cultivars. On the basis of yield and agronomic data, Lyon (05WA-316.K) was selected for further analysis in replicated advanced yield trials at Spillman Farm from 2007 to 2009.

Lyon was evaluated in the WSU Variety Testing Program at 8 to 11 locations from 2009 to 2013. Each location represented one of the three major precipitation zones found in eastern Washington, including low, intermediate, and high rainfall zone designations (annual precipitation <400, 400–500, and >500 mm, respectively). Lyon was also evaluated in the USDA–ARS Western Regional Spring Barley Nursery (WRSBN) from 2010 to 2012.

Seed yield evaluations were based on grain harvested from 7.4-m² plots. The percentage of plump kernels was evaluated by calculating the percentage by weight of the kernels that did not pass through a 0.24-cm by 1.9-cm sieve. All statistical analyses were performed using Agrobases Generation II SQL version 36.5.1 (Agromix Software, 2004). Analysis of variance for yield, test weight, plump kernels, heading date, height, protein, and lodging was performed across locations within years, and combined analysis was performed across location-years using entries common to all trials from 2007 to 2013. Genotypes and locations were treated as fixed effects. Mean comparisons of traits using a protected LSD ($P < 0.05$) test were made to identify significant differences between genotypes.

Seed Purification and Increase

In 2013, a 1.5-m by 18-m increase strip was sown at the Spillman Farm for examination of segregating types. Approximately 2000 single heads were randomly selected from

the F₈ strip, individually threshed, and planted as headrows by the Washington State Crop Improvement Association. Rows that appeared uniform and clean were subsequently harvested and bulked, creating F₉ breeder seed.

Characteristics

Agronomic Performance and Yield

Comparisons of Lyon to other barley cultivars currently grown in Washington and the Pacific Northwest region were done with emphasis on ‘Champion’ (WestBred), ‘Lenetah’ (Obert et al., 2008a; University of Idaho), Baroness (WestBred), ‘Harrington’ (Harvey and Rosnagel, 1984; University of Saskatchewan), and ‘Bob’ (Ullrich et al., 2003; WSU). These cultivars are widely grown and adapted in the Washington growing areas representing the majority of acres planted.

Grain yield, plant height, and heading date were evaluated from 2009 to 2013 in the WSU Variety Testing yield trials at approximately 10 locations per year. Of these, three locations, designated Fairfield, Farmington, and Pullman, are considered high-rainfall zones in eastern Washington, with a mean annual precipitation of approximately 500 to 600 mm. From 2009 to 2013, across 13 location-years, Lyon had significantly higher yields than Baroness and Bob and similar grain yield to Lenetah and Champion (Table 1).

In the WSU Variety Testing trials from 2009 to 2013, the plant height of Lyon was similar to that of Baroness and shorter than those of Bob, Champion, and Lenetah (Table 1). When tested from 2007 to 2013 in Pullman, WA, over 10 location-year tests, Lyon was taller than ‘Merese’, shorter than Champion and Harrington, and similar to Baroness (Table 2). Lyon had an earlier heading date than Baroness, Bob, and Lenetah (Table 1).

Lyon was included (as 05WA-316.K) in the WRSBN at 13 locations in 2010, 10 locations in 2011, and 14 locations in 2012. When summarized across locations and years, Lyon had a mean yield of 5284 kg ha⁻¹, a mean heading date of 182.7 d from 1 January, and a mean plant height of 29 cm (Table 3).

Test Weight, Plump Kernels, and Protein Content

When tested from 2007 to 2013 in Pullman, WA, over 10 location-years, Lyon had test weights similar to Baroness and

Table 1. Grain yield, plant height, and heading date (days from planting) of barley cultivars Lyon, Baroness, Bob, Champion, and Lenetah, from Washington State University Variety Testing yield trials in high rainfall (>500 mm) locations (Fairfield, Farmington, and Pullman) in Washington State (13 location-years), 2009–2013.

Cultivar	Grain yield	Plant height	Protein	Heading date
	kg ha ⁻¹	cm	%	d from planting
Lyon	5699.4	78.0	11.7	62.1
Baroness	5227.8	77.5	12.1	64.0
Bob	5082.8	81.3	12.4	63.1
Champion	5571.0	84.1	11.7	62.3
Lenetah	5557.5	80.8	11.8	64.8
CV (%)	11.2	6.1	1.8	1.4
LSD (0.05)	250.8	2.0	0.4	0.7

Table 2. Test weight, grain protein, plump kernels, and plant height of barley cultivar Lyon and check cultivars in Pullman, WA (10 location-years), 2007–2013.

Cultivar	Test weight	Grain protein	Plump kernels	Plant height
	kg m ⁻³	%	%	cm
Lyon	659.4	10.6	88.9	83.0
Baronesse	664.2	11.1	86.4	83.9
Harrington	655.5	11.3	88.3	88.5
Meresse	725.3	13.2	76.7	77.2
Champion	676.5	11.7	91.3	89.3
CV	1.8	4.98	5.4	5.5
LSD (<i>P</i> = 0.05)	6.5	0.33	2.6	2.5

Harrington, and lower than Champion and Meresse. Lyon has higher percentage plump kernels than Meresse but similar to Baronesse, Harrington, and Champion. Meresse is a hulless food barley with typically high test weights, low percentage plump kernels, and elevated β-glucan content (Table 2) (Rey et al., 2009). In the trials, Lyon showed grain protein content slightly lower than Baronesse, Harrington, Meresse, and Champion in Pullman from 2007 to 2013 (Table 2) and protein content similar to Champion, Lenetah, and Baronesse, and lower than Bob (Table 1). Lyon had a test weight of 660.7 kg m⁻³, 84.6% plump kernels, and 13.0% protein when averaged across locations and years in the WRSBN (Table 3).

Stripe Rust Evaluations

Lyon was evaluated for resistance to barley stripe rust (caused by *Puccinia striiformis* Westend. f. sp. *hordei* Eriks.) in fields under natural infection in various nurseries from 2007 to 2012. In 2010, Lyon had an intermediate reaction similar to Baronesse, with an infection type (IT) rating of 5 on a scale of 0 to 8, when tested in the WSU Barley Variety Trial Nursery and the National Stripe Rust Nursery in Mount Vernon, WA. Disease severity in Lyon (20%) was much lower than that of the susceptible check ‘Step toe’ (90%), lower than those of Baronesse (40%), Champion (60%), and Lenetah (30%), but higher than that of Bob (5%). The stripe rust disease severity levels at the Pullman sites were inadequate for resistance evaluation.

In 2011, Lyon was tested in the WSU Barley Variety Trial Nursery and the National Stripe Rust Nursery at Pullman and Mt. Vernon. Other named cultivars tested included ‘Bentley’, ‘Morex’ (Rasmusson and Wilcoxson, 1979), Spaulding, Step toe (Muir and Nilan, 1973), ‘Radiant’ (von Wettstein et al., 2004), and ‘Tetonia’ (Obert et al., 2008b). Stripe rust was generally low and not uniform at the testing locations. At Spillman Farm in Pullman, Lyon had an IT of 8, similar to Baronesse, Bentley, Champion, Meresse, Radiant, Spaulding, Tetonia, and Step toe, and a severity rating of 30%, similar to Spaulding, but higher than Bob, Baronesse, and Champion (Table 4). In Mt. Vernon, Lyon was rated with a 0.0 IT and 0.0% severity at both stem elongation and milk stages. This was similar to Bob and Baronesse, and lower than Champion, which had a rating of IT

Table 3. Grain yield, test weight, heading date, plant height, percentage plump kernels, and percentage protein across multiple location-years (LY) from in the Western Regional Spring Barley Nursery, 2009–2012.

Cultivar	Grain yield		Test weight		Heading date		Plant height		Plump kernels		Protein	
	kg ha ⁻¹	LY	kg m ⁻³	LY	From 1 Jan.	LY	cm	LY	%	LY	%	LY
Lyon	5284	37	660.7	31	182.7	29	74.3	29	84.6	30	13.0	8
Step toe	5188	53	614.9	43	180.5	41	78.4	43	89.2	40	11.0	13
Baronesse	5525	53	670.3	43	185.1	41	74.0	43	87.8	40	12.1	13
Harrington	4810	53	653.3	43	185.1	41	77.7	43	87.5	40	12.2	13
AC Metcalfe	4768	53	658.5	43	184.6	41	80.2	43	87.2	40	12.7	13
CDC Kindersley	4594	24	657.6	20	184.0	17	75.0	16	82.9	21	13.0	6
Nursery mean	4850		648.27		182.44		77.25		84.63		12.48	
Check mean	5073		649.25		183.84		77.56		87.91		12.00	

Table 4. Stripe rust evaluations, including infection type (IT) and percentage infection, in 2011 and 2012 at two locations, Pullman and Mt. Vernon, WA. Dates of evaluation are presented with the growth stage of the barley plant (stem elongation, flowering, milk, and soft dough).

Cultivar	Pullman				Mount Vernon							
	25 July 2011		10 July 2012		27 June 2011		15 July 2011		20 June 2012		19 July 2012	
	Soft dough		Flowering		Stem elongation		Milk		Stem elongation		Milk	
	IT	%	IT	%	IT	%	IT	%	IT	%	IT	%
Baronesse	8	5	0	0	0	0	0	0	5	10	0	0
Bentley	8	10	0	0	8	5	3	2	8	20	8	5
Bob	2	1	0	0	0	0	0	0	0	0	0	0
Champion	8	15	0	0	8	20	8	20	0	0	0	0
Lyon	8	30	8	5	0	0	0	0	5	20	0	0
Meresse	8	5	0	0	0	0	0	0	5	20	0	0
Morex	na	na	8	30	na	na	na	na	5	30	8	5
Radiant	8	1	0	0	0	0	0	0	0	0	8	10
Spaulding	8	30	na	na	0	0	0	0	na	na	na	na
Tetonia	8	20	na	na	0	0	0	0	na	na	na	na
Step toe	8	20	na	na	0	0	8	5	na	na	na	na

8 and 20% severity at both the stem elongation and the milk stages (Table 4).

In 2012, Lyon was tested in the WSU Barley Variety Trial Nursery and the National Stripe Rust Nursery at Pullman and Mt. Vernon. Stripe rust was low and not uniform in all locations. In Pullman, Lyon had an IT of 8 similar to Morex, but its severity was generally lower than that of Morex (Table 4). During stem elongation stage in Mt. Vernon, Lyon had an IT of 5, similar to Meresse, Baronesse, and Morex, lower than Bentley (IT 8), and higher than Bob and Champion. During the milk stage at Mt. Vernon, Lyon had an IT rating and severity of 0.0 for each, which was lower than Bentley, Morex, and Radiant, and similar to Baronesse, Bob, and Champion (Table 4).

Availability

Foundation seed will be available from the Washington State Crop Improvement Association in 2015. Small quantities may be obtained from the corresponding author for up to five years. Lyon is currently being considered for PVP status. Lyon has been deposited in the National Plant Germplasm System and will be available for distribution after five years from the date of this publication.

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