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California Avocados in Florida? Finding the Perfect Avocado for Production in East–Central Florida

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Avocado (*Persea americana* Mill.) is a high-value fruit where most U.S. consumption is supplied using imported product. Cultivars with good fruit quality and horticultural traits may provide a useful alternative crop in east-central Florida and possibly in other locations throughout the state. A portion of a population of 'Hass' x 'Bacon' and its reciprocal cross verified at USDA–ARS Subtropical Horticulture Research Laboratory, Miami, FL was planted in Fort Pierce at the USDA–ARS Horticultural Research Laboratory for a genetic mapping study. Extensive phenotypic data on tree growth, flowering, and fruit quality is being collected over the next three years. During the first year of data collection, six selections were identified with promising fruit quality and postharvest shelf life characteristics. These selections were tested in an informal taste panel consisting of 10 judges, with commercial 'Hass' avocado serving as the standard. Each panelist was asked to rate the samples for overall liking, and select the top four ranking samples. The 'Hass' standard ranked first or second in every panelist's ratings, but all tested materials were not rated significantly different from each other, suggesting they all could be commercially acceptable. The top three selections were chosen to be included in future replicated Indian River trials to identify superior performers in this region.

The avocado (*Persea americana* Miller) is an evergreen subtropical fruit tree native to subtropical areas of Latin America, Central America, and the Caribbean where it has been a staple in the diet of natives for many centuries (Ploetz et al., 1994). The genus *Persea* is among 50 genera in the family Lauraceae. A key feature of most members of this family is the presence of aromatic leaves. Other trees belonging to the Lauraceae include the bay laurel or sweet bay (*Laurus nobilis* L., source of culinary bay leaves), camphor laurel (*Cinnamomum camphora* L.), sassafras (*Sassafras albidum* (Nutt.) Nees), swamp bay (*Persea palustris* (Raf.) Sarg.), California bay (*Umbellularia californica* (Hook. & Arn.) Nutt.), and redbay (*Persea borbonia* (L.) Spreng.) (Ploetz et al., 1994).

Avocado originated from Mexico, Central America, and South America and was first planted in the United States in the 1800s. The three main avocado races are Mexican (M) (*P. americana* var. *drymifolia*), West Indian (WI) (*P. americana* var. *americana*), and Guatemalan (G) (*P. nubigena* var. *guatemalensis*). These races are easily distinguished among each other. Mexican types are most cold-tolerant and can withstand temperatures as low as –4 °C without damage (Yahia and Woolf, 2011). Fruits of Mexican varieties have thin skin and take up to 6 months to reach maturity. 'Hass', a Mexican-Guatemalan hybrid, increases in lipid content once mature so it is usually left on the tree, which can flower with last year's fruit still on it. In contrast, West Indian races prefer tropical environments and generally do not tolerate temperatures below –1.2 °C. Their fruit mature within 6–7 months, with a skin that has a thickness between that of Mexican and Guatemalan varieties. Fruit is variable in size and may be very large (> 1 kg). Guatemalan types are intermediate in cold tolerance. While West Indian types originated at low elevations, the Mexican and Guatemalan types are from higher altitude habitats (900–2400 m). Fruits of Guatemalan types have thick leathery skin and vary in size and shape from oval to ovoid and generally require a longer period of time to maturity (12–15 months) compared to the other two races (Ploetz et al., 1994). In Florida, however, fruit typically drops from the trees after only about 6 months. Today, over 90% of California's production is from 'Hass', a (G x M) x G hybrid, and is the main cultivar in other countries such as South Africa, Australia, New Zealand, Spain, Chile, Israel, and Mexico (Ploetz et al., 1994). In Florida, the main avocado cultivars are pure West Indian and West Indian-Guatemalan hybrids that are generally more suited for tropical climates (Knight, 2002).

Due to the decline in citrus production resulting from citrus canker and huanglongbing (citrus greening), some commercial citrus growers and homeowners may wish to consider avocado production to diversify or replace some current plantings. Although avocado production has significant potential, it must be noted that the newly introduced laurel wilt disease is a threat to Florida avocado production. Laurel wilt is caused by the fungus *Raffaelea lauricola* and vectored by the non-native Asian ambrosia beetle *Xyleborus glabratus* or redbay ambrosia beetle (Mayfield III et al., 2008).

California grows Guatemalan and Mexican avocados and their hybrids which have been shown to be more tolerant to laurel wilt than West Indian types. Cultivars with G x WI and WI backgrounds are the ones traditionally recommended for use

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in Florida, but unfortunately these types show higher laurel wilt susceptibility in preliminary tests and 'Simmonds' (WI), a major Florida cultivar, shows especially high disease sensitivity (Ploetz et al., 2012). Finding avocado cultivars with laurel wilt resistance will be a key factor in future sustainability. Another challenge in growing "California-type" avocado cultivars, such as 'Hass' in Florida, is their higher chilling requirements not always fulfilled in Florida, and higher anthracnose and *Phytophthora* root rot disease pressure of Florida's subtropical climate.

Avocado fruit quality and other horticultural traits suitable for production potential in east-central Florida (and possibly other locations throughout the state) are being investigated by evaluating phenotypic data, using a mapping population of 'Hass' x 'Bacon' and 'Bacon' x 'Hass', growing in Fort Pierce, FL. Avocado trees of such a Mexican or Guatemalan background generally provide greater cold-hardiness, which will be critical for production in this region. Six selections with acceptable fruit size, visual quality, postharvest shelf life, and good horticultural traits were identified and included in a sensory evaluation test. Characteristics for selection included a dark skin at maturity to help hide blemishes, a 'Hass'-like flavor and creamy texture, good horticultural growing traits and fruit quality such as good seed to flesh ratio, fruit size, good lipid content, and minimal postharvest rot incidence. Such a successful new avocado cultivar could provide the opportunity for expanding commercial and dooryard avocado production in east-central Florida and possibly other Florida locations.

Materials and Methods

Avocado fruit from the California mapping population of 'Hass' x 'Bacon' and 'Bacon' x 'Hass' were obtained in December 2013 from the USDA, ARS Horticultural Research Laboratory (HRL) farm in Fort Pierce, FL, and transferred to the UF/IFAS, Indian River Research and Education Center postharvest lab in Fort Pierce for ripening. Six selections were chosen based on good horticultural and postharvest traits and were included in the taste panel with store-bought 'Hass' used as a control. Ten fruits for each selection and 10 store-bought unripe 'Hass' fruit were ripened at room temperature (~23°C) without added ethylene in the lab until they were 10–20 N or less in firmness as determined by a Stable Micro Systems Texture Analyser (Model TA-XT2i, Scarsdale, NY, USA) using a flat-plate (5 cm diameter) and a 50 kg load cell. The fruit were measured every other day, at 8 and 12 d postharvest until reaching the fully ripe stage. Only fruits that reached 20–30N on the Texture Analyser (TA-XT2i, Texture Technologies Corp., New York), on the day prior to the scheduled date for tasting were used for the taste panel. The fruit were then transferred to the nearby USDA–ARS HRL sensory lab for washing, sanitizing, and sensory evaluation. Fruits were washed with 200 mL sooty mold solution (Fruit Cleaner 395, JBT Food Tech, Lakeland, FL) per ~2.4 gallons of lukewarm water, followed by a 3-min dip for sanitization dip with 100 ppm peroxyacetic acid (PAA) (Peraclean® 15, Degussa, Ont., Canada). Fruits were air-dried for at least two hours before placing at 5 °C until sensory evaluation the next day.

Sensory Evaluation. Panelists consisted of scientists from the IRREC and USDA ARS HRL as well as California and Florida commercial avocado and citrus industry representatives. The panel consisted of ten panelists and was not a consumer panel, due to its small size and level of general taste-panel experience. Fruit was prepared just prior to tasting by cutting each avocado vertically from the stem to blossom end, separating the halves, and removing the seed. Flesh at the stem and blossom ends, above and below the seed was removed and the remaining portions were peeled and cubed. Pieces (~2 cm^3 each) were placed into 30 mL plastic cups that were labeled with three-digit random numbers for each selection. The tasting was conducted in individual booths, under red lighting, with a small doorway through which trays with the samples were passed. Panelists rated overall preference using a 1–9 hedonic scale with 1 being dislike extremely and 9 being like extremely. Then, they completed a multiple choice questionnaire to best describe each sample. Textural descriptors included: firm, mushy, stringy, gritty, creamy, smooth, dry, watery, and oily. Flavor and aromatics descriptors included: bland, grassy, woody, piney-terpiney, sweet, fruity, nutty, buttery, savory, oily-fatty, and rancid. Those descriptors were selected based on previous research in California (Obenland et al., 2012). Panelists were also instructed to take a bite of carrot or cracker and a drink some water to rinse the palate between each sample (Obenland et al., 2012).

Sample serving was arranged in a William's design (balanced block) with each selection representing a treatment and the 10 panelists as the replicates. Data collection and analysis were performed using Compusense five® sensory software (Guelph, Ont., Canada). Differences between treatments (selections) were calculated using the Tukey's HSD tests ($P = 0.05$).

Results and Discussion

Fruit description. Fruit varied from 99.81 mm length and 65.90 mm width (R8 T23) to 141.95 mm length and 79.65 mm width (R5 T56) (Table 1). Mean fruit weight of each selection ranged from 213.3 (R8 T23) to 400.9 g (R5 T56) with mean flesh weight ranging from 147.7 g (R8 T23) to 356.7 g (R5 T56). Trees produced as little as 55 fruits (R5 T56) to as many as 225 fruits (R8 T36). The six selections in the study were chosen for sensory evaluation because earlier evaluations demonstrated their fruit

Table 1. Fruit number and characteristics from 'Hass' x 'Bacon' and 'Bacon' x 'Hass' avocado trees selected for sensory evaluation. Measurements were made when fruits were ripe (20–30 N) 8 (R7 T36, R7 T21, R5 T56) and 12 (R8 T36, R8 T23, R6 T29) days after harvest. N = 10.

Sample ID	Mean length (mm)	Mean width (mm)	Mean wt (g)	Mean flesh weight (g)	Fruits/tree
R8 T36	100.24	69.32	248.37	189.47	225
R8 T23	99.81	65.90	213.27	147.73	66
R7 T36	132.67	73.15	306.77	268.63	117
R7 T21	101.14	72.94	264.13	208.97	133
R6 T29	106.39	71.07	268.30	203.70	102
R5 T56	141.95	79.65	400.87	356.67	55
Standard error	(7.62)	(1.88)	(26.51)	(30.04)	(24.89)

developed acceptably low incidence of postharvest disorders and rots and had acceptable seed to flesh ratios compared to the other selections (data not shown).

Sensory Evaluation. The R8 T36 selection and commercial 'Hass' cultivar had the highest preference rating (6.5 = like somewhat) of all selections, but there were no significant differences among any of the selections ($P = 0.752$) for overall preference, the lowest, R6 T29, was rated 5.40 (data not shown). This similarity in ranking might be expected, since the selected hybrids were chosen to be close to 'Hass' as a fruit, and the panel size was small, and not representative of any consumer population. However, the high level of acceptance overall supports the potential that high quality new selections may be identified. Each panelist was also asked to rank their four favorite selections: 'Hass' was ranked first, followed by R5 T56 and R8 T36.

Over 50% of panelists characterized each of the evaluated selections as creamy, smooth, and firm (Fig. 1). 'Hass' was rated as the most creamy and the R8 T36 selection was characterized to be equally smooth as 'Hass'. Only a low percentage of panelists used the terms stringy, gritty, watery, or oily to characterize any of the selections.

Two flavor attributes, nutty and buttery, were identified by sensory panelists to be characteristic of the R8 T36, R6 T29, and R5 T56 selections (Fig. 2). None of the panelists thought that 'Hass' had negative attributes like stringy or gritty, and only 10% characterized it as rancid (Fig. 1. Fig. 2). However, only three selections were described as stringy or gritty and only by less than 20% of panelists.

Based upon results of this study, the selections evaluated appear to have fruit quality similar to commercial 'Hass'. Another

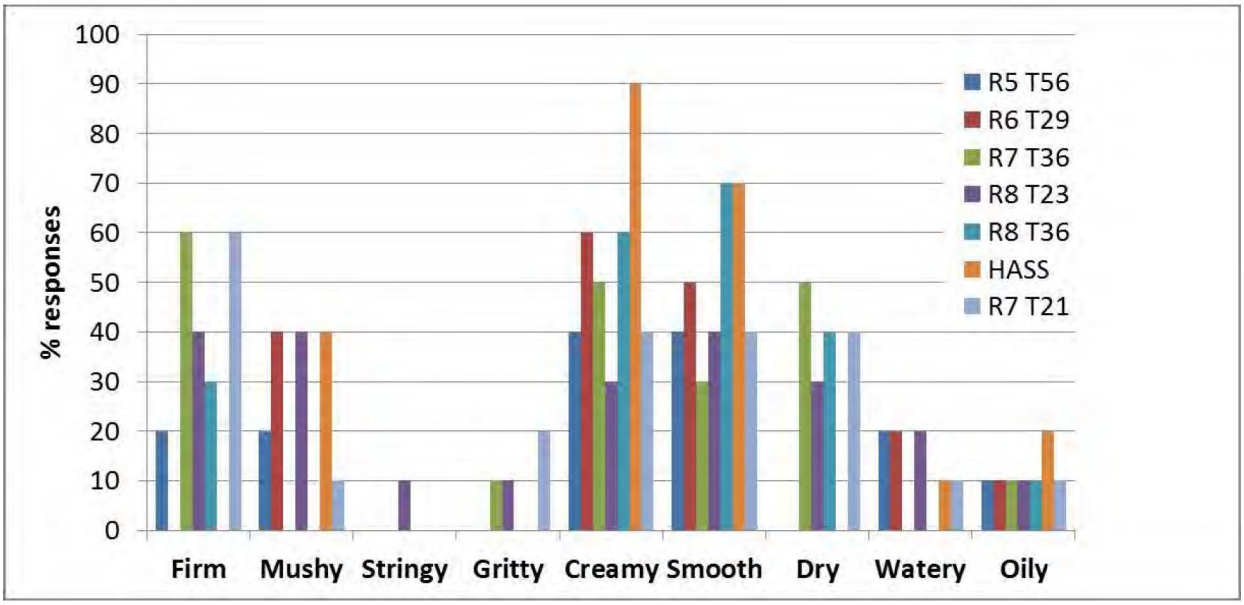

Fig. 1. Percentage of panelists characterizing the avocado flesh texture using the indicated descriptors. Store-bought 'Hass' served as a commercial standard.

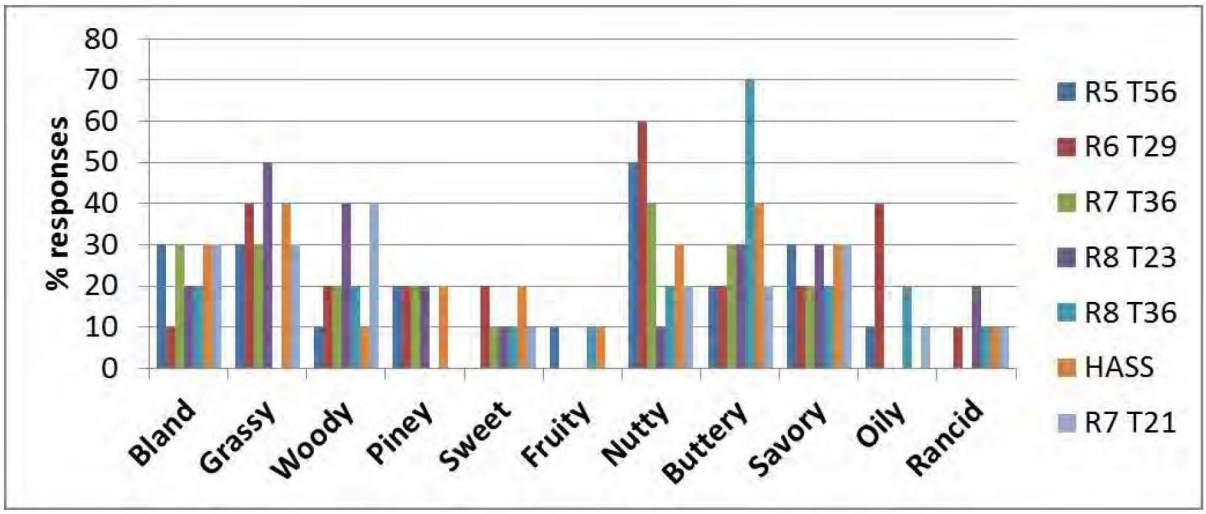

Fig. 2. Percentage of panelists characterizing the avocado flesh flavor using the indicated descriptors. Store-bought 'Hass' served as a commercial standard.

year of phenotypic and postharvest data will add selections to our next likeability study which will be expanded to include a minimum of fifty panelists. We hope to identify suitable selections for production in east-central Florida and address further concerns regarding growing 'Hass'-like avocados in the region.

Literature Cited

Knight Jr., R.L. 2002. History, distribution and uses, p. 1–14. In: Whiley, A.W., B. Shaffer, and N. Wolstenholme (eds.). The Avocado. Botany, Production and Uses. Second edition. CAB International, Wallingford, UK.

Mayfield III A.E., J.A. Smith, M. Hughes, and T.J. Dreaden. 2008. First report of laurel wilt disease caused by *Raffaelea* sp. on avocado in Florida. Plant Disease 92:6, p. 976.

Obenland, D., S. Collin, J. Sievert, F. Negm, and M.L. Arpaia. 2012. Influence of maturity and ripening on aroma volatiles and flavor in 'Hass' avocado. Postharvest Biol. Technol. 71:41–50.

Ploetz, R.C., G.A. Zentmyer, W.T. Nishijima, K.G. Rohrbach, and H.D. Ohr. (eds) 1994. Compendium of Tropical Fruit Diseases. St. Paul, APS Press. p. 71–72.

Ploetz, R.C., J.M. Pérez-Martínez, J.A. Smith, M. Hughes, T.J. Dreaden, S.A. Inch, and Y. Fu. 2012. Responses of avocado to laurel wilt, caused by *Raffaelea lauricola*. Plant Pathology 61:801–808.

Yahia E.M. and A.B. Woolf. 2011. Avocado (*Persea americana* Mill.). In: Postharvest biology and technology of tropical and subtropical fruits. Vol. 2: Acai to citrus. Woodland Publishing Ltd. p. 125–185.