

EVALUATION OF BLACKLINE RESISTANT (HYPERSENSITIVE) CULTIVARS

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ABSTRACT

The purpose of this trial is to evaluate blackline resistant cultivars developed by the UC Walnut Improvement Program for growth and performance, nut quality, flower response to blackline infected pollen, and to further the breeding program stock. Three blackline resistant cultivars 92-16-1, 95-29-4, 97-27-55 and Howard were planted in mid April 2005 in a single row, randomized complete block design with four double tree replicates per variety. In spring of 2007, 95-29-4 was grafted over to 94-22-44. Trees were a uniform size at planting. By 2010, 97-27-55 was the largest followed by 92-10-01 and Howard with the late grafted 94-22-24 being the smallest. With regard to phenology, 94-22-224 is the earliest leafing, blooming, and harvesting while Howard is the latest. The other two varieties are intermediate with 92-10-01 blooming before 97-27-55 but harvesting slightly afterwards. Leafing order of these two varieties is variable by year. In the second year of production (2010) Howard and 97-27-55 have the highest yield ratings and the late grafted 94-22-44 the lowest. Quality data was not available from Diamond as of this writing. Studies testing the varietal response to infected pollen show that none are prone to PFA. However, there is an indication that infected pollen may reduce set and further tests need to be conducted to verify these results.

OBJECTIVES

To evaluate three blackline resistant cultivars developed by the UC Walnut Improvement Program for:

1. Flower response to blackline infected pollen
2. Growth and performance
3. Nut quality

To provide open pollinated nuts to the UC Walnut Improvement Program from a blackline infected area to further the breeding of blackline resistant cultivars.

PROCEDURES

This trial was planted on open ground in a single row to the north of an existing young Howard orchard on Brentwood clay loam soil. The trial is irrigated on one side with the solid set sprinkler system and schedule for the Howard orchard. In 2006, a block of cherries was planted to the north of the trial row so that the trial now receives water from the sprinklers in both orchards for a full overlap that is typical of a standard irrigation system.

Three blackline resistant cultivars 92-16-1, 95-29-4, 97-27-55 and Howard were obtained from Dave Wilson as grafted nursery stock on Paradox rootstock. The trees were fairly uniform $\frac{3}{4}$ " stock with no statistical difference in size among varieties. The trees were planted in mid April 2005 in a single row, randomized complete block design with four double tree replicates per

variety. In spring of 2007, the 95-29-4 trees were grafted over to 94-22-44 by a professional grafter as further testing had determined that the original variety was not blackline resistant. All grafts grew well but this variety is now behind the others in maturity.

Tree growth was measured as trunk circumference at 20 cm above the graft union at planting and for the first 2 years and thereafter at 30 cm above the ground. General leaf and flower phenology data was collected beginning in 2009 once trees had begun to bloom and bear. Yield ratings using the UC Walnut Improvement Program system (Table 3) were collected in 2009 and 2010. Studies to determine tree response to infected pollen were conducted in 2009 and 2010. For these studies, flowers were bagged before they were receptive with 50-60 bags per variety. Once flowers were receptive, half the bags were injected with clean Chico pollen and the other half were injected with blackline infected Chico pollen. Two to three weeks later the bags were removed and nut set/drop evaluated. In 2009 a second evaluation of set was just before harvest and in 2010 the second evaluation was done 7-10 weeks after pollination. Nut samples were collected at harvest for Diamond quality analysis, crackout display, and walnut breeding stock.

RESULTS AND DISCUSSION:

Tree growth is shown in Table 1. Trees were all of uniform size at planting. During the first year 97-27-55 did not have as much growth as the other treatments and one of the Howard trees died. With the addition of irrigation from the north side (the new cherry orchard) in 2006 the growth resumed and evened out in all trees so there were no differences after the 2nd growing season. During that season, another Howard tree was clearly failing to thrive and although wasn't quite dead was taken out of future growth calculations. By the fall of 2009 growth differences had become apparent among the varieties: 97-27-55 was now significantly larger than all other varieties, 92-16-01 was the next largest of the resistant varieties, 94-22-44 (late grafted) was smaller than the other resistant varieties, with Howard being intermediate and similar to both 92-16-01 and 94-22-44.

Trees began to bear in 2009. The leafing and flowering data collected are shown in Table 2. Male bloom is not recorded as the blackline hypersensitive varieties do not produce catkins. Yield and harvest data are included in Table 3. The Diamond quality data from 2009 are included in the Walnut Improvement Program Report for that year. The Diamond quality data for this year were not yet available at this writing due to the statewide late harvest in 2010.

94-22-44 is the earliest leafing, blooming and harvesting cultivar. Bloom is quite rapid with just a few days between 1st female flower and peak female receptivity as is typical of protogynous cultivars. The variety had very light set which may be due to the earlier bloom or a delay in maturity as this variety was grafted 2 years after the other cultivars. The nuts are large and blocky; there may be a problem with shell seal.

92-16-01 is the next variety to bloom. In 2010 leaf out was quite prolonged and although it started leafing before 97-27-55, it didn't achieve 50% leaf out until after that variety, reversing the leafing order from the previous season. It harvested a few days after 97-22-55 and before Howard in both 2009 and 2010. The Yield Ratings were comparable to 97-27-55 and lower than Howard in 2009 but less than both these varieties in 2010. The nut is medium sized with a

pronounced tip and a high percentage of light kernels. There was a little Walnut Husk Fly on this variety late in the season.

97-27-55 is the next variety to bloom. Leaf out was the same as Howard in 2009 but in 2010 it was two weeks earlier than Howard and 1 week earlier than 92-16-01. Leafing was very uniform in 2010 compared to the prolonged leaf out of 92-16-01. It harvested a few days before 92-16-01 in both 2009 and 2010. Yield Ratings were comparable to 92-16-01 and lower than Howard in 2009 but were comparable to Howard in 2010. Nuts are smaller with some shell staining and open seals. The tree bark has a distinctive maroon color. This variety had a good deal of drop from Walnut Husk Fly. I expect this will be reflected in the quality samples.

Howard is the last variety to leaf, bloom and harvest and has been the highest yielding in both years although 97-27-55 was similar in 2010. Catkin abundance was quite sparse in 2010 in both the trial and adjacent Howard block as well as in most other varieties in the area.

The results of the pollination studies are included in Tables 4 and 5. These pollination studies were done in an attempt to determine the response of these new hypersensitive cultivars to infected pollen. This response may be a critical factor in their potential to become commercial options in blackline infested areas. If the hypersensitive response causes the nuts to abort when pollinated by infected pollen this will reduce yield.

In the spring of 2009 Gale McGranahan and her staff from the Walnut Improvement Program bagged and pollinated 2 of the hypersensitive selections and Howard. The third selection (94-22-24) had bloomed earlier than pollen could be collected for injection. They removed bags and evaluated nut drop 2 weeks after pollination. There was no difference in nut drop between clean and infected pollen. A week before harvest I made a second, unplanned count of nut set as I noticed that few of the flagged limbs had nuts. The mature nut set on limbs that were pollinated with infected pollen was less than half of that on those pollinated with uninfected pollen. Surprisingly, this increased drop also occurred on Howard as well as the two hypersensitive varieties. However, only 40-60% of the original bagged and flagged limbs remained after summer pruning, so the study was repeated in 2010 to get a more comprehensive data set and to include the earlier variety.

In the spring of 2010 Chuck Leslie and I bagged limbs on each variety and pollinated them as they became receptive with the pollen that had been stored in the freezer from the previous years test. Half the bags were injected with the infected pollen and half with clean pollen. The bags were removed and set evaluated 18-21 days after pollination. As we saw the previous year there was no reduction in nut set due to infected pollen. Input from Dr. Vito Polito indicated that this timing would give a good evaluation of PFA drop and that drop due to lack of pollination would not be apparent until 4-5 weeks after pollination. I did a second evaluation 7-10 weeks after pollination and found no set on those pollinated with infected pollen and very low set with those pollinated with clean pollen. This poor overall set is most likely due to compromised viability of the stored pollen.

It is clear that these 4 varieties are not subject to PFA drop. There is an indication that infected pollen may reduce nut set but no conclusions can be drawn from the limited data. Another trial is planned for next season with fresh pollen.

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Table 1: Average tree circumference taken at 20 cm above the union in 2005, 2006, 2007 and at 30 cm above ground in 2009 and 2010.

<i>Variety</i>	<i>Apr '05</i>	<i>Feb '06</i>	<i>Jan '07</i>	<i>Oct '09</i>	<i>Mar '10</i>
92-16-01	6.4	7.5 b	13.3	43.7 b	43.9 B
94-22-44	5.7	6.4 b	11.3	32.4 a	33.0 A
97-27-55	6.0	5.0 a	12.3	56.4 c	61.4 C
Howard	5.9	6.5 b	10.8	37.3 ab	37.1 Ab
	N.S.		N.S.		

Table 2: Phenology observations

<i>Variety</i>	<i>50% Leaf Date</i>		<i>1st Female</i>		<i>Peak Female</i>		<i>Last Female</i>	
	2009	2010	2009	2010	2009	2010	2009	2010
92-16-01	< 4/1	4/7	4/4	4/4	4/14		4/21	
94-22-44	< 4/1	3/23	4/3	3/29	4/5		4/14	4/15
97-27-55	4/1	3/30	4/13	4/15	4/21		4/28	
Howard	4/1	4/12	4/15	4/16	4/22		4/28	

Table 3: Yield and harvest data

<i>Variety</i>	<i>Harvest Dates</i>		<i>Yield Rating</i>		<i>Yield Rating System</i>
	2009	2010	2009	2010	
92-16-01*	10/6	10/7	5.7 b	5.3 b	1 = 1-2 nuts 2 = 3-10 nuts 3 = Look close to see nuts 4 = Low yield – easy to see nuts 5 = Low commercial yield 6 = Acceptable commercial yield 7 = Good commercial yield 8 = Great commercial yield 9 = More nuts than leaves
94-22-44	9/30	9/29	1.6 a	3.8 a	
97-27-55*	10/6	10/7	5.6 b	6.1 c	
Howard*	10/6	10/7	6.5 c	6.5 c	
* harvested the same date but maturity varied by a few days with 97-27-55 (earliest) < 92-16-01 < Howard (latest)					

Table 4: Bagged pollination results for 2009

<i>Variety</i>	<i>14 days post pollination</i>				<i>At Harvest</i>	
	<i>% Nut Set</i>		<i>Bags with set</i>		<i>Bags with set</i>	
	Infected	Clean	Infected	Clean	Infected	Clean
92-16-01	62%	63%	18/28 (64%)	16/24 (66%)	2/11 (18%)	6/14 (43%)
97-27-55	89%	85%	24/26 (92%)	18/20 (90%)	5/13 (38%)	6/11 (54%)
Howard	95%	98%	19/20 (95%)	23/23(100%)	3/10 (30%)	14/15(93%)
Average	82%	82%	84%	85%	29%	63%

Table 5: Bagged pollination results for 2010

<i>Variety</i>	<i>18-21 days post pollination</i>		<i>50-70 days post pollination</i>	
	<i>% Nut Set</i>		<i>% Nut Set</i>	
	Infected	Clean	Infected	Clean
92-16-01	76.4%	79.1 %	0.0%	3.0%
94-22-24	96.3%	91.6%	0.0%	1.1%
97-27-55	80.9%	83.1%	0.0%	3.4%
Howard	96.7%	94.7%	0.0%	2.1%
Average	87.6%	87.1%	0.0%	2.4%