Proc. of Second World Avocado Congress 1992 pp. 191-198

Properties of *Persea indica,* an Ornamental for Southern California

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Abstract. Persea indica **L. is the only member of the genus *Persea* surviving the Laurasian Mediterranean flora in Europe and Africa. Its evergreen foliage and small fruit make *P. indica* an attractive ornamental and a useful shade tree that improves the microclimate throughout the year. The concentrations of macro- and micronutrients in leaf tissue are comparable to the recommended levels for mature avocado trees. Analysis of essential oils shows high amounts of sesquiterpenes, of which caryophyllene and delta-cadinene are the major constituents. Chemical components of the leaf oils of the commercial Hass and Fuerte cultivars show many quantitative and qualitative differences compared to *P. indica.* Immature fruit of *P. indica* can be used in a bioassay to detect *Phytophthora cinnamomi, P. citricola,* and *P. parasitica* in soil.**

Persea indica (L.) Spreng is a living fossil, surviving the rich flora of the middle and late Pliocene vegetation (Axelrod, 1978). As the only member of the genus *Persea* in the once widespread Laurasian Mediterranean flora, *P. indica* currently survives in the maritime climate of the Canary Islands, Madeira, and the Azores. *P. indica* evolved in the African Gondwanaland flora and dispersed to Europe where fossils were found in the Miocene flora of Southern France and Spain (Axelrod, 1978). According to fossils identified in California and dated back to the Miocene, this plant must have migrated west at least 50 million years ago.

Plants of the Lauraceae are characterized by prominent oil cells in the leaves, wood and fruit. These oils are mostly aromatic and find wide use as medicine (sassafras tea, camphor), spices (cinnamon), and flavors (bay leaf) (Schroeder, 1976). *P. indica* is classified in the genus *Persea,* and the subgenus *Eriodaphne.* Although *P. indica* is a relative of the commercial avocado, *P. americana,* these two species are not graft compatible (Schroeder and Frolich, 1955).

Ornamental properties. Plants considered for landscape use enhance the environment in a variety of ways: physical, aesthetic, economic, and psychological (Harris, 1983). Landscape trees in populated areas are valued mainly for their improvement of the microclimate. Shade from trees reduces solar radiation and reflection from soil. Trees also modify wind patterns and reduce wind velocity. To a certain extent, plants can

remove pollutants from the air, and can absorb noise. Visual benefits play an increasing role in densely populated areas, and in this regard trees fulfill many different functions, such as providing color, form, texture, and patterns in the landscape. Economic benefits of trees in the landscape range from monetary value for the wood to an increase in real estate value. In addition, trees can provide a potential wildlife habitat in urban settings.

Because *Persea indica* exhibits many of these desired features as an ornamental tree, it is frequently planted in Florida and Southern California. The smooth and silver-colored bark provides a striking contrast to the shiny dark green foliage. The tree grows with a straight trunk and has been used as a source of timber in its native habitat. The leaves are oblong, glabrous, and 6 to 13 cm long. Fruit are scarcely fleshy, grow to a length of under 2 cm and are borne in clusters (Fig. 1). Immature fruit are green and turn black when ripening. The evergreen foliage and the small fruit make *P. indica* an attractive ornamental and a useful tree that ameliorates the microclimate throughout the year.

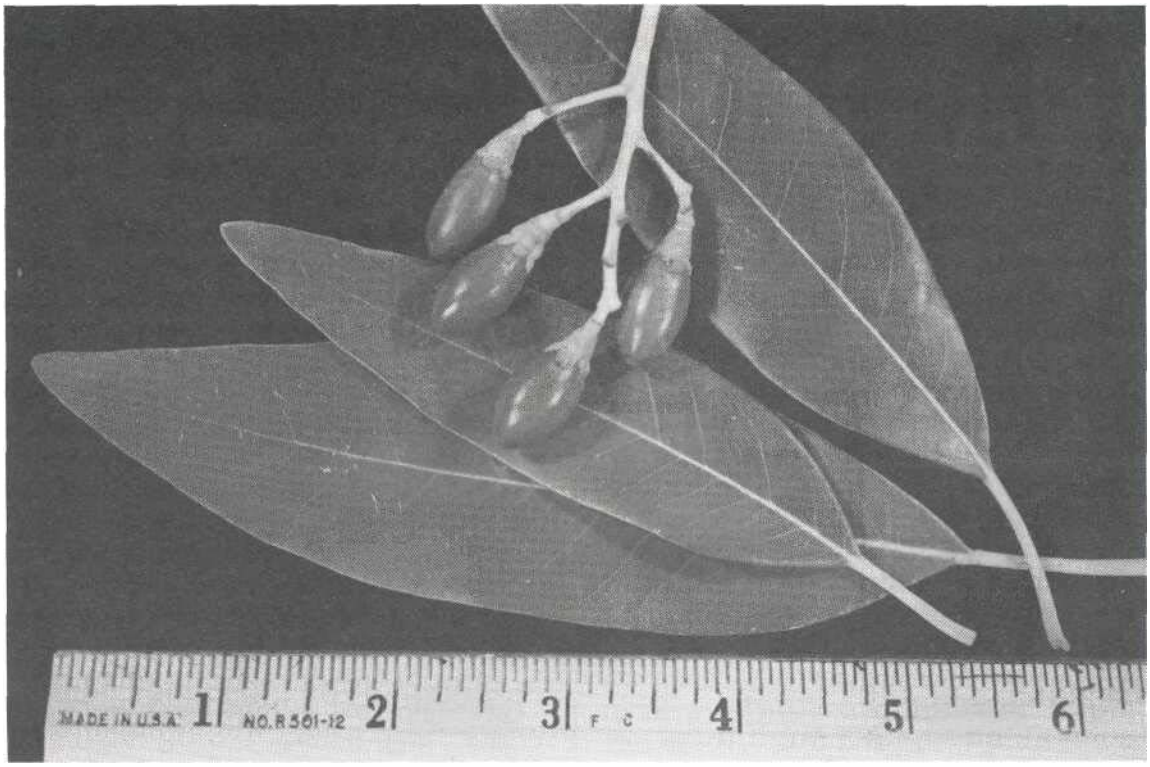

Figure 1. Leaves and immature fruit of *Persea indica.*

Leaf nutrient analysis. The nutritional status of mature *P. indica* leaves was determined. Samples were collected in February from the distal end of branches, oven dried at 70C, and analyzed for macro- and micronutrient concentrations.

Essential oils and alkanes in leaves. For essential oil analysis, 500 g of healthy leaves were randomly harvested from a 32-year-old *P. indica* seedling tree at the University of California Research and Extension Center, Irvine, California. The leaves were macerated and steam distilled in a Clevenger apparatus for 2 h. The resulting oil was

kept under nitrogen until injected into a Shimadzu Mini-3 gas chromatograph with a flame ionization detector and 50:1 split ratio. A J&W DB-5 fused silica capillary column was used with 0.25 mm i.d., 60 m length and 0.25 micrometer coating thickness. The injector temperature was 200C. The oven temperature was programmed to 65C for 30 min and then increased at a rate of 1C/min. to 200C, where it remained for 25 min. N-octane and n-eicosane were added to some samples for standardization of retention times.

For mass spectra identification a Hewlett-Packard 5890II gas chromatograph, a 5971A mass selective detector and G1030A MS computer station were used. A capillary direct interphase heated at 280C delivered column output into the quadruple mass spectrometer with electrons of 70 eV energy for electron impact ionization. The appropriately diluted oil in hexane (1 //L) was injected in splitless mode. Injector temperature was 270C and helium flow was 22 cm/sec. All other parameters were the same as for the Shimadzu gas chromatograph. Some mass spectra were identified by the NIST/EPA/MSDC data base (49,000 spectra) stored in the computer.

Indicator for *Phvtophthora. Phytophthora* root rot is a serious disease causing substantial losses in avocado production (Zentmyer, 1980). In the seedling stage *P. indica* is very susceptible to *Phytophthora cinnamomi,* the major pathogen of commercial avocado, and has been used to test for the presence of the fungus (Zentmyer and Ohr, 1978). For this test, young seedlings are placed in soil suspension, and within 3 to 5 days black stripe cankers develop on the stem and root system. Other species of *Phytophthora,* such as *P. citricola* Sawada and *P. parasitica,* are reported to attack *P. indica* seedlings (Zentmyer, 1980). Another method to test for the presence of *P. cinnamomi* uses whole firm fruit of *Persea americana* that are placed in soil and flooded with water (Zentmyer *et al.,* 1960, 1967; Zentmyer and Ohr, 1978). Purplish brown spots develop at the water line within 4 to 6 days. Recently, however, seedlings of *P. indica* have been discovered in the Canary Islands that show resistance to *Phytophthora cinnamomi* (Schroeder, 1989).

An experiment was conducted to determine whether fruit of *Persea indica* can be used to test for the presence of *Phytophthora* in soil. Green, immature *P. indica* fruit were collected in February and March, 1991 from a tree at the University of California Research and Extension Center, Irvine, California. Field soil, known to be infested with *Phytophthora cinnamomi* and *P. parasitica,* and autoclaved soil for control was placed in Styrofoam cups and Petri dishes. The suspension in the cups consisted of 20 g soil with 200 mL of distilled water, while the slurry in the Petri dishes was prepared with 10 g of soil and sufficient water to immerse half of the fruit. The root system of ten-week-old *P. indica* seedlings was placed in the soil suspension, and green, immature *P. indica* fruit, collected two days before the experiment started, were placed in the soil slurry. The experiment was conducted in a greenhouse at 19/29C average day/night temperatures and natural photoperiod. Development of canker on stems, blackening of roots, discoloration of fruit, and wilting symptoms of seedlings were monitored. Once symptoms were visible, affected plant parts and comparable tissue of controls were plated on selective PVP medium (Tsao and Ocana, 1969) to confirm the presence of

the *Phytophthora* fungi. A second experiment was conducted in the same manner as described above, using autoclaved soil as control, *P. cinnamomi*-infested field soil, and autoclaved soil that was inoculated with 1 mg per container *Phytophthora citricola* (P1273 strain), grown on millet.

Results

Leaf nutrient analysis. Concentrations of macronutrients in *Persea indica* leaves were mostly within the ranges considered adequate for leaves of mature *P. americana* trees (Table 1). Boron levels of *P. indica* were slightly low, and iron levels were threefold above the highest recommended concentration for *P. americana.* Leaves appeared healthy and showed no signs of mineral deficiencies or toxicities.

Table 1. Nutrient concentration in mature *Persea indica* leaves and adequate range of elements in *Persea americana* leaves[z] .

Element	Unit	*P. indica*	*P. americana*
Nitrogen	%	1.87	1.6 – 2.0
Phosphorus	%	0.14	0.08 – 0.25
Potassium	%	0.87	0.75 – 2.00
Calcium	%	1.35	1.00 – 3.00
Magnesium	%	0.47	0.25 – 0.80
Sulfur	%	0.25	0.20 - 0.60
Boron	ppm	40.00	50 – 100
Iron	ppm	671.00	50 – 200
Manganese	ppm	72.00	30 – 500
Zinc	ppm	41.00	30 – 150
Copper	ppm	13.00	5 – 15
Chloride	%	0.18	Excess: 0.25 – 0.50
Sodium	%	0.087	Excess: 0.25 – 0.50

[z] Range of elements for *P. americana* trees adapted from Leaflet 2024, Division of Agricultural Sciences, University of California - revised May, 1978.

Essential oils and alkanes in leaves. The occurrence of essential oils for *P. indica* and *P. americana* cvs. Hass and Fuerte are shown in Figure 2. The ratio of monoterpenes, sesquiterpenes, and sesquiterpene esters are shown in Table 2. Of the monoterpenes, cis-ocimene was the most abundant with 1.1%, and of the sesquiterpenes, beta-caryophyllene (24.0%) was followed by germacrene D (9.1%) and delta cadinene (9.1%). Ratios were similar for *P. indica* and the Hass cultivar, where the majority of oils were sesquiterpenes and sesquiterpene esters. In contrast, oils from leaves of the cv. Fuerte were mainly comprised of monoterpenes and contained no sesquiterpene esters at all.

The order of elution of MS-identified monoterpenes was dimethyl benzene, alpha-pinene, beta-myrcene, decane, beta-phellandrene, cis-ocimene and trans-ocimene. That of sesquiterpenes was delta-elemene, alpha-cubebene, alpha-copaene, beta-bourbonene, beta-caryophyllene, beta-gurjunene, alpha cadinene, gamma gurjunene, alpha-caryophyllene, gamma-muurolene, germacrene D, valencene, alpha-muurole, gamma-cadinene, delta-cadinene, beta-calacorene, alpha-cadinol, and santalol. In 'Hass' and 'Fuerte', beta-pinene, +-limonene, 1,8-cineole, estragole and anethole were additionally identified with the MS. Hass spectra of alpha-cadinene, caryophyllene, sesquiterpene esters, and germacrene D that were isolated from essential oils of *P. indica* are shown in Figure 3.

Alkanes of *Persea* have been analyzed earlier (Scora *et a*l., 1975) and are shown in Table 3. *P. indica* has an alkane composition characteristic of the subgenus *Eriodaphne* with high levels of C_{33} and low levels of C_{29}. Some of the cultivars of the subgenus *Persea* that are hybrids between *guatemalensis* and *drymifolia* are characterized by leaf alkanes comprised of one third of C_{29} and nearly one third of C_{33}.

Table 2. Component percentages of essential oils from leaves of *Persea indica* and *P. americana* cultivars.

	Monoterpenes	Sesquiterpenes (%)	Sesquiterpene esters (%)
P. indica	1.9	72.5	25.6
P. americana cv. Hass	9.9	66.2	23.8
P. americana cv. Fuerte	88.1	11.9	0.0

Table 3. Percent alkane composition in leaves of *Persea indica* and *P. americana* cultivars (from Scora *et al.,* 1975).

Alkane	*P. indica*	*P. Americana* cv. Hass	*P. Americana* cv. Fuerte
$C_{23}H_{48}$	0.5	0.0	0.1
$C_{24}H_{48}$	0.5	0.0	0.1
$C_{25}H_{52}$	1.0	0.7	0.7
$C_{26}H_{54}$	0.9	0.6	0.4
$C_{27}H_{56}$	2.5	12.1	13.3
$C_{28}H_{58}$	1.9	1.3	1.5
$C_{29}H_{60}$	3.1	33.6	33.3
$C_{30}H_{62}$	7.5	3.8	4.1
$C_{31}H_{64}$	3.7	15.2	12.5
$C_{32}H_{66}$	3.8	0.3	0.1
$C_{33}H_{68}$	64.2	29.8	29.5
$C_{34}H_{70}$	5.2	0.6	1.1
$C_{35}H_{72}$	4.9	2.0	3.4

Table 4. Number of *Persea indica* seedlings and immature fruit that developed pathogenic symptoms in a soil suspension or slurry with *Phytophthora* infested soil, or autoclaved soil as control.

	Seedlings				Fruit	
Treatment	Total	Stem canker	Black root tips	Wilting	Total	Discoloration
Exp. 1:						
Control	25	0	0	0	40	0
P. cinnamomi	20	18	20	14	30	27
P. parasitica	20	17	17	0	30	12
Exp. II:						
Control	18	0	0	0	36	0
P. cinnamomi	18	16	18	15	36	28
P. citricola	18	17	18	17	36	22

Support for purchase of the mass selective detector used in this study was provided by National Science Foundation grant DIR-8914574.

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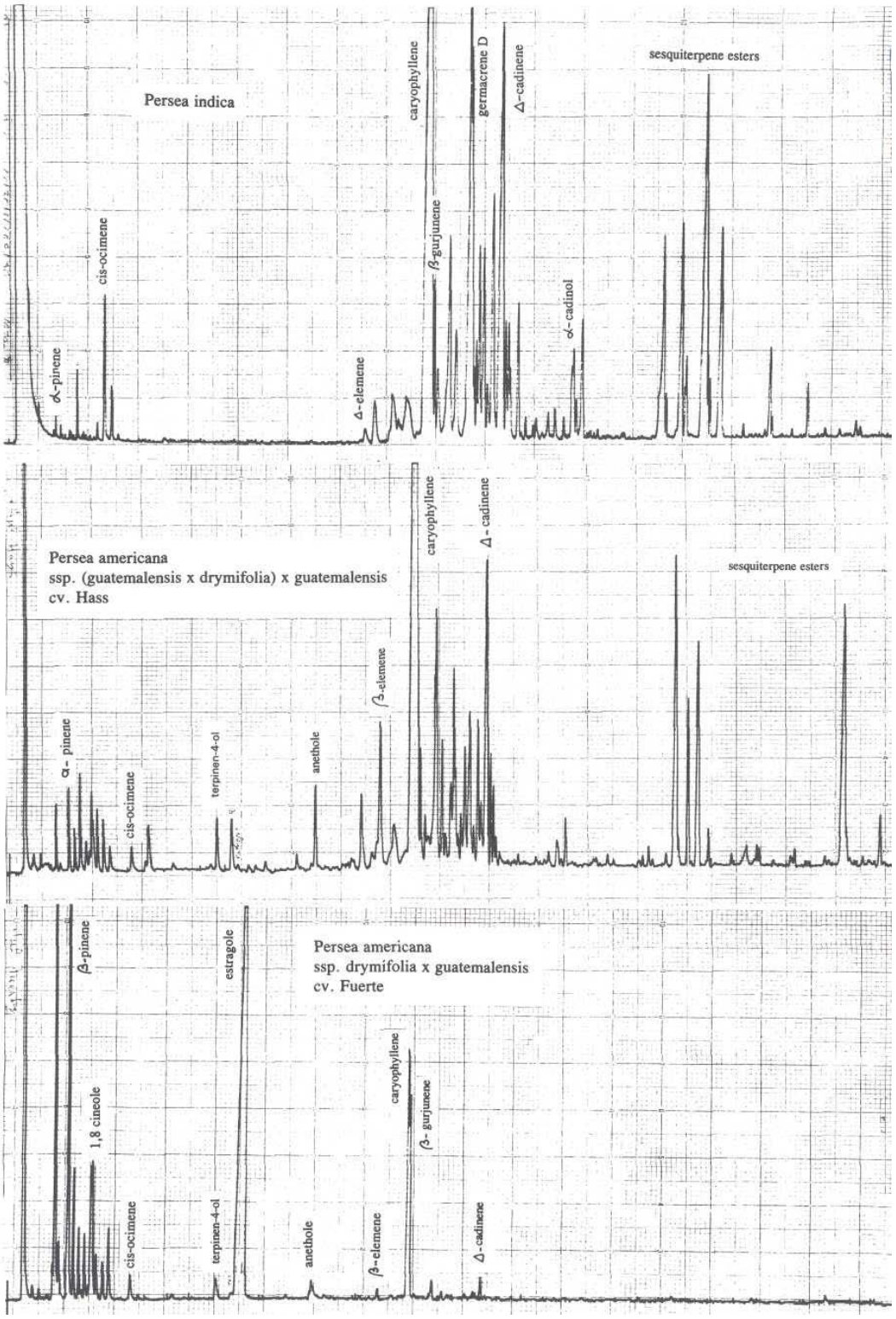

Figure 2. Gas chromatograph analysis of essential oils from leaves of Persea indica and Persea americana cultivars Hass and Fuerte.

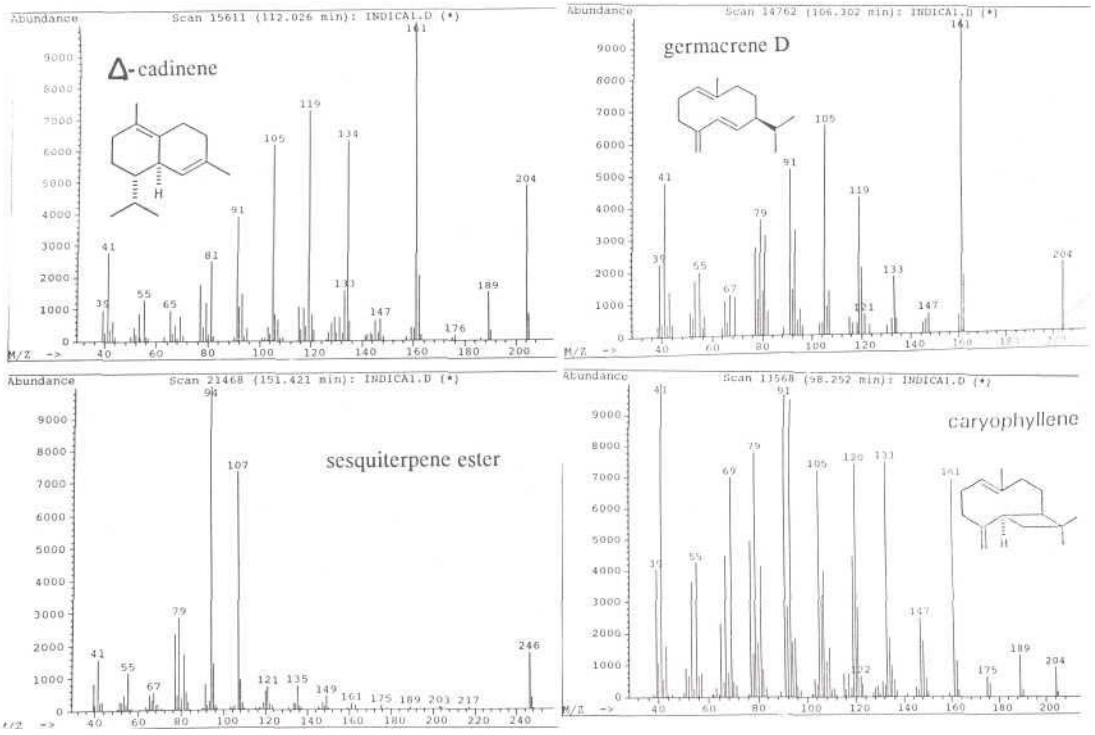

Figure 3. Mass spectrum of compounds isolated from essential oils of *Persea indica* leaves.