US00PP28200P3

(12) **United States Plant Patent**
Mehlenbacher et al.

(10) **Patent No.: US PP28,200 P3**
(45) **Date of Patent: Jul. 18, 2017**

(54) ***CORYLUS* PLANT NAMED 'MCDONALD'**

(50) Latin Name: ***Corylus avellana* cultivar**
Varietal Denomination: **McDonald**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 376 days.

(21) Appl. No.: **14/544,504**

(22) Filed: **Jan. 13, 2015**

(65) **Prior Publication Data**

US 2016/0205823 P1 Jul. 14, 2016

(51) **Int. Cl.**
A01H 5/08 (2006.01)

(52) **U.S. Cl.**
USPC **Plt./152**

(58) **Field of Classification Search**
USPC Plt./152
CPC A01H 5/0825
See application file for complete search history.

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(57) **ABSTRACT**

A new and distinct *Corylus* plant named 'McDonald' characterized by moderate vigor and upright-spreading plant habit, yellowish-green developing and fully expanded leaves during the spring and summer, resistance to eastern filbert blight caused by the fungus *Anisogramma anomala* (Peck) E. Müller, presence of random amplified polymorphic DNA markers 152-800 and 268-580 in DNA, expression of incompatibility alleles S_2 and S_{15} in the styles, and DNA fingerprints at 14 of 21 microsatellite marker loci differ from both parents, 'Tonda Pacifica' and 'Santiam', and from one parent at an additional 5 marker loci.

17 Drawing Sheets

ACKNOWLEDGMENT OF GOVERNMENT SUPPORT

This invention was made with government support under Specific Cooperative Agreement No. 58-5358-4542 awarded by the United States Department of Agriculture. The government has certain rights in the invention.

Botanical denomination: *Corylus avellana* cultivar.

Variety designation: 'McDonald'.

BACKGROUND

The present Invention relates to a new and distinct cultivar of *Corylus* plant, botanically known as *Corylus avellana*, and hereinafter referred to by the name 'McDonald'.

The new *Corylus* resulted from a controlled cross of female parent 'Tonda Pacifica' (U.S. Plant Pat. No. 22,715) and male parent 'Santiam' (unpatented) made in 1997. Hybrid seeds from the cross were harvested in August 1997,

stratified, and seedlings grown in the greenhouse during the summer of 1998. From this cross, a total of 132 seedling trees were planted in the field in Corvallis in October, 1998. 'McDonald' was discovered and selected as a single plant within the progeny of the stated cross-pollination in a controlled environment in Corvallis, Oreg., USA. It was originally assigned the designation OSU 880.027, which indicates the row and tree location of the original seedling.

'Tonda Pacifica' (OSU 228.084) was released in 2010 (Mehlenbacher et al., 2011), is from a cross of 'Tonda Gentile delle Langhe'×OSU 23.024 (='Barcelona'×'Extra Ghiaghli'). 'Santiam' (Mehlenbacher et al., 2007), released in 2005, carries a dominant allele for a very high level of resistance to eastern filbert blight (EFB) from 'Gasaway' (unpatented). 'Tonda Gentile delle Langhe' (unpatented), the female parent of 'Tonda Pacifica', is an important cultivar in Piemonte, northern Italy. 'Barcelona' (unpatented), Oregon's most widely planted hazelnut cultivar, is known as 'Castanyera' where it originated in Catalunya, Spain. 'Extra Ghiaghli' (unpatented), obtained from Greece, is a clone of the important Turkish cultivar 'Tombul'. 'Gasaway' (unpatented) is the source of a single dominant gene for resistance to eastern filbert blight.

The new cultivar was asexually reproduced by rooted suckers annually for nine years (2004-2005, 2007-2013) in Corvallis, Oreg. The new cultivar was also asexually propagated by whip grafting in 2005 in Corvallis, Oreg. The unique features of this new *Corylus* are stable and reproduced true-to-type in successive generations of asexual reproduction.

SUMMARY

The following traits have been observed and are determined to be the unique characteristics of 'McDonald'. These characteristics in combination distinguish 'McDonald' as a new and distinct cultivar:

1. Moderate vigor and upright-spreading plant habit.
2. Yellowish-green developing and fully expanded leaves during the spring and summer.
3. Resistance to eastern filbert blight caused by the fungus *Anisogramma anomala* (Peck) E. Müller.
4. Presence of random amplified polymorphic DNA markers 152-800 and 268-580 in DNA of 'McDonald' amplified by the polymerase chain reaction. These two markers are linked to a dominant allele for resistance to eastern filbert blight from the cultivar 'Gasaway' (unpatented).
5. Expression of incompatibility alleles S_2 and S_{15} in the styles.
6. DNA fingerprints at 14 of 21 microsatellite marker loci differ from both parents, 'Tonda Pacifica' and 'Santiam', and from one parent at an additional 5 marker loci. Additional DNA fingerprints of grandparent 'Tonda Gentile delle Langhe', standard cultivar 'Barcelona', eastern filbert blight resistance source 'Gasaway' and five cultivars released by Oregon State University hazelnut breeding program are shown in Table 6.

Comparisons in two replicated trials conducted in Corvallis, Oreg., plants of the new *Corylus* differed from plants of the *Corylus avellana* cultivar 'Barcelona' and other cultivars and selections of *Corylus avellana* known to the Inventors primarily in nut size, nut shape, kernel percentage (ratio of kernel weight to nut weight), frequency of defects (blank nuts, moldy kernels, twins, etc.), time of pollen shed, time of nut maturity, length of the husk or involucre, and plant size. For example:

- Blank nut frequency: 'McDonald' 2.7% in first trial, 5.1% in second trial, %, 'Barcelona' 7.7% in first trial and 7.1% in second trial;
- Pollen shed: 'McDonald' sheds pollen with 'Dorris', 'Wepster' and 'Yamhill', slightly later than 'Tonda Pacifica', and slightly earlier than 'Sacajawea', 'Yamhill' and 'York'. 'McDonald' descriptor=5;
- Nut maturity: 'McDonald' nuts mature 14 days earlier than 'Barcelona'; and
- Husk Length: 'McDonald' 1.5 times nut length, same as 'Barcelona', while 'Wepster' is 2 times nut length.

'McDonald' is well-suited to the blanched kernel market for use in chocolate products and baked goods. 'McDonald' combines high nut yield, early nut maturity, small round nuts and kernels, high kernel percentage, good kernel blanching and excellent flavor. The tree is moderately vigorous and has a desirable growth habit.

DNA markers and field observations indicate that 'McDonald' has a very high level of resistance to eastern filbert blight (EFB) caused by the fungus *Anisogramma anomala* (Peck) E. Müller. The resistance is conferred by a dominant allele from 'Gasaway'. EFB is now present throughout the Willamette Valley where 99% of the U.S. hazelnut crop is grown. Pruning to remove cankers and fungicide applications are currently used to manage the disease in orchards of 'Barcelona' and other susceptible cultivars. Thus, 'McDonald' is suitable for planting in areas with high disease pressure, as are previous releases 'Santiam' (2005), 'Yamhill' (2008, unpatented), 'Jefferson' (2009, unpatented), 'Dorris' (2012, U.S. Plant Pat. No. 25,022) and 'Wepster' (2013, U.S. Plant Pat. No. 27,141). 'Wepster', released as a cultivar in 2013, is cross-compatible with 'McDonald' in both directions. Thus 'Wepster' and 'McDonald' can be planted together with each serving as a pollinizer for the other.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying colored photographs illustrate the overall appearance of the new cultivar, showing the colors as true as it is reasonably possible to obtain in colored reproductions of this type. Foliage colors in the photographs may differ slightly from the color values cited in the detailed botanical description which accurately describe the colors of the new *Corylus*.

FIG. **1** shows a tree the new cultivar 'McDonald' hazelnut in the 8th leaf.

FIG. **2** shows a tree of the new cultivar 'McDonald' hazelnut in winter at end of 7th leaf.

FIG. **3** shows a tree of the new cultivar 'McDonald' tree in winter at end of 7th leaf.

FIG. **4** shows August 2013 trees of the new cultivar 'McDonald' (left) and 'Jefferson' (right, unpatented), 8th leaf.

FIG. **5** shows trees of the new cultivar 'McDonald' (left) and 'Wepster' (right, unpatented), 8th leaf.

FIG. **6** shows nuts, husks and leaves of 'McDonald' hazelnut.

FIG. **7** shows nuts and husks of 'McDonald' hazelnut.

FIG. **8** shows nuts, raw kernels, and blanched kernels of hazelnuts 'Wepster' (OSU 894.030), 'Yamhill', 'McDonald' (OSU 880.027) and 'Barcelona'.

FIG. **9** shows nuts, raw kernels and blanched kernels of hazelnuts 'Yamhill', 'McDonald' (OSU 880.027) and 'Barcelona'.

FIG. **10** shows nuts, raw kernels and blanched kernels of hazelnuts 'McDonald' (OSU 880.027) and 'Barcelona'.

FIG. **11** is a graph showing maturity of 'McDonald' (OSU 880.027) and 'Barcelona' based on percentage of nuts on the ground. Four trees of each genotype were harvested in 2013 on four dates (September 13, September 20, September 27 and October 4). Percentages of nuts on the ground based on weight are cumulative.

FIGS. **12**A-**12**B show a phenology chart showing time of female receptivity (bottom, red) and pollen shed (top, green) of 'McDonald' (OSU 880.027) and other hazelnut cultivars (December 2011-March 2012).

FIGS. **13**A-**13**D show a phenology chart showing bloom stage and pollen shed of hazelnut cultivars, pollinizers and selections (December 2012-March 2013).

DETAILED DESCRIPTION

The cultivar 'McDonald' has not been observed under all possible environmental conditions. The phenotype may vary somewhat with variations in environment such as temperature and light intensity, without, however, any variance in genotype. The aforementioned photographs and following observations and measurements describe plants grown in Corvallis, Oreg. under commercial practice outdoors in the field during the fall, winter and spring. Plants used for the photographs and description were propagated by tie-off layerage and growing on their own roots, and seven or eight years old. In the following description, color references are made to The Royal Horticultural Society Colour Chart, 1966 Edition, except where general terms of ordinary dictionary significance are used. The list of UPOV descriptors are from the Mar. 28, 1979 Hazelnut guidelines from UPOV.

Botanical classification: *Corylus avellana* cultivar 'McDonald'.

Parentage:

Female, or seed, parent.—*Corylus avellana* cultivar 'Tonda Pacifica' (U.S. Plant Pat. No. 22,715). 'McDonald' is resistant to eastern filbert blight, while 'Tonda Pacifica' is highly susceptible. 'McDonald' and 'Tonda Pacifica' have different alleles at 16 of the 21 microsatellite markers loci. 'McDonald' has incompatibility alleles 2 and 15. 'Tonda Pacifica' and 'Wepster' have alleles 1 and 2. 'McDonald' has a shorter husk than 'Tonda Pacifica' and earlier nut maturity.

Male, or pollen, parent.—*Corylus avellana* cultivar 'Santiam' (unpatented).

Propagation (type rooted suckers):

Time to initiate roots.—About 30 days at 20° C.

Time to produce a rooted young plant.—About six months at 22° C.

Root description.—Fine to thick; freely branching; creamy white in color.

Propagation (type whip grafting):

Time to budbreak on the scions.—About 14 days at 25° C.

Time to produce a grafted plant.—About six months at 25° C.

Plant description:

General appearance.—Natural habit is perennial shrub, but in commercial orchards, is a single trunk tree. Upright-spreading plant habit.

Growth and branching habit.—Freely branching; about 15 lateral branches develop per plant. Pinching, that is, removal of the terminal apices, enhances branching with lateral branches potentially forming at every node.

Vigor.—Moderate vigor growth habit.

Size.—Plant height is about 5 meters; plant diameter or spread is about 5 meters.

Trunk.—At 30 cm above the soil line, 10.52 cm in 2007.

Lateral branch description:

Length.—About 33.5 cm.

Diameter.—About 5 mm.

Internode length.—About 3.2 cm.

Texture.—Smooth, glabrous.

Strength.—Strong. Color, immature: 139D.

Color, mature.—177D.

Foliage description:

Arrangement.—Alternate, simple.

Length.—About 10.4 cm.

Width.—About 8.7 cm.

Shape.—Oblong to ovate.

Apex.—Obtuse to acute.

Base.—Cordate.

Margin.—Serrate.

Texture, upper and lower surfaces.—Slightly pubescent.

Venation pattern.—Pinnate.

Color.—Developing foliage, upper surface 141C, lower surfaces: 139C. Fully expanded foliage, upper surface: Spring and summer, 139B; late summer and fall, 139B. Fully expanded foliage, lower surface: Spring and summer, 139C; late summer and fall, 139C. Venation, upper surface: Spring and summer, 139C; late summer and fall, 139C. Venation, lower surface: Spring and summer, 139D; late summer and fall, 139D.

Leaf but description:

Shape.—Globular.

Time of leaf budbreak.—Descriptor=6 (medium to late). 'McDonald' leaf budbreak one week before 'Dorris', 'York' and 'Wepster'; 4 days later than 'Tonda Pacifica' and 'Sacajawea'.

Color.—178C.

Petiole description:

Length.—About 2.7 cm.

Diameter.—About 1.8 mm.

Texture, upper and lower surfaces.—Pubescent.

Color, upper surface.—Spring and summer, 139D; late summer and fall, 139D.

Color, lower surface.—Spring and summer, 139D; late summer and fall, 139D.

Flower description: Male inflorescences are catkins, color prior to elongation 176D. Catkin length 31.7 mm. Female inflorescence style color 047B.

Time of female flowering.—Descriptor=5 (medium).

Time of female flowering compared to male flowering.—Protogyny (descriptor=1, earlier).

Involucre constriction.—Absent.

Involucre length.—1.5 times length of nut, descriptor=5.

Size of indentation.—Descriptor=7 (strong).

Strength of serration of indentation.—Descriptor=7 (strong).

Pubescence on husk.—Descriptor=9 (present).

Thickness of callus at base.—Descriptor=5 (medium).

Jointing of bracts.—Descriptor=2 (on one side).

Nut description:

Length.—About 18.4 mm.

Width.—About 18.9 mm.

Depth.—About 17.9 mm.

Nut shape.—Round. Nut shape index [(Width+Depth)/2*Length]=1.00. Nut compression index (Width/Depth)=1.05.

Nut shell color.—164A. Nut weight: About 2.51 grams.

Kernel weight.—About 1.29 grams.

Kernel percentage (*kernel weight/nut weight*).—About 51.5%.

Number of fruits per cluster.—Two to three.

Nut shell coloration.—164A.

Number of stripes on shell.—Descriptor=3 (few).

Prominence of fruit apex.—Medium prominent, descriptor=5.

Size of fruit pistil scar on shell.—Very small, descriptor=3.

Hairiness of top of fruit.—Weak, descriptor=3.

Curvature of nut basal scar.—Flat.

Double kernels.—Absent.

Kernel shape.—Globular.

Shape of kernel in cross-section.—Circular.

Lateral groove in kernel.—Absent.

Corkiness of pellicle of kernel.—Rating 2.6 (vs. 3.0 for 'Jefferson'); descriptor=4 (slight to medium corky).

Nut yield (*pounds per tree or per acre*).—Total 17.11 kg per tree in first trial, 21.43 kg per tree in second trial.

Storability of fruits.—Excellent, similar to OSU releases and check cultivars.

Disease/pest resistance: Plants of the new *Corylus* are highly resistant to eastern filbert blight caused by the fungus *Anisogramma anomala* (Peck) E. Müller, although a few small cankers may develop under high disease pressure. Plants of the new *Corylus* are resistant to bud mites (*Phytoptus avellanae* Nal.), while plants of 'Tonda Gentile delle Langhe' are highly susceptible, and plants of 'Barcelona' are highly resistant.

Temperature tolerance: Plants of the new *Corylus* have been observed to tolerate temperatures from −21 to 38° C. in the field in Corvallis, Oreg.

COMPARATIVE DATA

Tree size, growth habit, yield, and yield efficiency Tree sizes in the two trials were estimated by measuring trunk diameters 30 cm above the soil line, at the end of the 7^{th} growing season (December 2012 and 2013, respectively). Trunk cross-sectional area (TCA) was calculated from trunk diameter. Trees of 'McDonald' are moderately vigorous, and their upright-spreading growth habit should be grower-friendly (easy to manage).

In the first trial (Table 1), TCA of 'McDonald' (86.9 cm^2) was similar to 'Jefferson' (unpatented), 'Dorris', and 'York' (U.S. Plant Pat. No. 24,972). Trees were larger than 'Yamhill' (unpatented) but smaller than 'Wepster'. Total nut yield per tree was 17.11 kg, which is slightly less than 'Jefferson', 'Yamhill' and 'Wepster' and about the same as 'Dorris' and 'Sacajawea' (unpatented). Nut yield efficiency of 'McDonald' (0.198 kg/cm^2) was similar to 'Sacajawea' and 'Wepster', and lower than 'Jefferson' and 'Yamhill'.

In the second trial (Table 1), trees of 'McDonald' were similar in size to 'Jefferson'. In adjacent rows planted at the same time to EFB-susceptible selections, TCAs for 'Barcelona', 'Lewis' and 'Clark' were 138.6, 77.6 and 63.7 cm^2, respectively. The TCA of 'McDonald' is 63% of 'Barcelona'. In previous trials, tree size of 'Jefferson' and 'Lewis' has been about 70% of 'Barcelona'. Growers have been pleased with this level of vigor. Total nut yield per tree was 21.43 kg for 'McDonald' vs. 22.99 kg for 'Jefferson', 16.88 kg for the pollinizer 'Felix' (U.S. Plant Pat. No. 24,973), and 17.68 kg for 'Santiam'. Nut yield efficiency for 'McDonald'7 (0.245 kg/cm^2), which adjusts for differences in tree size, was similar to 'Santiam' (0.267 kg/cm^2), lower than 'Jefferson' (0.299 kg/cm^2) and higher than 'Felix' (0.133 kg/cm^2).

TABLE 1

Nut yield, trunk cross-sectional area, and yield efficiency of 'McDonald' and other hazelnut cultivars and selections in two trials

Cultivar	No. trees	Yield per tree (kg) Year 3	Year 4	Year 5	Year 6
First trial (2006 planting)					
OSU 833.082	7	0.71	2.60	2.25	5.95
OSU 879.031	7	0.31	1.42	2.13	5.17
'McDonald'	7	0.29	1.13	2.44	6.54
OSU 881.078	7	0.23	1.08	2.08	5.08
Dorris	7	0.42	2.84	3.30	6.51
Jefferson	7	0.41	3.55	3.35	6.97
Sacajawea	7	0.26	1.92	2.51	6.52
Santiam	7	0.29	1.76	3.73	7.25
Wepster	7	0.24	1.56	2.56	6.62
Yamhill	7	0.78	2.79	3.88	7.34
York	7	0.41	1.52	2.48	6.13
$LSD_{0.05}$		0.17	0.55	0.75	0.89
Second trial (2007 planting)					
'McDonald'	4	0.15	1.10	4.85	7.38
Felix	4	0.06	1.04	2.91	7.93
Jefferson	4	0.55	1.97	5.63	4.60
Santiam	4	0.20	1.11	4.09	5.46
$LSD_{0.05}$		0.21	0.43	0.54	2.04

Cultivar	No. trees	Yield per tree (kg) Year 7	Total	TCA[z] (cm^2)	YE[y] ($kg \cdot cm^{-2}$)
First trial (2006 planting)					
OSU 833.082	7	2.46	13.97	68.1	0.205
OSU 879.031	7	6.54	15.58	87.2	0.179
'McDonald'	7	6.71	17.11	86.9	0.198
OSU 881.078	7	6.67	15.15	112.4	0.135
Dorris	7	5.70	18.78	84.0	0.225
Jefferson	7	5.79	20.07	85.4	0.235
Sacajawea	7	6.76	17.97	93.7	0.196
Santiam	7	6.34	19.36	79.2	0.244
Wepster	7	8.68	19.67	99.2	0.198
Yamhill	7	4.94	19.73	78.5	0.249
York	7	4.42	14.97	85.6	0.175
$LSD_{0.05}$		1.26	2.62	10.4	0.027
Second trial (2007 planting)					
'McDonald'	4	7.95	21.43	87.55	0.245
Felix	4	4.95	16.88	128.43	0.133
Jefferson	4	10.25	22.99	77.52	0.299

TABLE 1-continued

Nut yield, trunk cross-sectional area, and yield efficiency of 'McDonald' and other hazelnut cultivars and selections in two trials

Santiam	4	6.83	17.68	66.81	0.267
$LSD_{0.05}$		1.18	2.45	13.48	0.029

[z]Trunk cross-sectional area calculated from trunk diameters measured in late fall at the end of the seventh season.
[y]Yield efficiency = Total nut yield/TCA.

A high percentage of the nuts and kernels of 'McDonald' in both trials were marketable (Table 2). Very few moldy kernels were observed in 'McDonald', in striking contrast to 'Santiam'.

TABLE 2

Frequency of good nuts, and of nut and kernel defects in 'McDonald; and other hazelnut cultivars and selections in trials planted in 2006 and 2007

	Frequency (%)[z]			
Selection	Good	Blanks	Brown stain	Moldy
First trial (n = 7)				
OSU 879.031	92.7	3.7	0.4	1.0
'McDonald'	88.0	2.7	0.0	1.0
OSU 881.078	84.7	8.9	0.0	2.1
OSU 833.082	87.0	4.4	0.0	4.0
Dorris	80.7	7.5	0.2	4.2
Jefferson	84.2	3.8	0.1	4.4
Sacajawea	87.8	3.1	0.0	3.4
Wepster	86.7	7.6	0.2	1.1
Yamhill	91.3	2.3	0.1	2.2
York	83.7	8.7	0.3	1.7
Santiam	76.2	3.0	0.0	7.9
$LSD_{0.05}$	5.6	3.6	0.9	2.2
Second trial (n = 4)				
'McDonald'	83.5	5.1	0.1	2.1
Felix	88.9	4.2	0.2	2.1
Jefferson	80.1	4.3	0.3	5.7
Santiam	68.8	2.8	0.1	17.3
$LSD_{0.05}$	3.5	2.5	0.3	2.3

	Frequency (%)[z]			
Selection	Shrivel	Poor fill	Twins	Black tips
First trial (n = 7)				
OSU 879.031	1.0	0.6	0.3	0.3
'McDonald'	7.5	0.5	0.0	0.3
OSU 881.078	2.8	1.1	0.1	0.3
OSU 833.082	2.8	0.7	0.5	0.6
Dorris	4.3	1.9	0.1	1.2
Jefferson	2.8	3.8	0.5	0.5
Sacajawea	3.1	1.2	0.1	1.3
Wepster	2.7	1.4	0.1	0.3
Yamhill	2.5	1.6	0.0	0.1
York	2.8	1.2	0.0	1.6
Santiam	9.4	2.3	0.2	0.9
$LSD_{0.05}$	2.7	2.3	0.5	0.9
Second trial (n = 4)				
'McDonald'	4.5	4.5	0.1	0.3
Felix	0.4	2.9	0.3	1.1
Jefferson	0.4	8.9	0.6	0.6
Santiam	1.8	9.6	0.1	0.1
$LSD_{0.05}$	1.0	2.5	0.4	0.5

[z]Means of years 4-7.
LSD = least significant difference.

Percent kernel (the ratio of kernel weight to nut weight) for 'McDonald' (52%) is higher than 'Barcelona' (typically 43%) and 'Jefferson' (45%) (Table 3). Yields of kernels per acre would be high for 'McDonald'. Although 'McDonald' is not the highest-yielding selection, its yields have been consistently good and the nuts consistently well-filled. In contrast, 'Yamhill' trees occasionally set very heavy nut crops, and the nuts can be so poorly filled that the kernels are not marketable.

TABLE 3

Nut and kernel weight, kernel percentage, and ratings for fiber, blanching and bud mite susceptibility for 'McDonald'and other hazelnut cultivars and selections in two trials.

Selection	Nut wt (g)[z]	Kernel wt (g)	Kernel percentage	Fiber[y]	Blanching[x]	Bud mite[w]
First trial (n = 7)						
OSU 879.031	2.34	1.15	49.0	—	5.2	—
McDonald'	2.39	1.21	50.7	—	3.8	—
OSU 881.078	2.37	0.97	41.0	—	4.5	—
OSU 833.082	2.72	1.12	41.3	—	2.6	—
Dorris	3.24	1.32	40.8	—	2.9	—
Jefferson	3.53	1.51	42.8	—	4.8	—
Sacajawea	2.52	1.29	51.2	—	2.8	—
Santiam	2.09	1.03	49.5	—	5.1	—
Wepster	2.23	0.98	43.9	—	3.1	—
Yamhill	2.18	1.01	46.4	—	5.0	—
York	2.59	1.12	43.4	—	4.8	—
$LSD_{0.05}$	0.23	0.13	3.0	—	0.7	—
Second trial (n = 4)						
'McDonald'	2.62	1.37	52.3	2.6	3.3	1.8
Felix	2.71	1.37	50.8	3.0	2.2	2.0
Jefferson	3.76	1.67	44.5	3.0	4.3	1.2
Santiam	2.28	1.15	50.6	3.0	4.2	2.2
$LSD_{0.05}$	0.22	0.04	1.0	0.1	0.4	0.2

[z]Means for nuts and kernels are over four years.
[y]Amount of fiber on the pellicle was rated in the second trial from 1 (none) to 4 (much).
[x]Blanching was rated from 1 (complete pellicle removal) to 7 (no pellicle removal).
[w]Susceptibility to bud mite (primarily *Phytoptus avellanae* Nal.) was rated on four trees of each selection in the second trial on a scale of 1 (no blasted buds) to 5 (many blasted buds). Shown are mean ratings for 5 years (2009-2013).
LSD = least significant difference.

Nut maturity date. The nuts of 'McDonald' are borne in clusters of 2-3 in husks about 50% longer than the nuts. The husks are slit down the side, and flare open as they dry at maturity. About 95% of the nuts fall free of the husk at maturity (range 85-100%). The other 5% of the nuts would come out of the husks as they moved through the harvester. When mature, the shells are light tan in color. Harvest date is estimated to be 14 days before 'Barcelona', allowing it to be harvested before the start of the rainy season (Table 4 and FIG. **11**).

TABLE 4

Harvest notes for four hazelnut genotypes harvested by hand for three years in the second trial.

Year	Selection	Date	Down[z]	Free[y]
2010	'McDonald'	Sep. 28	88	99
	Felix	Oct. 12	87	77
	Jefferson	Oct. 12	86	78
	Santiam	Sep. 28	89	97
2011	'McDonald'	Oct. 27	96	93
	Felix	Oct. 27	96	81
	Jefferson	Oct. 27	88	64
	Santiam	Sep. 30	81	94
2012	'McDonald'	Oct. 4	97	98
	Felix	Oct. 18	85	84

TABLE 4-continued

Harvest notes for four hazelnut genotypes harvested by hand for three years in the second trial.

Year	Selection	Date	Down[z]	Free[y]
	Jefferson	Oct. 18	81	89
	Santiam	Oct. 5	97	91

[z]Estimated percentage of nuts on the ground as opposed to in the tree.
[y]Of the nuts on the ground, estimated percentage free of the husk.

Nuts in the first trial were annually raked and fed through a Mave harvester. Nuts in the second trial were hand-harvested and notes recorded at the time of harvest (Table 4). Notes included the date, the percentage of nuts on the ground (as opposed to in the tree), and the percentage of the nuts on the ground that were free of the husk (as opposed to inside the husk). We harvest more than 2000 trees by hand every fall, visiting a block once every 7 to 10 days, and harvesting a tree if >70% of the nuts are on the ground. Thus the percentages are estimates. The harvest dates and percentage down indicate that maturity of 'McDonald' is about 14 days earlier than 'Barcelona' (Table 4). To more precisely estimate nut maturity, the four trees of 'McDonald' in the second trial and four trees of 'Barcelona' in adjacent rows were harvested by hand at weekly intervals in the final year of the trial (2013). The maturity curves from the 2013 harvest (FIG. **11**) show that nuts of 'McDonald' drop at least 14 days sooner than those of 'Barcelona'. Most orchards planted since 2009 have been of 'Jefferson', which matures about three days after 'Barcelona'. Plantings of 'McDonald' and 'Wepster' would allow harvest to begin two weeks earlier.

Nut and kernel characteristics: 'McDonald' can be used in the blanched kernel market as a companion for 'Wepster' and an alternative to 'Yamhill', 'Lewis', 'Clark' and 'Sacajawea'. 'McDonald', like 'Wepster' and 'Yamhill', has a very high level of EFB resistance, while 'Lewis', 'Clark' and 'Sacajawea' have lower level of quantitative resistance. The nut shape is round with a slight point, which lends itself well to sizing and cracking. The shells are thin and easy to crack, and most kernels remain whole when the shell is broken. The kernel size of 'McDonald' is small, similar to 'Clark', and larger than 'Wepster'. Raw kernels are attractive and have a light brown pellicle with a moderate amount of attached fiber (rating =2.6) on a scale of 1 (no fiber) to 4 (much fiber). Pellicle removal is rated on a scale of 1 (complete pellicle removal) to 7 (no pellicle removal), with ratings <4.0 being desired. Most of the pellicle on 'McDonald' kernels is removed from the kernels with dry heat in the blanching process (ratings=3.8 and 3.3 in the first and second trials, respectively) which is better than 'Yamhill' (rating=5.0). Kernel texture, flavor and aroma are excellent, and desirable for use in baked goods and chocolate products.

In two trials, 'McDonald' produced fewer nut and kernel defects (and more good kernels) than 'Barcelona' in adjacent rows. The nut and kernel data were similar in the two trials. The frequency of moldy kernels in 'McDonald' in the two trials was very low (1.0-2.1%) in contrast to 'Jefferson' (4.4-5.7%) and especially 'Santiam' (7.89-17.3%). Kernel mold is a problem in 'Lewis' and 'Santiam', particularly when weather is cool and wet in spring and early summer. The frequency of poorly filled nuts is low compared to other selections, even though 'McDonald' crops consistently well.

Incompatibility and pollinizers. The trees set a moderate to high amount of catkins that shed copious amounts of pollen in early mid-season, with 'Wepster', 'York' and 'Yamhill'. Pollen has been collected and used in several controlled pollinations, and both quantity and viability appear to be very good. 'McDonald' has incompatibility alleles S_2 and S_{15} as determined by fluorescence microscopy. Both alleles are expressed in the females, but only S_{15} is expressed in the pollen because of dominance. By convention, alleles expressed in the pollen are underlined.

Time of pollen shed and female receptivity were recorded weekly from early December 2011 to late March 2013 (FIGS. **12**A-**12**B). Female inflorescences of 'McDonald' emerged in early mid-season and were fully receptive in mid-January. 'Wepster' (S_1 S_2) is recommended as a companion cultivar, as 'Wepster' and 'McDonald' are cross-compatible in both directions. At least one additional pollinizer that sheds compatible pollen in midseason and late-midseason is recommended. Suitable pollinizers include 'York' (S_2 S_{21}) and 'Gamma' (S_2 S_{10}). 'Yamhill' (S_8 S_{26}) is also a suitable pollinizer and is an attractive option as "temporary trees" in double-density plantings. Pollen of 'Jefferson' (S_1 S_3) is compatible on females of OSU 880.027, but the time of pollen shed is later than ideal. Pollen of 'Dorris' (S_1 S_{12}), 'Sacajawea' (S_1 S_{22}) and 'Barcelona' (S_1 S_2) is also compatible on females of OSU 880.027. Pollen of 'Tonda di Giffoni' (S_2 S_{23}) is incompatible because it expresses S_2. Pollen of 'Delta' (S_1 S_{15}), 'Felix' (S_{15} S_{21}) and 'Theta' (S_5 S_{15}) is incompatible because of the shared allele S_{15}. Inclusion of 'Wepster' as a companion cultivar in the orchard results in no loss in total nut yield. Alternative orchard designs include plantings of different cross-compatible cultivars in adjacent rows. Flowering times will continue to be observed, and pollinizer recommendations adjusted accordingly. Pollinizers with a high level of EFB resistance would eliminate the need for fungicide control in the entire orchard.

Pests and diseases. Based on DNA marker data, 'McDonald', like 'Wepster' and 'Yamhill', has a very high level of resistance to EFB conferred by a dominant allele from 'Gasaway', so fungicide applications are not needed. RAPD markers 152-800 and 268-580 that flank the resistance allele in 'Gasaway' are present in 'McDonald', and these markers are transmitted to its seedlings. Additional RAPD markers linked to resistance are also present. Trees of 'McDonald' have not yet been challenged with the EFB pathogen in glasshouse or structure inoculations. No cankers have been observed on the 11 trees of 'McDonald' in the yield trials, while several cankers have been noted on adjacent trees of susceptible genotypes.

Susceptibility to bacterial blight caused by *Xanthomonas campestris* pv. *corylina* has not been quantified, but no trees in the two trials were affected.

Susceptibility to big bud mite (primarily *Phytoptus avellanae* Nal.) was rated in the second trial (Table 3) after leaf fall once per year for five years (December 2009-2013). The scale was from 1 (no blasted buds) to 5 (many blasted buds). The average ratings indicate adequate resistance for 'McDonald' (1.8), 'Jefferson' (1.2), 'Felix' (2.0) and 'Santiam' (2.2). Blasted buds are very rare on 'McDonald', so chemical applications should not be necessary to control bud mite.

Propagation: Layers of 'McDonald' are moderately vigorous and root well, but have lower vigor and caliper than those of 'Jefferson' and 'Barcelona'.

DNA Fingerprinting: Primers used are shown in Table 5, and results shown in Table 6.

TABLE 5

Primers and annealing temperatures for the 21 microsatellite marker loci used to fingerprint 'McDonald' and other hazelnut cultivars.

Locus	Repeat motif	Size	Primers 5'-3' (Forward above, Reverse below)	T_s	n	He	Ho	PIC	r	LG	Reference	Locus
A614	$(TC)_{17}(CA)_{10}NNN(CA)_6$	125-156	Hex-TGGCAGAGCTTTGTCAGCTT (SEQ ID NO: 1) R-GCAGTGGAGGATTGCTGACT (SEQ ID NO: 2)	60	14	0.85	0.85	0.84	0.00	6	Gurcan et al. 2010a	A999614
A616	$(AC)_{11}$	136-162	Fam-CACTCATACCGCAAACTCCA (SEQ ID NO: 3) R-ATGGCTTTTGCTTCGTTTTG (SEQ ID NO: 4)	60	13	0.85	0.85	0.83	0.00	8	Gurcan et al. 2010a	A616
A640	$(CT)_{15}(CA)_{13}$	354-378	F-TGCCTCTGCAGTTAGTCATCAAATGTAGG (SEQ ID NO: 5) Fam-CGCCATATAATTGGGATGCTTGTTG (SEQ ID NO: 6)	67	11	0.80	0.73	0.77	0.04	10	Gurcan et al. 2010a	A640
B619	$(TC)_{21}$	146-180	Fam-AGTCGGCTCCCCTTTTCTC (SEQ ID NO: 7) R-GCGATCTGACCTCATTTTTG (SEQ ID NO: 8)	60	14	0.88	0.88	0.87	0.00	3	Gurcan et al. 2010a	B619
B634	$(AG)_{15}$	218-238	Hex-CCTGCATCCAGGACTCATTA (SEQ ID NO: 9) R-GTGCAGAGGTTGCACTCAAA (SEQ ID NO: 10)	60	9	0.76	0.76	0.73	0.00	4	Gurcan et al. 2010a	B634
B671	$(AG)_6NN(GA)_{17}$	221-249	Hex-TTGCCAGTGCATACTCTGATG (SEQ ID NO: 11) R-ACCAGCTCTGGGCTTAACAC (SEQ ID NO: 12)	60	13	0.86	0.88	0.84	−0.01	9	Gurcan et al. 2010a	B671
B709	$(GA)_{21}$	219-233	Ned-CCAAGCACGAATGAACTCAA (SEQ ID NO: 13) R-GCGGGTTCTCGTTGTACACT (SEQ ID NO: 14)	60	8	0.74	0.76	0.70	0.01	5	Gurcan et al. 2010a	B709
B733	$(TC)_{15}$	161-183	Ned-CACCCTCTTCACCACCTCAT (SEQ ID NO: 15) R-CATCCCCTGTTGGAGTTTTC (SEQ ID NO: 16)	60	8	0.68	0.68	0.63	0.00	7.2	Gurcan et al. 2010a	B733
B741	$(GT)_5(GA)_{12}$	176-194	Fam-GTTCACAGGCTGTTGGGTTT (SEQ ID NO: 17) R-CGTGTTGCTCATGTGTTGTG (SEQ ID NO: 18)	60	10	0.77	0.78	0.74	0.00	5	Gurcan et al. 2010a	B741
B749	$(TC)_{12}$	200-210	Hex-GGCTGACAACACAGCAGAAA (SEQ ID NO: 19) R-TCGGCTAGGGTTAGGGTTTT (SEQ ID NO: 20)	60	6	0.60	0.64	0.51	−0.03	1	Gurcan et al. 2010a	B749

TABLE 5-continued

Primers and annealing temperatures for the 21 microsatellite marker loci used to fingerprint 'McDonald' and other hazelnut cultivars.

Locus	Repeat motif	Size	Primers 5'-3' (Forward above, Reverse below)	T_s	n	He	Ho	PIC	r	LG	Reference	Locus
B767	$(TC)_{15}(AT)_7$	198-238	Fam-CCACCAACTGTTTCACACCA (SEQ ID NO: 21) R-GCGAAATGGAGCTCTTGAAC (SEQ ID NO: 22)	60	16	0.87	0.80	0.86	0.04	8	Gurcan et al. 2010a	B767
B774	$(AG)_{15}$	195-213	Ned-GTTTTGCGAGCTCATTGTCA (SEQ ID NO: 23) R-TGTGTGTGGTCTGTAGGCACT (SEQ ID NO: 24)	60	8	0.80	0.80	0.77	0.01	5	Gurcan et al. 2010a	B774
B795 $s(TC)_5$	$(TC)_8Ns(CT)_7Ns(CT)_{10}N$	296-332	Fam-GACCCACAAACAATAACCTATCTC (SEQ ID NO: 25) R-TGGGCATCATCCAGGTCTA (SEQ ID NO: 26)	60	12	0.76	0.74	0.74	0.01	9	Gurcan et al. 2010a	B795
C115	$(TAA)_5(GAA)_{12}$	167-226	Fam-ATTTTCCGCAGATAATACAGG (SEQ ID NO: 27) GTTTCCAGATCTGCCTCCATATAAT (SEQ ID NO: 28)	60	14	0.80	0.80	0.77	0.00	4	Bassil et al. 2005b, Gokirmak et al. 2009	C115
KG807	$(TAAA)AA(TAAA)_2A(TAAA)_2$	226-248	AAGCAAGAAAGGGATGGT (SEQ ID NO: 29) FAM-CTTACAGATAAATGGCTCAAA (SEQ ID NO: 30)	54	4	0.67	0.78	0.60	−0.07	11	Gurcan and Mehlenbacher 2010	KG807
KG809	$(AGG)_6$	333-345	Hex-AGGCATCAGTTCATCCAA (SEQ ID NO: 31) F-GGAAGGTGAGAGAAATCAAGT (SEQ ID NO: 32)	55	5	0.66	0.64	0.60	0.01	4	Gurcan and Mehlenbacher 2010	KG809
KG811	$(GA)_{17}$	240-278	Ned-AAGGCGGCACTCGCTCAC(SEQ ID NO: 33) F-GAACAACTGAAGACAGCAAAG (SEQ ID NO: 34)	58	12	0.83	0.82	0.81	0.01	2	Gurcan and Mehlenbacher 2010	KG811
KG827	$(CT)_{13}AA(CA)_7$	264-282	Fam-AGAACTCCGACTAATAATCCTAACCCTTGC (SEQ ID NO: 35) GAGGGAGCAAGTCAAAGTTGAGAAGAAA (SEQ ID NO: 36)	67	9	0.78	0.84	0.75	−0.04	9	Gurcan and Mehlenbacher 2010	KG827
KG830	$(CT)_{14}GTATT(CA)_8$	279-311	Ned-TGGAGGAAGTTTTGAATGGTAGTAGAGGA (SEQ ID NO: 37) AAAGCAACTCATAGCTGAAGTCCAATCA (SEQ ID NO: 38)	67	9	0.79	0.78	0.76	0.00	9	Gurcan and Mehlenbacher 2010	KG830
Soman-G	$(AAT)_5$	193-200	Hex-TGGCGTTGCAACATATTCTC (SEQ ID NO: 39)	54	3	0.60	0.98	0.51	−0.27	NA	unpublished	Soman-G

TABLE 5-continued

Primers and annealing temperatures for the 21 microsatellite marker loci used to fingerprint 'McDonald' and other hazelnut cultivars.

Locus	Repeat motif	Size	Primers 5'-3' (Forward above, Reverse below)	T_s	n	He	Ho	PIC	r	LG	Reference	Locus
(=856-MS1-13)			R-GCCATCTTTAGAAAG TTCGATACAG (SEQ ID NO: 40)									

Primers fluorescent tags are FAM, HEX and NED
Ta annealing temperature (° C.)
n number of alleles
He expected heterozygosity
Ho observed heterozygosity
PIC polymorphism information content
r estimated null allele frequency
LG linkage group; NA = not yet assigned
Reference for development and characterization

TABLE 6

Allele sizes in 'McDonald' and eight other hazelnut cultivars at 21 microsatellite loci.

Locus	'McDonald'	'Tonda Pacifica'	'Santiam'	'Tonda Gentile delle Langhe'
A614	135/158	135/150	132/158	125/135
A616	150/160	150/160	150/152	150/152
A640	362/368	368/374	355/362	355/368
B619	158/172	166/172	158/166	150/166
B634	222/228	228/228	222/236	228/228
B657	211/219	211/229	219/227	219/227
B671	229/237	229/239	225/237	239/243
B709	229/229	229/235	229/229	229/229
B733	173/175	173/175	175/181	173/175
B741	178/188	178/186	186/188	176/184
B749	207/209	207/209	209/209	207/209
B767	200/214	200/218	212/214	214/218
B774	203/213	203/207	209/213	203/211
B795	317/333	315/333	317/333	315/333
C115	174/197	174/183	194/197	174/174
KG807	252/252	228/252	242/252	238/252
KG809	339/339	339/342	339/342	339/342
KG811	245/267	245/257	257/267	257/267
KG827	272/284	270/284	272/272	268/278
KG830	291/295	291/295	291/295	291/295
Soman-G	196/200	196/200	196/200	196/200

Locus	'Barcelona'	'Wepster'	'Yamhill'	'Dorris'
A614	125/132	135/158	132/158	132/158
A616	144/152	152/160	150/150	150/152
A640	355/374	368/374	355/368	372/374
B619	158/172	166/172	158/172	158/166
B634	228/228	228/228	236/236	228/228
B657	219/223	227/229	219/229	211/227
B671	225/229	239/249	225/243	229/249
B709	227/235	229/235	229/229	229/229
B733	173/175	173/175	181/185	173/181
B741	178/186	178/186	178/186	178/186
B749	209/209	207/209	209/209	207/207
B767	214/240	200/242	214/238	214/218
B774	203/207	203/207	203/211	203/207
B795	333/333	333/333	333/333	333/333
C115	174/194	183/194	197/216	194/216
KG807	238/252	252/252	230/252	242/252
KG809	339/339	342/342	348/348	339/348
KG811	261/267	257/257	251/261	257/267
KG827	282/284	270/282	268/282	272/284
KG830	291/295	295/305	291/295	295/297
Soman-G	196/200	196/200	196/200	196/200

TABLE 6-continued

Allele sizes in 'McDonald' and eight other hazelnut cultivars at 21 microsatellite loci.

Locus	'York'	'Felix'	'Gasaway'
A614	124/158	138/143	143/158
A616	144/152	150/152	150/150
A640	363/374	368/372	362/368
B619	158/166	158/166	172/176
B634	228/236	228/236	222/234
B657	221/223	219/227	225/229
B671	243/249	229/237	237/249
B709	229/233	229/233	229/229
B733	173/181	175/181	175/175
B741	178/186	186/186	186/188
B749	209/209	207/207	207/209
B767	236/238	214/214	214/214
B774	203/209	203/213	203/209
B795	333/333	321/333	317/319
C115	197/197	197/216	216/219
KG807	242/252	238/242	242/252
KG809	339/348	339/348	339/348
KG811	257/257	251/267	257/261
KG827	268/272	272/284	272/282
KG830	295/295	293/303	291/305
Soman-G	196/200	196/200	196/196

'McDonald' fingerprint same as both parents: 2
'McDonald' fingerprint same as one parent: 5
'McDonald' fingerprint different from both parents: 14

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aagcaagaaa gggatggt 18

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aggcatcagt tcatccaa 18

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ggaaggtgag agaaatcaag t 21

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aaggcggcac tcgctcac 18

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gaacaactga agacagcaaa g 21

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agaactccga ctaataatcc taacccttgc 30

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gagggagcaa gtcaaagttg agaagaaa 28

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<400> SEQUENCE: 37

tggaggaagt tttgaatggt agtagagga 29

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aaagcaactc atagctgaag tccaatca 28

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tggcgttgca acatattctc 20

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<223> OTHER INFORMATION: Synthetic oligonucleotide

<400> SEQUENCE: 40

gccatcttta gaaagttcga tacag 25

We claim:

1. A new and distinct cultivar of *Corylus* plant as herein illustrated and described.

* * * * *

FIG. 1

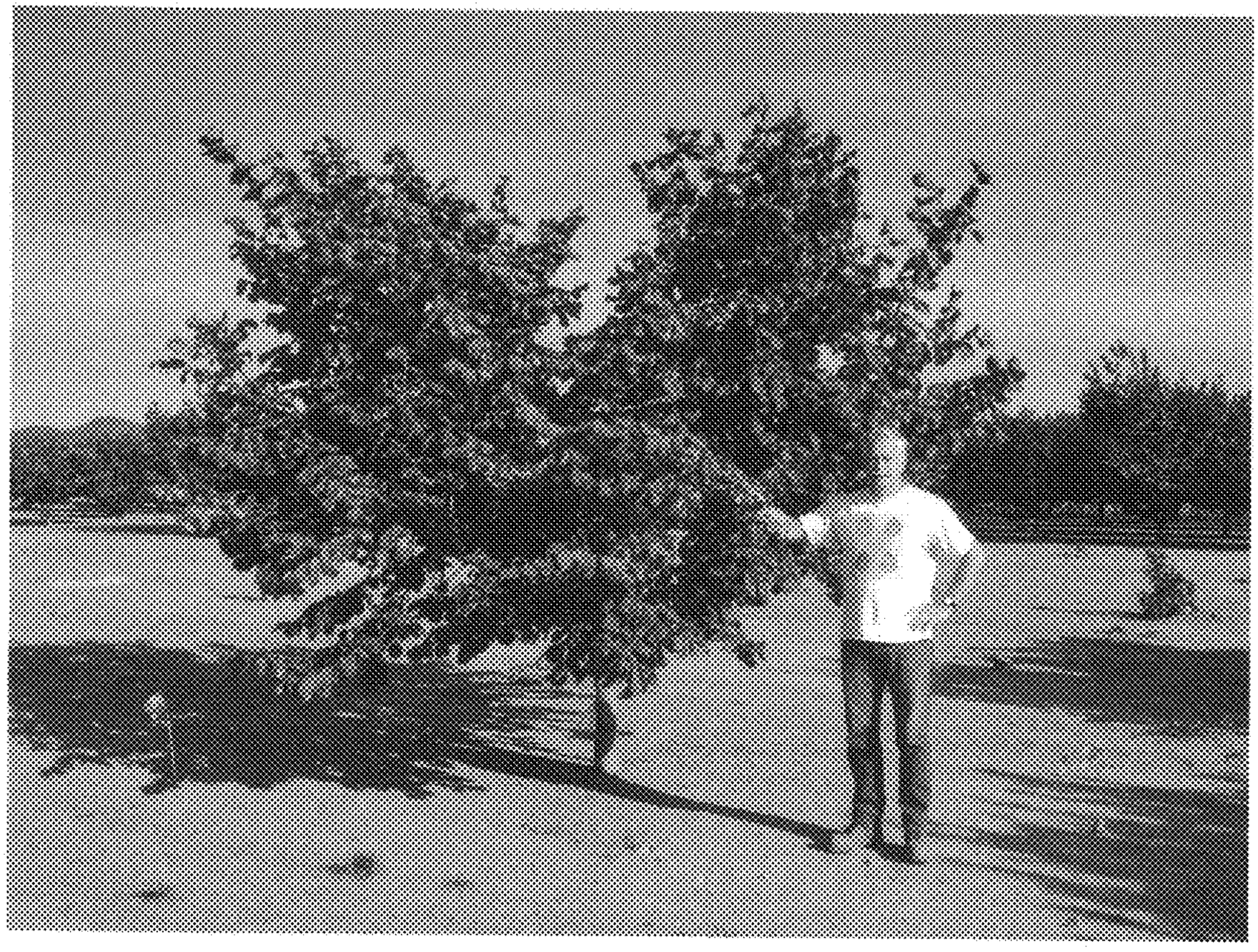


FIG. 2

FIG. 3

FIG. 4

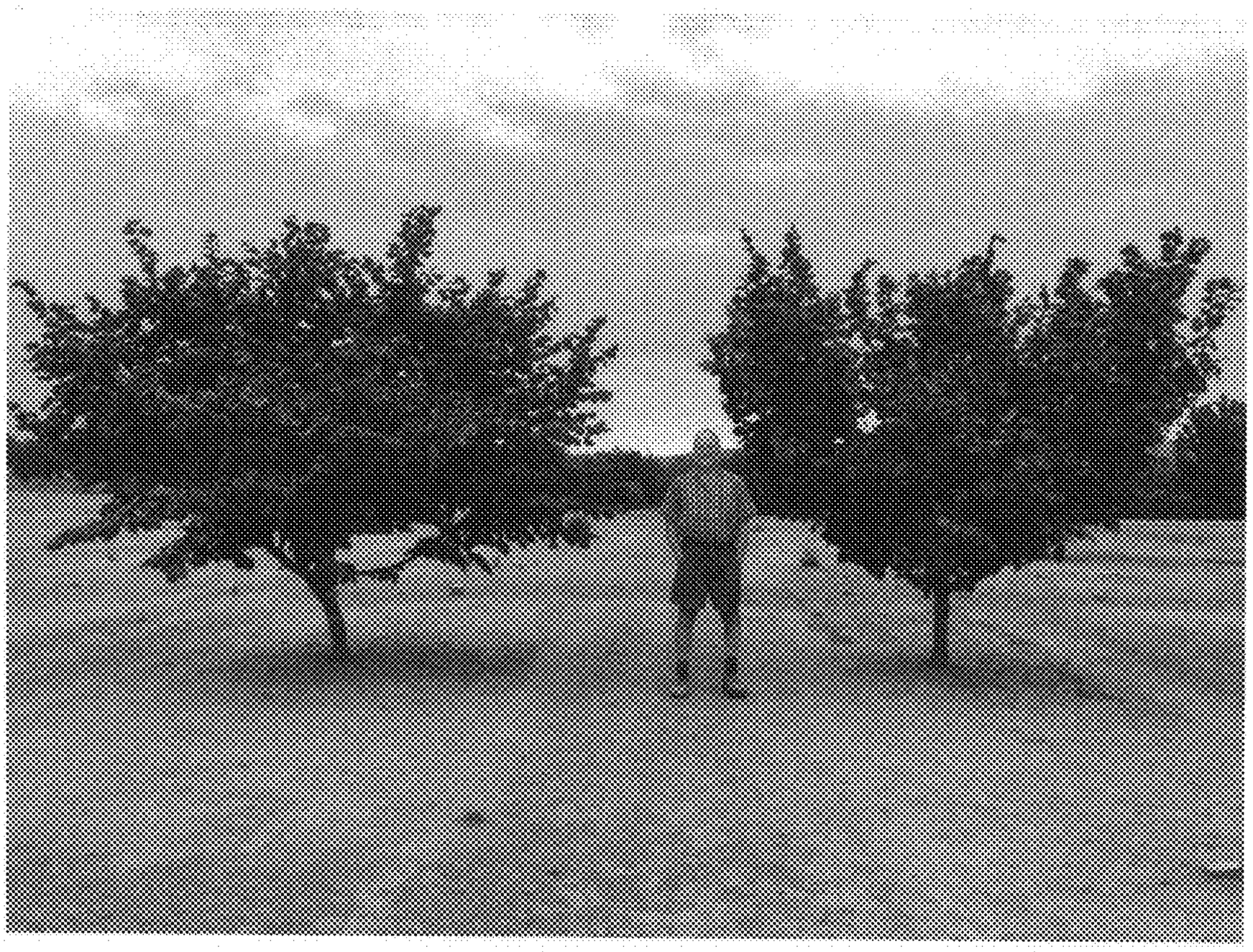


FIG. 5

FIG. 6

FIG. 7

FIG. 8

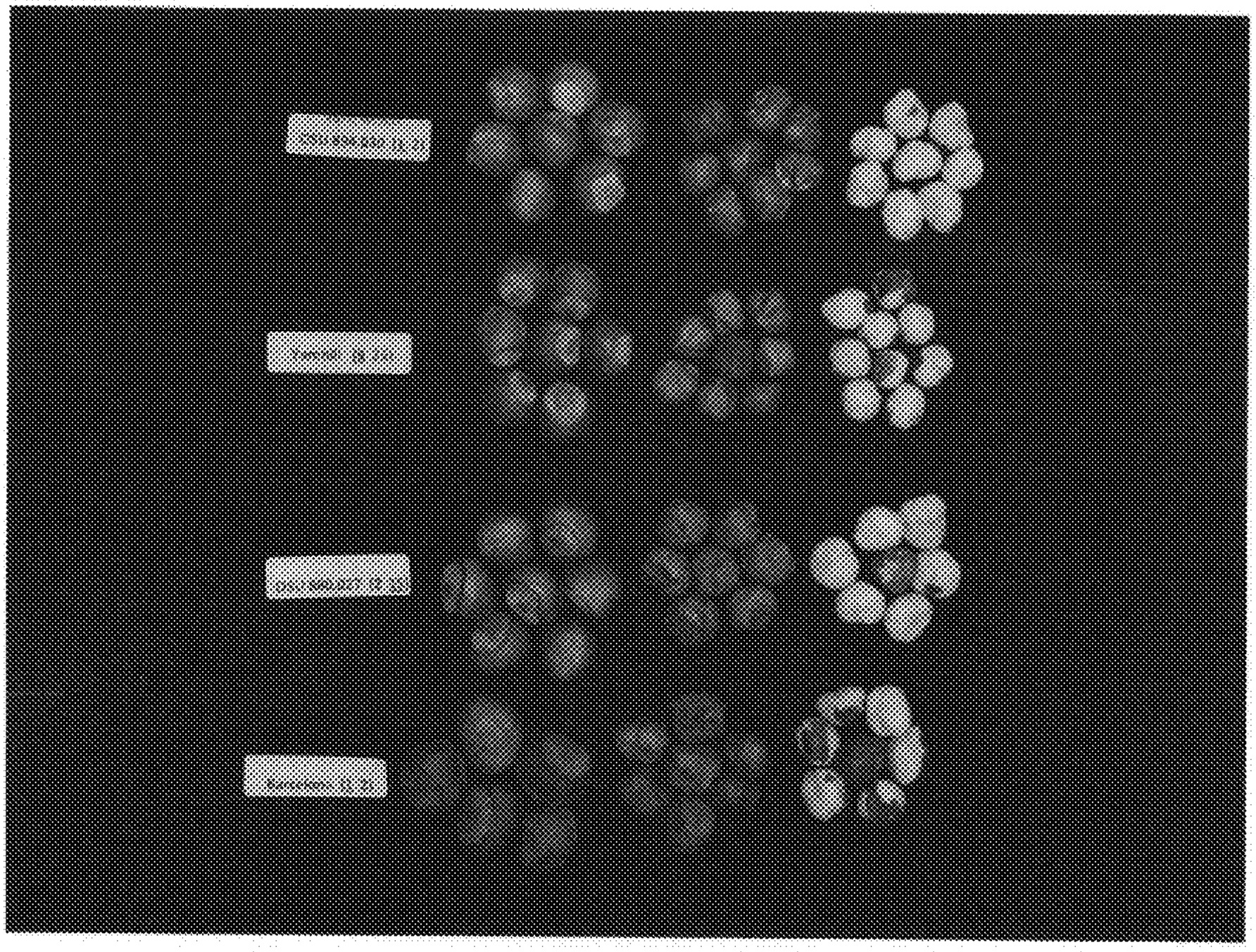


FIG. 9

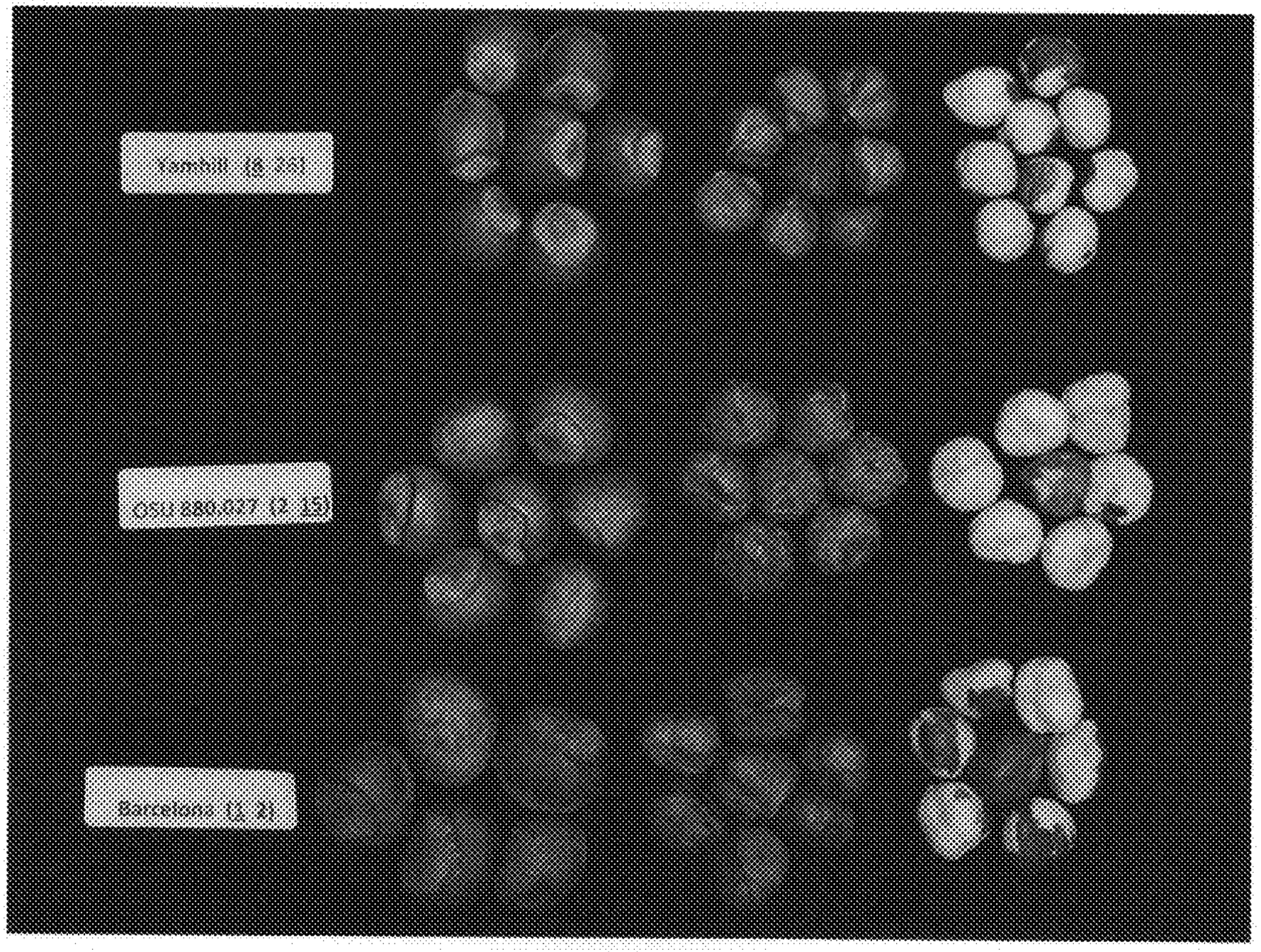


FIG. 10

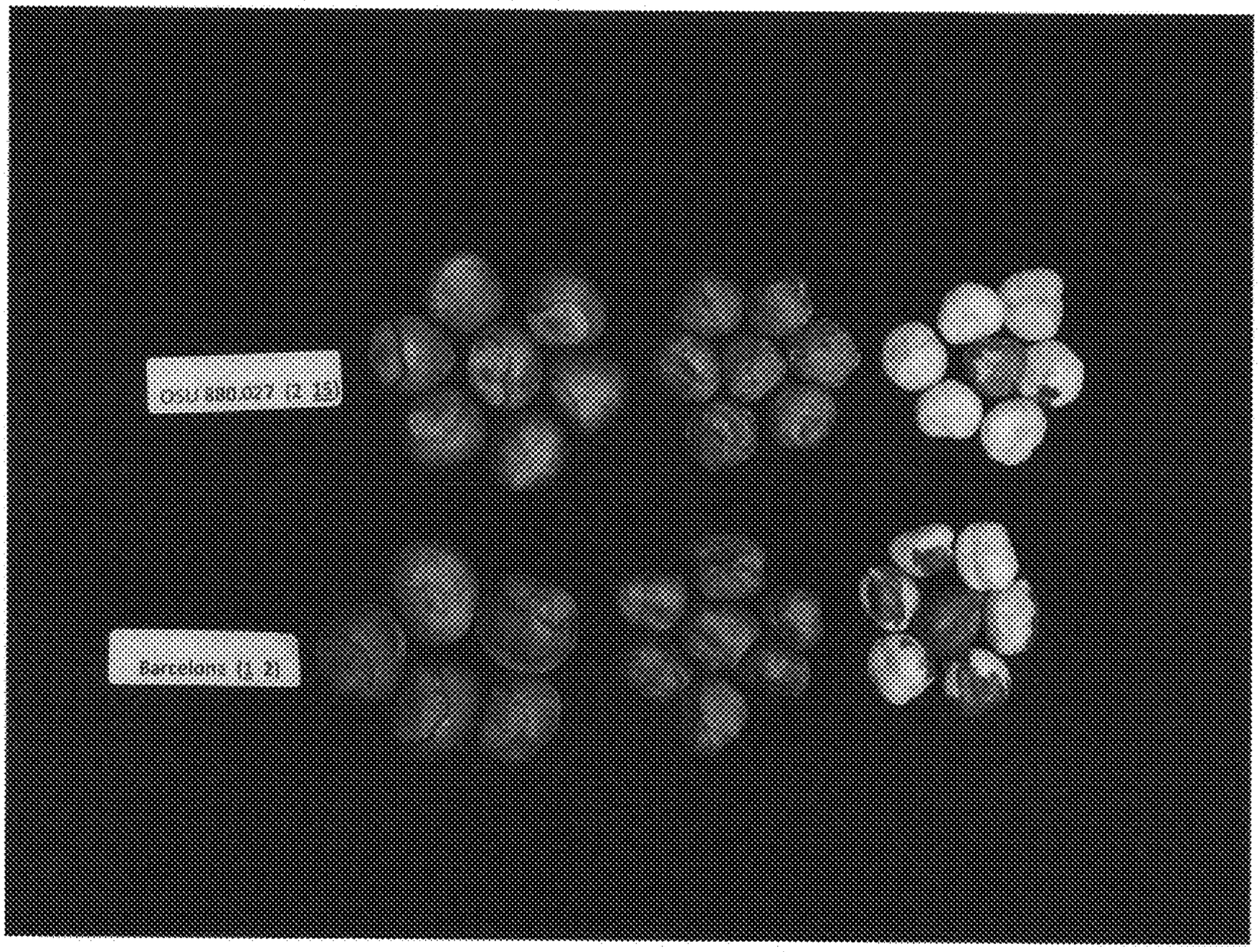
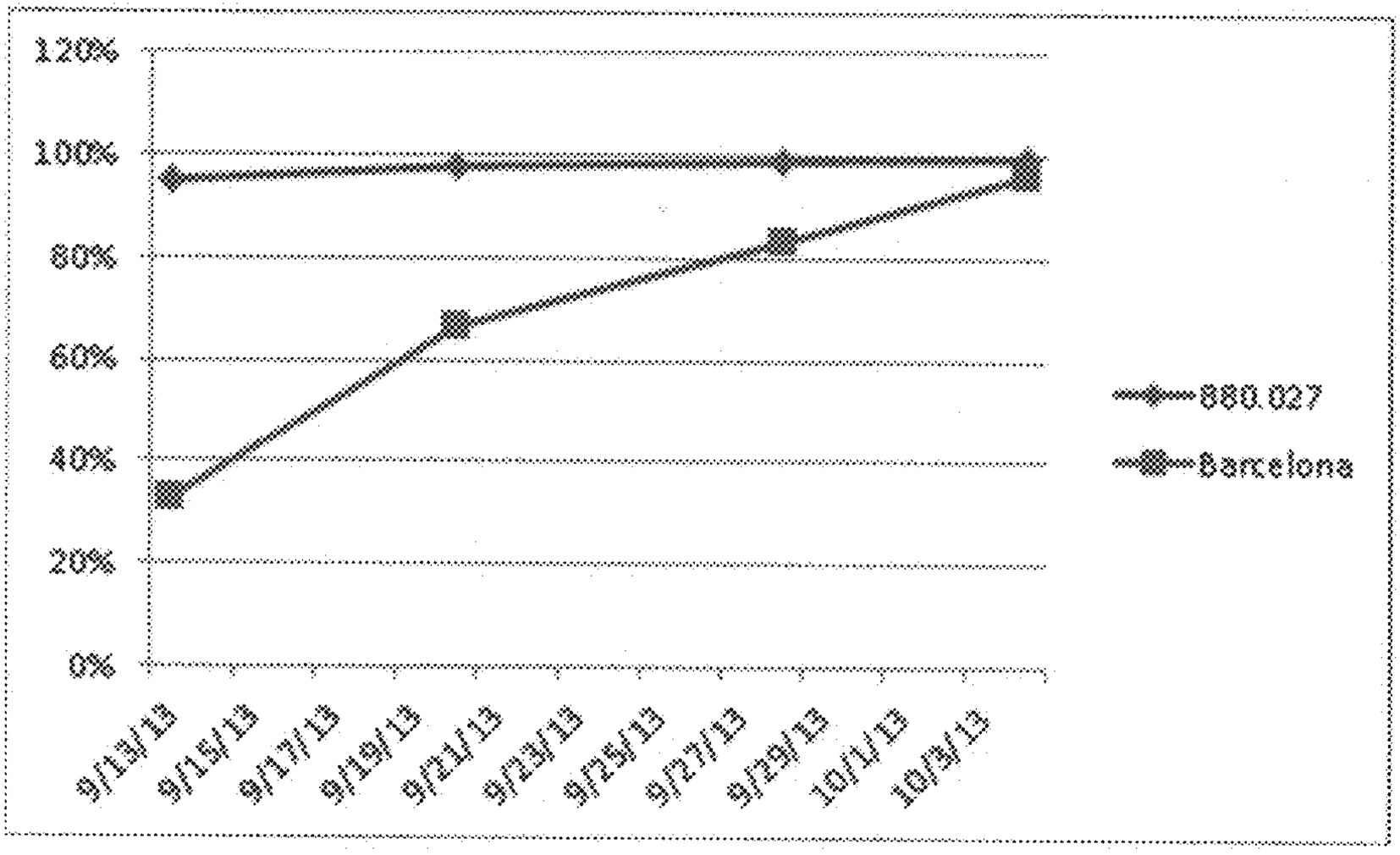


FIG. 11


120%
100%
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9/17/13
9/19/13
9/21/13
9/23/13
9/25/13
9/27/13
9/29/13
10/1/13
10/3/13
880.027
Barcelona

FIG. 12A

Phenology Chart 1. Time of female receptivity (bottom, red) and pollen shed (top, green) of OSU 880.027 and other hazelnut cultivars (Dec 2011 - Mar 2012).

	Dec		Jan						Feb						March			
Genotype	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-29	1-5	6-10	12-21	25-31
Wepster								10	95-90	-50	-90							BB
(1, 2)	Rd+3	Rd+3f		Rd/f+2	I+3	I+3	I+3fS		I+3/S+3									
06						dk			blk			Red/dk						
T. di Giffoni	1st			5	10	25	75	~95	~90	BB	Leaves 1/4"							
(2, 23)	Red		I+2/S	I+2/S+2	MS			MS	MS									
02					dk			dk	blk									
Yamhill				20	50	95	100-50		~90	done		gr lsp			BB			
(3, 26)	Rd		Rd+3f		MS+2	I+2/S+2			I+2/S+3	MS	MS							
109-1 '07					Red	Red/dk			dk		blk							
Dorris					10	50	90-20		~95	done								BB
(1, 12)				Rd+2	Rd+3			Rd/f+3	I+2/S	I+2/S+2	MS							
08					blk				dk/blk		bb							
York							30		100-50	~80								BB
(2, 21)			Rd+2		Rd+3	Rd+3f	Rd/f+2		I+3/S		I+3/S+2		MS					
06					dk		dk		dk		blk		blk					
Lewis						1st	35	60-20	90-30		~80		BB					
(3, 8)			1st Rd				Rd/f	I+2	I+3		I	I+2/S+2						
02							Few female	Red	Red		Red	Red						
Santiam						1st	20	100-50	done						BB			
(3, 15)	Rd+2		Rd+2		Rd+3	Rd+3	Rd+2fs+3		I+3/S		I+2/S+3	MS						
06	Black			bk	bk				blk		blk	blk						

Female flower stages: RD = Red dot; I = styles protruding ~1-3mm, straight; FS = First appearance of 'spiders' (reflexed styles), and MS = majority of flowers are in 'spider' stage.

Green = Pollen shed (a minus sign in front of the number indicates the percent of catkins that have already shed out); drop = 50% catkins dropped.

Red = Female flowers, red, blk (black), dk (dark, not quite red, not yet black).

BB = date of leaf budbreak.

FIG. 12B

Phenology Chart 1. Time of female receptivity (bottom, red) and pollen shed (top, green) of OSU 880.027 and other hazelnut cultivars (Dec 2011 - Mar 2012).

	Dec		Jan						Feb						March			
Genotype	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-29	1-5	6-10	12-21	25-31
Wepster								10	95-20	-50	-90							BB
(1, 2)	Rd+3	Rd+3R		Rd/I+2	I+3	I+3	I+3/S		I+3/S+3									
06						dk			blk			Red/dk						
Sacajawea					1st	10	75		100-60	-80					BB			
(1, 22)	Rd+3R		Rd/I+3	I+2/S	I/S+3		MS		MS		MS	MS						
06	Red		Red		Red/dk		Red/dk				dk/dk	blk						
880.027					5	20	100-40		-80									BB
(2, 15)	Rd		Rd+2	Rd/I	Rd+3R	I+2	I+3/S		I+2/S+3	MS	MS							
06					dk		dk		dk	dk	dk/dk							
Hall's Giant					1st	25	80		95-10	-40	100-60	-80						BB
(5, 15)					Rd	Rd	Rd/I		I+3	I+3/S+2	MS	MS						
02									Red		Red	dk						
Gamma							85		90-20	-70								BB
(2, 10)				Rd		Rd/I	Rd+3R+2		I+2/S		I+2/S+2							
09						Red			Red		Red	blk						
Felix							1st		10	30	50	95-80						BB
(15, 21)	Rd/I			Rd+2R+2		I+3/S			I+3/S+2									
07				dk		Red			Red		Red/dk							
Jefferson							1st		10	75	100-50	-80						BB
(1, 3)			1st Rd				Rd		Rd+2	Rd	Rd/I+2	I+2/S+2						
06												Red						

Female flower stages: RD = Red dot; I = styles protruding ~1-3mm, straight; FS = First appearance of 'spiders' (reflexed styles), and MS = majority of flowers are in 'spider' stage.

Green = Pollen shed (a minus sign in front of the number indicates the percent of catkins that have already shed out); drop = 50% catkins dropped.

Red = Female flowers; red, blk (black), dk (dark, not quite red, not yet black).

BB = date of leaf budbreak.

FIG. 13A

Phenology Chart 2. Bloom stage and pollen shed of hazelnut cultivars, pollinizers and selections (Dec 2012 - Mar 2013)

	Dec		Jan						Feb						March			
	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10		
Genotype	22-Dec	30-Dec	4-Jan	9-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
Area 11							warm/dry											
T. Pacifica				5			15	75	100 -40	-80		Gr tip			BB			
(1, 2)		Rd	Rd+3	Rd8+2			Rd / I+3	I+3	I / S+3	MS			MS					
06							Dark		Red/dk				Dark					
Area 12 (planted 1980)																		
TGDL	36	85	75	-90	-95						Gr tip	BB						
(2, 7)		Rd	I+2 / S+2				MS		MS	MS			MS					
R01.05			Red				Red		Red/dk		Dark		Black					
Area 12 (planted 2007)																		
Yamhill						1st	25		75	100 -20	-90		Gr tip	BB				
(8, 26)		Rd	Rd+2	Rd / I	n/c	n/c	Rd8+2	I+2/S+3	n/c	MS			MS					
109-1 '07			Red				Red	Red	Red/dk				Black					
Area 17																		
Dorris							30		95	100 -40								
(1, 12)	Rd+3	Rd+2 / I	Rd			Rd+3	I+3 / S		I+2 / S+2				MS	MS		Gr tip	BB	
06						Dark							dk/blk	Black				
York							1st		25	75	100-30	-90		Gr tip			BB	
(2, 21)	Rd+2	Rd+3			Rd+3 / I	Rd+2 / I+2	I+3 / S		I/S+3				I / S+3					
06						Dk	Red		Dk				Dark	Black				
880.027							25		75	-90				Gr tip		BB		
(2, 15)	Rd+2	Rd+3			Rd+2 / I	Rd / I+3	I+2 / S+3		MS		MS							
06						Red			Red		Dark							
Webster							1st		20	95	-80			Gr tip			BB	
(1, 2)	Rd+3d	Rd+3d	Rd+3d			Rd8+3	I/S+3				MS							
06			Red			Red					Dark							

Flower stages: RD = Red dot, I = styles protruding ~1-3mm, straight; FS = First appearance of 'spiders' or flowers with reflexed styles, and MS = majority of flowers are in 'spider' or fully reflexed stage.

Green = Pollen shed (a minus sign in front of the number indicates AS62the percent of catkins that have already shed out); drop = 50% catkins dropped.

Red = Female flowers; red, blk (black), dk (dark, not quite red, not yet black).

FIG. 13B

Phenology Chart 2. Bloom stage and pollen shed of hazelnut cultivars, pollinizers and selections (Dec 2012 - Mar 2013).

	Dec		Jan						Feb						March			
	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10		
Genotype	22-Dec	30-Dec	4-Jan	8-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
Area 17																		
Santiam								65	100					Gr tip	BB			
(3, 15)			Rd		Rd+2		Rd / I+2	I+2 / S+2	I / S+3	MS			MS					
06			Dark				dk			dk			blk					
Yamhill								20	80	95	60		Gr tip		BB			
(8, 26)	Rd+3	Rd+3 / I		I+3 / S			I+3 / S	I / S+3	S+3	MS	MS							
06							Red			Red	Dark							
Jefferson										40	100	60				Gr tip	BB 3/22	
(1, 3)				1st Rd				Rd+2 / I+2		I+2		I+3	I+2 / S+2	MS		MS		
06								Red		Red		Red/dk	Dark			Dark		
Sacajawea								1st	20	100	90		Gr tip	BB				
(1, 22)	I+3		I+3	I+3/S+2				MS			MS		MS			MS		
06			Red					Red			Dark		dk/blk			Black		
Eta / VR										30	70	100-30	80				BB 3/22	
(11, 26)				1st Rd				Rd		Rd/I+2	I+2/S	I/S+3				MS		
06										Red		Red				Red/Dark		
Theta / VR												5	40		75	90	75	BB
(5, 15)	1st Rd		Rd		Rd+2			Rd/I		I+3	I+3/S					MS	Gr tip	post 3/22
06											Red					Red / Black		
A 11 South																		
Felix									5	25	80	100-40	90		Gr tip		BB 3/22	
(15, 21)	Rd	Rd+2		Rd+3			Rd / I		I / S+3		MS		MS					
07							dk	Red	Red/dk				Dk/Blk					

FIG. 13C

Phenology Chart 2. Bloom stage and pollen shed of hazelnut cultivars, pollinizers and selections (Dec 2012 - Mar 2013).

	Dec		Jan						Feb						March			
	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10		
Genotype	22-Dec	30-Dec	4-Jan	8-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
A11 South:																		
Jefferson									1st	30	90	100-70			Gr tip		BB 3/22	
(1, 3)								Rd+3	Rd+2 / 1	I+3	I+3 / S	I+3 / S	I+2 / S+2	I / S+3		MS		
07								Red		Red		Red/dk	Dark			Black		
Santiam							0	50	100 -10						Gr tip	BB		
(3, 15)	Rd 1st	Rd		Rd+2	Rd+3	Rd+3 / 1		I+2 / S	I+2 / S+2	MS		MS						
07		Dark							Dark	dk/blk		Black						
Lewis				1st				40	95	100 -80	-90	Gr tip	BB					
(3, 8)		Rd+2		Rd/I+2			Rd/I+2	I+2/S	S+3	MS		MS	MS					
104-25		Red					Red	Red	Red	Red		Red	Red/dk					
				Weather cold!														
Ares 17																		
Jefferson									10	20	85	100-30	-90			Gr tip	BB 3/20	
(1, 3)								Rd / I		Rd / I+2	I+3 / S	I+2 / S+2	MS			MS		
09											Red/dk	dk	dk			Black		
Gamma								5	55	100 -40	-80			Gr tip			BB 3/23	
(2, 10)							Rd	Rd / I+3	I+2 / S+2		I / S+3		MS			MS		
09								Red			dk		Dark			Black		
Yamhill							1st	15	80	100 -20	-80		Gr tip		BB			
(8, 26)	Rd+2	Rd+2 / I		Rd / I+3	I+3			I+2 / S+2	S+2	MS			MS					
09				Red					Red	Dark			Black					
Santiam								30	100 -10	-30								
(3, 15)		Rd		Rd	Rd+3			I+3	I+3/S+2	MS								
09				Dark					Dark	Black								
Eta (984.075)											1st	30	80	-70	-85		Gr tip	
(11, 28)								Rd		Rd / I+2	I+2 / S	I+3 / S		I / S+2		MS	BB after	22-Mar
09										Red		Red/dk		Red		Black		

FIG. 13D

Phenology Chart 2. Bloom stage and pollen shed of hazelnut cultivars, pollinizers and selections (Dec 2012 - Mar 2013).

	Dec		Jan						Feb						March			
	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10		
Genotype	22-Dec	30-Dec	4-Jan	8-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
Area 17																		
Theta (1001.008)											1st	10	50	70	85	100	Gr tip	late BB
(5, 15)						Rd		Rd	Rd/I	I+3			I+3		I+2 / S	I+3 / S		
09										Dark			Dark			Black		
880.027*								S	70	100 -40	-90			Gr tip		BB		
2, 15		Rd	Rd+3 / I			Rd / I+2	Rd+3 / I+3	I+2 / S+3	S+3	MS	MS	MS	MS			MS		
09 Border							Red			Red	Red/dk	Dark	Ok/Blk			Black		
Dorris								1st	75	100 -25	-90		-			Gr tip	BB 3/21	
1, 12		Rd		Rd+2	Rd+3		Rd+2 / I	I+2 / S		MS	MS							
09 border					dk			Red		Dark	Black							
Wepster									10	50	-90					Gr tip	BB 3/22	
1, 2	Rd+3	Rd+2 / I		Rd	Rd+2 / I+2		I+3	I+3 / S+2		I / S+3	MS		MS					
09 border					Red			Red		Red	Dark		Black					
NCGR																		
Butler								1st	40	100 -20	-80	-95						
(2, 3)			1st Rd		Rd/I		I+2		I+2	I+2/S+2	n/c	I/S+3	MS					
N04.18									Red				Red/Dark					
Daviana							1st	30	75	100 -20	-80							
(3, 11)								Rd	Rd/I+2	I+2/S+2	n/c	I/S+3	MS					
N05.20									Red				Red					