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Increased Suberin Accumulation in Peach x Almond Hybrids

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Abstract. **Suberin accumulation in mechanically wounded bark tissue was determined fluorimetrically in greenhouse-grown peach [*Prunus persica* (L.) Batsch] and F_2 progeny from peach x almond [*P. amygdalus* (Mill.) DA. Webb] hybrids. In general, suberin accumulation following wounding was significantly greater for progeny from almond-type than for peach-type hybrids. Hybrids from parents with almond tree type combined with peach fruit type accumulated the highest suberin levels. These data may partially explain the differences observed among peach and peach x almond hybrids in relative susceptibility to Leucostoma canker [*Leucostoma persoonii* Hohn. and *L. cincta* (Fr.) Hohn.] and injury caused by lesser peachtree borer. The association of higher suberin accumulation with specific phenotypic characteristics could simplify the selection of desirable seedlings in a breeding program that includes canker resistance as an objective.**

Leucostoma canker, caused by the fungi *Leucostoma persoonii* and *L. cincta*, is a major disease of peach in the northern fruit-growing region of North America. Infections are initiated through injured tissues or cracks in the bark caused by cold-injury, pruning cuts and other mechanical injuries, leaf scars, shade-weakened twigs, etc. There are no known chemical or cultural treatments to prevent *Leucostoma* infections (Biggs, 1989b).

Low levels of natural resistance to *Leucostoma* spp. have been observed in peach cultivars and germplasm (Chang et al., 1989; Scorza and Pusey, 1984). Resistance in peach has been correlated with the rate of suberin formation in wounds (Biggs, 1989a; Biggs and Miles, 1988). The heritability of suberin has been shown to be high for full sib families (h^2 = 0.93–0.96) and moderately high (h^2 = 0.47–0.56) for individual trees (Biggs et al., 1992). Suberin accumulation is moderately difficult to determine and no field characters associated with it have been described.

Puterka et al. (1993) reported a reduced incidence of lesser peachtree borer (*Synanthedon pictipes* Grote and Robinson) (LPB) infestation and Leucostoma canker in F_1 peach x almond hybrids. They concluded that peach x almond hybrids could be valuable sources of resistance to LPB and *Leucostoma* spp.; however, they suggested that further studies were needed to elucidate the inheritance and mechanism of resistance and linkage to almond traits. In this study, we examined peach and F_2 peach x almond hybrids developed from the F_1 trees studied by Puterka et al. (1993) to determine the presence of variation in suberin accumulation following wounding.

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Materials and Methods

Seed collected from F_1 hybrid trees from a cross of KV77017 peach ('Com-Pact Redhaven' x 'Empress') x 'Mission' almond (Puterka et al., 1993) were stratified for 90 d and planted in the greenhouse in Feb. 1993. Plants were fertilized on a regular basis with 10N–10P–10K plus micronutrients. In July of the same year, these plants were transferred to 400-cm^3 pots. From December to February (90 d), plants were stored in the dark at 4 °C and irrigated when necessary. Following this dormancy period plants were returned to a warm (25–27 °C) greenhouse and placed under a regular maintenance program of fertilization and pest control. Prior to the postdormancy growth flush, all plants were trimmed to 30 cm height and pruned to three main shoots. Plants treated in 1995 were subject to a second 90-d dormancy cycle during Winter 1994–95. Control peach plants were KV77017 and Lovell grafted onto Bailey rootstock. These grafted plants were grown under the same conditions as the F_2 seedlings. F_1 trees were rated as almond-like or peach-like based on characteristics of the leaves and outer bark.

Wounding studies were conducted in Apr. 1994 (one peach cultivar and one clonal selection, and F_2 progeny from six peach x almond hybrid selections, 126 plants total) and 1995 (the same F_2 progeny from four of the six peach x almond hybrids used in 1994, 84023, 84032, 84035, and 84041, 63 plants total) to quantify suberin accumulation in healthy phloem/cortex tissues adjacent to the wound site. Wounds to the depth of the xylem were made with a 4-mm-diameter cork borer on the main stem of each plant, ≈2.5 cm above the soil line. Samples for suberin measurements were taken 10 d after wounding by removing, with a cork borer, the tissues supporting one of the margins at the side of each wound. Suberin measurements were made with fluorescence microscopy as described (Biggs and Miles, 1988). Slides were coded so that the histotechnologist was blind to the specimen identity. The following additional data about the anatomy of wound-related tissues were collected from these samples: total thickness of suberized tissues, including primary lignosuberized tissue and new phellem; the mean number of cells in the new phellem; and the mean suberized cell thickness (calculated as total thickness/number of cells). All measurements were made in the outer cortex just internal to the original phellem. Data were analyzed with the SAS General Linear Models procedure assuming a random effects model and type IV sums of squares for unequal cell sizes (SAS Inst., 1987).

Results

Analysis of variance for suberin accumulation in response to wounding showed significant main effects for genotype and year, although the genotype × year interaction was nonsignificant (data not shown). The lack of a significant interaction of genotype × year indicates that relative suberin accumulation among the clones was consistent in both years of the experiment. The significant year effect was not unexpected since suberin accumulation is influenced by environmental factors, mainly temperature, that could not be kept constant in the greenhouse from one year to the next. Mean suberin autofluorescence values ranged from 11.2 mV for F_2 progeny of peach x almond F_1 hybrid 84035 to 7.8 mV for peach clone 77017, a difference of slightly more than 50%. The two peach x almond F_2 hybrids with the highest suberin accumulation were progeny of F_1 trees with almond tree and peach fruit characteristics, although the progeny mean of the second highest F_1 clone, 84041, was not significantly different from the means of Lovell peach and three other peach x almond F_2 hybrids (Table 1).

When classified according to parental tree type, suberin accumulation was higher for progeny from almond tree types than for progeny from peach tree types (10.1 vs. 9.3 mV, respectively, $P \leq 0.05$). When classified by parental fruit type, suberin accumulation was higher for trees that were the progeny of peach fruit types than for those from almond fruit types (10.3 vs. 9.3 mV, respectively, $P \leq 0.05$).

Anatomical characters varied among clones (Table 1). Lovell peach had the thickest layer of suberized tissue and the most phellem cells at 10 d after wounding, and values for both characteristics were significantly higher than

Table 1. F_1 clone or cultivar, number of F_2 plants examined, F_1 parental tree type and fruit type classification, suberin autofluorescence 10 days after wounding, thickness of the suberized layer, number of suberized phellem cells in the suberized layer, and mean cell diameter from various peach and peach x almond F_2 hybrids wounded in 1994 and 1995.

F_1 clone or cultivar[z] (no.)	F_2 plants examined[z] (no)	F_1 type Tree	F_1 type Fruit	Suberin autofluorescence (mV)[y]	Suberized zone thickness (μm)	Phellem cells (no.)	Cell diam (μm)
84035	49	Almond	Peach	11.2 a[x]	20.1 ab	4.5 ab	4.5 ab
84041	34	Almond	Peach	10.2 ab	17.5 b	4.1 bc	4.3 ab
84034	12	Peach	Almond	9.9 a–c	19.8 ab	4.5 ab	4.7 ab
84023	25	Almond	Almond	9.5 bc	17.5 b	3.6 c	5.1 a
Lovell	28	Peach	Peach	9.3 bc	21.6 a	5.2 a	4.2 b
84032	17	Almond	Almond	9.2 b–d	19.8 ab	4.8 ab	4.3 ab
84030	18	Almond	Almond	8.7 cd	16.9 b	3.6 c	4.9 ab
77017	6	Peach	Peach	7.8 d	20.0 ab	4.7 ab	4.3 ab

[z]Lovell and 77017 were grafted peach plants. Clones 84023, 84032, 84035, and 84041 were wounded in both years.

[y]Autofluorescence intensity measured over a circular area with 272 μm in diameter, each measured area contained ≈100 cells. Nonwounded bark autofluorescence intensity = 0.

[x]Mean separation by Waller–Duncan k ratio *t* test ($P \leq 0.05$).

those measured in F_2 progeny of F_1 clones 84030 and 84023 (F_1 trees with almond tree and almond fruit characteristics), and F_2 trees of F_1 clone 84041 (F_1 trees with almond tree and peach fruit characteristics). For cell size, F_2 trees of F_1 clone 84023 had the largest average number of phellem cells, but this number was only significantly different for that from Lovell peach (Table 1). None of the anatomical features was correlated with suberin accumulation, which was not unexpected, based on previous observations (Biggs and Miles, 1988).

Discussion

Our results suggest that trees with an almond bark and leaf phenotype that produced peach type fruit yield progeny with a higher average suberin accumulation in response to wounding. This suberin response has been linked to a higher level of resistance to Leucostoma canker in peach (Biggs and Miles, 1988; Biggs, 1989a). Whereas the lower level of suberin accumulation was expected in the peach trees (KV77017 and Lovell) based on the higher susceptibility of peach to Leucostoma canker (Puterka et al., 1993), the lower levels of suberin accumulation in progeny of almond tree-almond fruit type F_1 trees was unexpected. An explanation may rest in hybrid vigor in progeny from trees expressing traits from both species. This vigor, if in fact it exists, may result in more production of suberin. The fact that almond type trees with peach type fruit were the highest suberin accumulators is encouraging for the production of resistant peach cultivars since the selection for peach fruit traits may not prejudice the selection of resistant types. Although it appears that a combination of peach and almond traits can produce trees with more suberin accumulation, inoculation studies are necessary to further clarify the link between suberin levels, Leucostoma canker resistance, and peach and almond tree and fruit characteristics that can be used as selection criteria.

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