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‘Burgundy Lace’ Ornamental Hazelnut

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Burgundy Lace is a new ornamental hazelnut (*Corylus avellana*) cultivar. It was released by the Oregon Agricultural Experiment Station in Apr. 2015. ‘Burgundy Lace’ combines the deeply dissected leaves of the cutleaf hazelnut with red leaf color and resistance to eastern filbert blight (EFB) incited by *Anisogramma anomala*. The tree has an upright-spreading growth habit that should be easy to manage in a landscape. The nuts are edible, although the size is smaller and yields lower than that in cultivars planted for nut production.

Origin

‘Burgundy Lace’, tested as OSU 954.076, resulted from a cross of OSU 562.034 × OSU 562.062 (Fig. 1) made in 1998 to create a new ornamental cultivar. The original cutleaf hazelnut is known as *C. avellana* f. *heterophylla*, for which the form names *laciniata*, *urticifolia*, *quercifolia*, and *incisa pinnatifida* are also used (Kasapligil, 1972; Rehder, 1949). Until now, the cutleaf form appears to be represented by a single clone that was first described as *C. urticifolia* by Noisette in 1825 (Rehder, 1949) and was mentioned by (Goeschke, 1887) as ‘Geschlitztblättrige Waldnuss’. Its leaves are slightly smaller, more deeply lobed, and more sharply toothed than those of standard European cultivars. The cutleaf trait is recessive and controlled by a single locus (Mehlenbacher and Smith, 1995). OSU 562.034 is from a cross of ‘Cutleaf’ × VR6-28 and OSU 562.062 is from a cross of ‘Cutleaf’ × ‘Redleaf #3’. OSU 562.034 and VR6-28 carry a dominant allele from ‘Gasaway’ for a very high level of resistance to EFB (Mehlenbacher et al., 1991) incited by *A. anomala*. OSU 562.062 and ‘Redleaf #3’ carry a dominant allele for leaf anthocyanin in the heterozygous state. ‘Redleaf #3’ is an open-pollinated seedling of ‘Barcelona’; the pollen parent is believed to be the redleaf ‘Rode Zeller’ (syn. ‘Rote Zellernuss’), which was described by Beijerinck (1950). Hybrid seeds from the controlled cross were harvested in Aug. 1998, stratified, and the resulting seedlings grown in a glasshouse during the summer of 1999 using standard practices (Thompson et al., 1996). Seedlings that combined red leaf color and the cutleaf trait were preferred, and 38 of the 40 seedlings planted in the field in Oct. 1999 combined these two traits. The designation OSU 954.076 indicates the row and tree location of the original seedling. A single nut was observed on the original seedling in Sept. 2002 and a light crop was observed in Sept. 2003, but the nuts were not harvested. A light crop was again observed in 2004 and the nuts were harvested by hand, dried, and evaluated. Nuts were observed in subsequent years (2005–12) on the original seedling tree but were not harvested.

OSU 954.076 was propagated by tie-off layerage of the suckers of the original seedling in late June starting in 2005. The rooted layers from this first propagation were lined out in a nursery row the year after layerage, and two trees were planted in the guard row of a replicated yield trial in Spring 2007. The rooted layers from the second propagation (in 2006) were lined out in a nursery row in 2007 and one tree was planted in the guard row of a replicated yield trial in Spring 2008. The trials were located at the Smith Horticulture Research Farm in Corvallis, OR. Trees in the trial and guard rows were observed in the third to the seventh leaf. In 2013 and 2014, growers and nursery representatives were shown trees of OSU 954.076 and asked to comment on its suitability as a landscape plant. These comments supplemented the notes recorded by the hazelnut breeding program and led to its release as ‘Burgundy Lace’.

Description

Descriptions are based on plants 5–7 years old growing in the field. Descriptions of color for plant parts are based on comparison with the Royal Horticultural Society Color Chart, 1966 Edition (Royal Horticultural Society, 1966). Young leaves, upper and lower surfaces, are purple (RHS 187A). Leaves of ‘Burgundy Lace’ near the shoot terminals retain their purplish-red color in late summer (Fig. 2). Fully expanded leaves are light purple (RHS 183B) in spring and summer, but the color of older leaf blades fades to green (RHS 137A) as they age, and veins on the bottoms of the leaves remain purple (RHS 182B). In the fall, the leaf color changes to yellow, as do leaves of nut cultivars, although the veins on the lower leaf surface retain a slight purple color (RHS 182B). Average leaf length is ≈12 cm and average leaf width is ≈10 cm. The leaves are deeply serrated, as are those of ‘Cutleaf’ (Figs. 2 and 4). Catkin color before elongation is RHS 176B and female inflorescence style color is RHS 183B. Catkins and vegetative buds retain their dark purple color in late summer, fall, and winter.

Tree sizes in the trials and guard rows were estimated by measuring trunk diameters 30 cm above the soil line at the end of the seventh growing season, from which trunk cross-sectional area was calculated. Trees of ‘Burgundy Lace’ are moderately vigorous, similar in size to ‘Jefferson’ (Tables 1 and 3) whose size, in previous trials, was ≈70% of that of ‘Barcelona’. The upright-spreading growth habit of ‘Burgundy Lace’ trees (Fig. 3) should be easy to manage in a landscape setting. ‘Burgundy Lace’ and all selections of

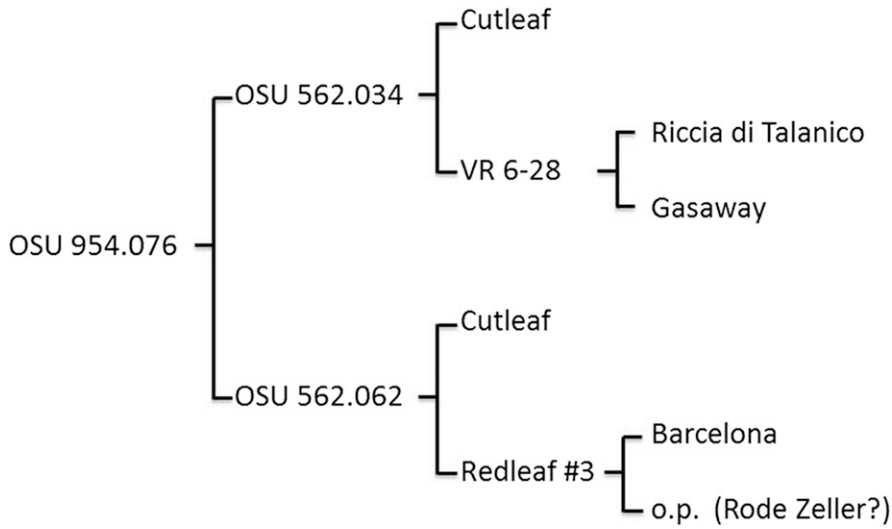

Fig. 1. Pedigree of ‘Burgundy Lace’ ornamental hazelnut.

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Fig. 2. Leaves and twigs of 'Burgundy Lace' hazelnut in early June.

C. avellana naturally sucker from the base. These suckers need to be regularly removed if a tree form is desired.

Most nuts of 'Burgundy Lace' are borne in clusters of two, in husks about half as long as the nuts (Fig. 4). The nuts are slightly long and compressed. The husks open as they dry and ≈98% of the nuts fall free of the husk at maturity. The shells of mature nuts are medium brown in color (RHS 166C) and have pubescence at the apical end. The harvest date is estimated to be 3 d before that of 'Barcelona' based on notes recorded at the time of hand-harvest in the two trials. In the 2007 trial, total nut yield per tree averaged 10.04 kg for 'Burgundy Lace', which is less than that of the other four cultivars (Table 1). Nut yield efficiency for 'Burgundy Lace' (0.122 kg·cm^{-2}), which adjusts for differences in tree size, was similar to that of 'Felix' (0.133 kg·cm^{-2}) and lower than that of 'Jefferson', 'Santiam', and 'McDonald'. In the 2008 trial, total nut yield per tree was 11.39 kg for 'Burgundy Lace', which is more than that of 'Eta' (7.78 kg) but less than that of the other 13 genotypes (Table 3). Nut yield efficiency for 'Burgundy Lace' (0.134 kg·cm^{-2}) was similar to that of the pollinizer 'Theta', higher than that of 'Eta', and lower than that of 'Jefferson' and the other cultivars

Table 1. Nut yield, trunk cross-sectional area (TCA), yield efficiency, and bud mite ratings of hazelnut cultivars in a trial planted in 2007, including two trees of Burgundy Lace in a guard row.

		Yield per tree (kg)								
Cultivar	No. of trees	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Total	TCA^z (cm^2)	YE^y (kg·cm^{-2})	Bud mite rating^x
Felix	4	0.06	1.04	2.91	7.93	4.95	16.88	128.4	0.133	2.0
Jefferson	4	0.55	1.97	5.63	4.60	10.25	22.99	77.5	0.299	1.2
McDonald	4	0.15	1.10	4.85	7.38	7.95	21.43	87.6	0.245	1.8
Santiam	4	0.20	1.11	4.09	5.46	6.83	17.68	66.8	0.267	2.2
Burgundy Lace	2	0.09	0.56	2.29	2.87	4.24	10.04	82.2	0.122	3.0
LSD 0.05		0.21	0.43	0.54	2.04	1.18	2.45	13.48	0.029	0.2

^{z}TCA calculated from trunk diameters measured in late fall at the end of the seventh season 30 cm above the soil line.
^{y}Yield efficiency = total nut yield/TCA.
^{x}Bud mite susceptibility rated on a scale of 1 (no blasted buds) to 5 (many blasted buds).
LSD = least significant difference.

Table 2. Nut and kernel weight, kernel percentage, ratings for fiber and pellicle removal, and frequency of nut and kernel defects in hazelnut cultivars in a trial planted in 2007, including two trees of Burgundy Lace in a guard row^z.

							Frequency (%)^z							
Cultivar	No. of trees	Nut wt (g)	Kernel wt (g)	Kernel percentage	Fiber^y	Pellicle removal^x	Good	Blanks	Brown stain	Moldy	Shrivel	Poor fill	Doubles	Black tips
Felix	4	2.71	1.37	50.8	3.0	2.2	88.9	4.2	0.2	2.1	0.4	2.9	0.3	1.1
Jefferson	4	3.76	1.67	44.5	3.0	4.3	80.1	4.3	0.3	5.7	0.4	8.9	0.6	0.6
McDonald	4	2.62	1.37	52.3	2.6	3.3	83.5	5.1	0.1	2.1	4.5	4.5	0.1	0.3
Santiam	4	2.28	1.15	50.6	3.0	4.2	68.8	2.8	0.1	17.3	1.8	9.6	0.1	0.1
Burgundy Lace	2	1.72	0.76	44.1	2.8	6.6	87.5	6.8	0.0	0.5	0.3	4.8	0.0	0.3
LSD (0.05)		0.22	0.40	1.0	0.1	0.4	3.5	2.5	0.3	2.3	1.0	2.5	0.4	0.5

^{z}Values are means for years 4–7.
^{y}Amount of fiber on the pellicle was rated from 1 (none) to 4 (much).
^{x}Pellicle removal (blanching) was rated from 1 (complete pellicle removal) to 7 (no pellicle removal).
LSD = least significant difference.

Table 3. Nut yield, trunk cross-sectional area (TCA), yield efficiency, and bud mite ratings of hazelnut cultivars in two trials planted in 2008, including one tree of Burgundy Lace in a guard row.

		Nut yield per tree (kg)								
Cultivar	No. trees	2010	2011	2012	2013	2014	Total	TCA^z (cm^2)	YE^y (kg·cm^{-2})	Bud mite rating^x
EFB-resistant cultivars										
Eta	4	0.06	0.67	1.69	1.87	3.50	7.78	77.9	0.100	2.0
Gamma	4	0.15	0.78	3.31	5.13	8.24	17.62	97.6	0.181	2.9
Jefferson	4	0.22	2.65	4.79	5.88	8.57	22.11	75.9	0.292	1.2
Theta	4	0.04	1.24	4.00	4.91	4.56	14.75	101.7	0.149	1.6
Yamhill	4	0.22	2.83	4.79	6.81	8.70	23.35	73.7	0.318	1.1
Burgundy Lace	1	0.02	1.48	2.27	3.11	4.51	11.39	84.9	0.134	3.1
LSD (0.05)		0.11	0.52	0.95	1.24	1.55	3.30	14.4	0.038	0.4
EFB-susceptible cultivars in an adjacent trial										
Barcelona	3	0.20	1.65	4.67	5.36	8.31	20.19	125.80	0.161	1.0
Clark	3	0.48	3.42	1.87	6.13	6.32	18.22	72.50	0.251	3.0
Lewis	3	0.37	3.35	2.21	7.64	6.83	20.41	80.00	0.255	2.7
Sacajawea	3	0.05	0.86	4.25	6.86	9.06	21.07	99.10	0.214	1.1
LSD (0.05)		0.19	0.58	0.87	0.94	1.57	2.81	16.70	0.028	0.4

^{z}TCA calculated from trunk diameters measured in late fall at the end of the seventh season.
^{y}Yield efficiency = total nut yield/TCA.
^{x}Susceptibility to bud mite (primarily *Phytoptus avellanae* Nal.) was rated on trees of each cultivar on a scale of 1 (no blasted buds) to 5 (many blasted buds). Shown are mean ratings for 5 years (2010–14).
LSD = least significant difference; EFB = eastern filbert blight.

Fig. 3. Tree of 'Burgundy Lace' hazelnut in early June.

Fig. 4. Twigs, leaves, nuts, and husks of 'Barcelona' (left), 'Cutleaf' (center), and 'Burgundy Lace' (right) hazelnuts in early August.

in the trial. Although 'Burgundy Lace' would not be planted for nut production, its nuts show a very low frequency of defects (Tables 2 and 4). In the 2007 trial, nut weight was 1.72 g and kernel percentage was 44.1%, the latter being similar to 'Barcelona' (typically 43% to 44%). The amount of fiber on the pellicle was rated on a scale of 1 (no fiber) to 4 (heavy fiber). The rating for 'Burgundy Lace' (2.8) was similar to that of 'Jefferson' (3.0) and indicates a moderate amount of fiber. Kernel blanching, or ease with which the pellicle can be removed with dry heat followed by rubbing, was rated on a scale of 1 (complete pellicle removal) to 7 (no pellicle removal). The rating for 'Burgundy Lace' (6.6) indicates that very little of the pellicle is removed by dry heat. Very few moldy kernels were observed in 'Burgundy Lace' (0.5%), in striking contrast to 'Santiam' (17.3%) (Table 2). The results from the second trial (Table 4) were nearly identical: nut weight 1.71 g, kernel percentage 44%, fiber rating 2.8, and blanching rating 6.6, with 87.5% good nuts and very few defects. The kernels, raw or roasted, are not attractive.

The number of catkins was rated in the 2007 trial simultaneously with bud mite ratings on a scale of 1 (no catkins) to 5 (many catkins). Catkin ratings for 'Burgundy Lace' (3.7) and 'Jefferson' (3.7) were intermediate, and less than the ratings for 'McDonald' (4.2), 'Santiam' (4.1), and 'Felix' (3.9). Hazelnuts flower in midwinter, with few other plants. Catkins elongate in mid to late winter in response to warm temperatures, and because of their small size, 'Burgundy Lace' catkins would not constitute an attractive display in the garden. The catkins are purple (RHS 176B), but the pollen is yellow.

Incompatibility and Pollinizers

'Burgundy Lace' has incompatibility alleles S_6 and S_{20} as determined by fluorescence microscopy. Both alleles are expressed in the females, but only S_6 is expressed in the pollen because of dominance. The trees set a moderate number of catkins. The catkins are abnormal and small, slightly larger than those of 'Cutleaf', and shed little pollen. For practical purposes, 'Burgundy Lace' is male-sterile, although collection of a handful of catkins can give a trace of pollen.

Time of female receptivity and catkin elongation were observed weekly for 4 months in each in two winters, starting in Dec. 2012 and 2013. Female flower receptivity of 'Burgundy Lace' is late, ≈4 weeks later than 'Barcelona' and 1 week earlier than 'Cutleaf'. Time of catkin elongation of 'Burgundy Lace' is also late, ≈3 weeks later than that of 'Barcelona' and 3 weeks earlier than that of 'Cutleaf'. The date of leaf budbreak is ≈1 week later than that of 'Cutleaf' and 2.5 weeks later than that of 'Barcelona'. Pollen of the following EFB-resistant cultivars is compatible on females of 'Burgundy Lace': 'Yamhill' ($S_{\underline{8}}$ S_{26}), 'Dorris' ($S_{\underline{1}}$ $S_{\underline{12}}$), 'McDonald' (S_2 $S_{\underline{15}}$), 'Wepster' ($S_{\underline{1}}$ S_2), 'York' (S_2 $S_{\underline{21}}$), 'Gamma' (S_2 $S_{\underline{10}}$), 'Jefferson' (S_1 $S_{\underline{3}}$), 'Felix' ($S_{\underline{15}}$ $S_{\underline{21}}$), and 'Theta' ($S_{\underline{5}}$ $S_{\underline{15}}$). By convention, alleles expressed in the pollen are underlined. Because females of 'Burgundy Lace' are receptive late in the season, the late-shedding pollinizers 'Felix' and 'Theta' would be most effective.

Pests and Diseases

In May 2012 and 2014, DNA was extracted from young leaves of 'Burgundy Lace' and several other selections and amplified with the polymerase chain reaction. Random amplified polymorphic DNA (RAPD) markers UBC 152_{800}, UBC 268_{580}, and AA12_{850} that are linked to the EFB resistance gene from 'Gasaway' (Mehlenbacher et al., 2004) are present in 'Burgundy Lace'. No cankers were observed in the field in the two trials, although a heavily diseased orchard was located nearby,

Table 4. Nut and kernel weight, kernel percentage, ratings for fiber and pellicle removal, and frequency of nut and kernel defects in hazelnut cultivars in a trial planted in 2008, including one tree of Burgundy Lace in a guard row.

							Frequency (%)[z]							
Cultivar	No. of trees	Nut wt (g)	Kernel wt (g)	Kernel percentage	Fiber[y]	Pellicle removal[x]	Good	Blanks	Brown stain	Moldy	Shrivel	Poor fill	Doubles	Black tips
EFB-resistant cultivars														
Eta	4	3.02	1.42	47.1	3.1	3.9	85.9	2.8	1.8	2.1	0.4	5.7	1.0	0.7
Gamma	4	2.41	1.24	51.7	3.0	6.4	78.8	5.2	0.7	2.2	1.4	11.5	0.3	0.1
Jefferson	4	3.65	1.65	45.2	2.9	4.5	75.6	4.1	0.1	5.8	0.4	13.1	0.6	1.2
Theta	4	2.27	1.15	50.5	2.2	2.6	89.1	2.4	0.3	1.8	0.3	5.8	0.3	0.3
Yamhill	4	2.36	1.11	47.3	1.4	5.1	76.0	2.3	0.1	2.5	0.8	18.4	0.1	0.3
Burgundy Lace	1	1.72	0.76	44.1	2.8	6.6	87.5	6.8	0.0	0.5	0.3	4.8	0.0	0.3
LSD (0.05)		0.09	0.03	0.8	0.2	0.4	3.6	2.6	0.6	1.2	0.7	3.4	0.5	0.1
EFB-susceptible cultivars in nearby trial														
Barcelona	3	3.89	1.71	44.0	2.5	4.3	68.3	5.3	0.2	4.0	1.4	16.0	6.0	0.2
Clark	3	2.47	1.24	50.0	2.6	3.1	73.1	2.6	1.0	4.0	0.5	18.3	0.8	0.3
Lewis	3	2.94	1.36	46.2	1.3	4.1	65.3	2.0	0.2	11.0	1.3	19.7	2.0	0.8
Sacajawea	3	2.81	1.46	51.9	1.3	3.1	82.7	4.9	0.0	4.7	2.1	5.0	0.2	0.5
LSD (0.05)		0.16	0.07	0.7	0.3	0.3	5.9	2.0	0.7	1.6	1.1	6.4	0.8	0.5

[z]Values are means for years 4–7.
[y]Amount of fiber on the pellicle was rated from 1 (none) to 4 (much).
[x]Pellicle removal (blanching) was rated from 1 (complete pellicle removal) to 7 (no pellicle removal).
LSD = least significant difference; EFB = eastern filbert blight.

and cankers developed on susceptible trees in the same trials. Two additional trees of 'Burgundy Lace' were planted in a seedling row in Apr. 2010 and monitored over the next 7 years. In contrast to nearby trees of susceptible trees, neither 'Burgundy Lace' tree developed cankers. Trees of 'Burgundy Lace' have not yet been challenged with the EFB pathogen in glasshouse or structure inoculations, but the field observations and the presence of the three RAPD markers indicate that 'Burgundy Lace' has a very high level of resistance to EFB, so fungicide applications are not needed. The pathogen is now present throughout the Willamette Valley and can also be found in the eastern United States where it naturally occurs but causes little damage on the wild American hazelnut (*C. americana*). The response of 'Burgundy Lace' to inoculation with other isolates of EFB from the eastern United States has not been tested. Susceptibility to bacterial blight incited by *Xanthomonas campestris* pv. *corylina* has not been quantified, but none of the three trees in the two trials were affected. Nevertheless, copper sprays to minimize damage from this pathogen are recommended.

Susceptibility to big bud mite (primarily *Phytoptus avellanae* Nal.) was rated in the 2007 trial (Table 3) after leaf fall once per year for 5 years (Dec. 2009–13). The scale was from 1 (no blasted buds) to 5 (many blasted buds). The average rating for 'Burgundy Lace' (3.0) is lower than that for 'Cutleaf' (4.0), which was rated 1 year at the Smith Farm and 3 years (2000–02) at the nearby USDA National Clonal Germplasm Repository. In the 2008 trial, the bud mite rating for 'Burgundy Lace' (3.1) is the same as for the moderately susceptible 'Clark' (3.0). Although the number of blasted buds is higher than desired, 'Burgundy Lace' has a lower rating than 'Cutleaf' and sprays should not be necessary to control this pest.

'Burgundy Lace' was propagated by tie-off layerage of the suckers eight times over 11 years (2005–15). Compared with other selections of the same age, layers generally rooted well and their size was slightly larger than average. About 20 well-rooted layers were annually harvested from the base of the original seedling. In vitro cultures of 'Burgundy Lace' were established, and micropropagation is slow but feasible.

Availability

An application for a U.S. plant patent has been submitted for 'Burgundy Lace'. Nurseries interested in propagating 'Burgundy Lace' should pursue a licensing agreement with Oregon State University's Office for Commercialization and Corporate Development. Scions and rooted layers will be made available to licensed nurseries. A list of licensed nurseries and micropropagators, and additional information, is available from S.A. Mehlenbacher.

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