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PERFORMANCE OF CLONAL AVOCADO ROOTSTOCKS IN DADE COUNTY, FLORIDA[1]

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ABSTRACT

Six clonal rootstocks of *Persea Americana* ('Bo Borehard', 'Duke 7*,* 'G1033', 'Parida', 'Thomas', and 'Toro Canyon') and two clonal rootstocks of *P. Americana* X *schiedeana* ('G755b' and 'G755c') were obtained from a commercial nursery in California and tested under conditions found in production areas of Dade County, FL. Rootstocks were grafted with 'Choquette' scions and planted in pots filled with Rockdale fine sandy loam infested or not infested with

Phytophthora cinnamomi. After about four months, a portion of the plants in infested and noninfested soil were flooded for one week. At the end of the flooding period net CO_2 assimilation (photosynthesis), percent root necrosis, and root, shoot, and total plant dry weight were determined for flooded and nonflooded plants. All plant responses were significantly influenced by rootstock cultivar, and these responses were generally not affected by flooding or challenge with *P. cinnamomi.* 'Parida', 'G1033', Toro Canyon', and 'Duke 7' exhibited reduced photosynthesis and biomass accumulations, as well as foliar symptoms of Fe-deficiency and poorly formed and necrotic root systems. Although these results are from a single experiment, it appears that adaptation to alkaline soils may be a primary determinant of the performance of these rootstocks in Dade County.

The Florida avocado industry is based on cultivars of the West Indian (WI) and Guatemalan (G) races of *Persea Americana* and their hybrids. During standard cultural practices, scions of these cultivars are grafted onto seedlings of either 'Lula' (G X WI) or 'Waldin' (WI) (4). The large seed of the latter cultivars produce vigorous, uniform rootstocks which are well-adapted to the calcareous soils in which avocados are grown in Dade County, FL. However, both cultivars are susceptible to phytophthora root rot which is caused by *Phytophthora cinnamomi* (3). The pathogen is widespread in Dade County, and in combination with flooding, phytophthora root rot can cause severe damage to avocado trees in the area (2, 3, 5).

Avocado rootstocks that resist phytophthora root rot have been identified at the University of California at Riverside (1, 8). The program started by Dr. George Zentmyer has produced several tolerant clones and the best of these are now available through commercial nurseries in California.

Our research on the root rot X flooding interaction has focused on identifying responses of avocado in Florida to these factors and on controlling root rot in the presence or absence of flooding. In the present study we assessed eight different cultivars of

rootstock developed in the California program under conditions found in avocado production areas in Dade County; rootstock performance was determined with host parameters that are affected by root rot and flooding (3, 5).

MATERIALS AND METHODS

Rootstocks were clonally propagated by Brokaw Nursery, Inc., Saticoy, CA and air-freighted to Homestead. According to instructions provided by the nursery, rootstocks were grafted within 2-3 days of arriving in Homestead; scions of 'Choquette' were used on all plants. After roots on the clonal rootstocks were well-established, the nurse seed was cut from the clone, the cut surface was treated with Captan fungicide (Captan 50W, Stauffer Chemical Co., Mountain View, CA), and plants were transferred individually to 15 cm-diameter pots filled with a peat-perlite potting medium. After about two months, they were transplanted into 20 cm-diameter pots filled with Rockdale fine sandy loam either infested or not infested with sorghum seed that was colonized by *P. cinnamomi* (3). Plants were incubated in a non-air-conditioned greenhouse in which temperatures ranged from 20-39°C, watered as needed, and drenched about every 2-3 weeks with a commercial 20-20-20 fertilizer. Label rates of a commercial sequestered Fe formulation (Sequestrene 138 Fe, Ciba-Geigy Corp., Greensborough, NC) were applied to all plants one and two months after transplanting, and foliar symptoms of Fe-deficiency were rated visually with the scale devised by Young (7) about one month after each Fe application.

After four months, half of the infested and noninfested plants were flooded for one week in fiberglass reservoirs such that water levels were maintained about 2 cm above the soil surface. Net CO_2 assimilation (net photosynthesis) was determined at the end of the week with a portable gas and water vapor exchange analyzer and a Parkinson leaf chamber described previously by Schaffer and Ploetz (5). A slide projector was used to illuminate leaves in the chamber to insure that photosynthetic photon fluxes exceeded saturation for avocado (6).

Root systems were harvested after the measurement of photosynthesis and washed free of soil under flowing water. Percent root necrosis was determined visually and necrotic roots were assayed for colonization by *P. cinnamomi* by plating on a selective medium (3). Roots and shoots were dried at 70°C for dry weight determinations.

RESULTS

Of the variables tested, only rootstock cultivar had a consistent effect on host responses tested (Tables 1 and 2). Flooding and infestation of soil with *P. cinnamomi* had no or minor effects on net photosynthesis, root necrosis, and dry matter accumulation of plants in the study. Rootstock cultivar had a significant effect ($P < 0.05$) on net photosynthesis, dry matter accumulation, root necrosis, and foliar symptoms of Fe-deficiency (Tables 1 and 2).

Phytophthora cinnamomi was not recovered from plants in noninfested soil. In infested soil, *P. cinnamomi* was never recovered from 'Duke 7', 'G1033', 'Parida', and 'Thomas', was recovered infrequently from 'G755b', 'G755c', and 'Toro Canyon' (i.e., < 1% of all

assayed roots), and from about 9% of the necrotic roots of'Bo Borchard'; rates of recovery for the different cultivars were not significantly different.

DISCUSSION

To a limited or great extent, each host response tested gave an indication of the probable performance of each cultivar in avocado-production areas of Bade County. For example, 'Parida' had significantly lower rates of photosynthesis and dry matter accumulations, and higher levels of root necrosis and foliar Fe-deficiency than some or all of the other cultivars tested; it would probably not be a good rootstock for the area. In contrast, other cultivars such as 'G755b', 'G755c', 'Bo Borchard', and 'Thomas' appear to be well-adapted to soil and conditions in the area (i.e., flooding) and further work may demonstrate their value in Bade County.

Table 1. Response of plants on different avocado rootstocks to growth in Rockdale fine sandy loam.[w]

Rootstock cultivar[x]	Botanical description[y]	Mean Pn[z]	Mean dry weight (g)		
			shoot	root	total
Bo Borchard	*P. americana* M	5.4 ab	169.7 a	39.5 a	209.2 a
Duke 7	*P. americana* M	5.1 ab	95.2 bc	20.7 c	115.9 bc
G755b	*P. americana* G X *P. schiedeana*	6.3 a	116.2 b	31.0 ab	147.2 b
G755c	*P. americana* G X *P. schiedeana*	3.5 ab	170.9 a	30.8 ab	201.8 a
G1033	*P. americana* G	3.5 ab	59.3 bc	17.1 c	76.3 bc
Parida	*P. americana* G X M	1.3 b	45.6 c	17.6 c	63.2 c
Thomas	*P. americana* M	2.0 ab	121.8 ab	25.5 bc	147.3 ab
Toro Canyon	*P. americana* M	3.2 ab	76.8 bc	16.4 c	93.1 bc

[w]Rootstocks were grafted with scions of 'Choquette' and planted in Rockdale fine sandy loam. Plant responses were tabulated after about 4 months. Since neither infestation of soil with *Phytophthora cinnamomi* nor flooding significantly ($P < 0.05$) affected these host responses, responses for each cultivar were pooled across treatments for analysis. Means in columns followed by the same letter are not significantly different according to Tukey's studentized range test at $P < 0.05$.

[x]Rootstocks were clonally propagated by Brokaw Nursery, Inc., Saticoy, CA.

[y]The rootstocks of *Persea americana* are either of the Mexican (M) or Guatemalan (G) race, or are G X M hybrids. 'G755b' and 'G755c' are interspecific crosses between *P. americana* G and *P. schiedeana*. This information was kindly provided by Dr. Bob Bergh, University of California at Riverside.

[z]Mean Pn = net assimilation of CO_2 in μmols m^{-2} s^{-1} for all leaves assayed for a given cultivar.

Table 2. Recovery of *Phytophthora cinnamomi* from and root necrosis and foliar symptoms of Fe-deficiency for avocado plants on different rootstocks planted in Rockdale fine sandy loam.

Rootstock cultivar	Mean % root necrosis[x]		Fe-deficiency[y]	Mean % recovery of *P. cinnamomi*[z]
	Flooded	Nonflooded		
Bo Borchard	30.3 b,e	22.3 b,e	0 b	9.4
Duke 7	24.0 b,e	21.7 b,e	0 b	0
G755b	29.0 b,e	15.8 b,f	0.1 b	0.2
G755c	33.3 b,e	27.1 b,e	0.1 b	0.3
G1033	33.8 b,e	20.0 b,e	0.3 b	0
Parida	68.3 a,e	58.0 a,e	0.7 a	0
Thomas	28.8 b,e	22.0 b,e	0 b	0
Toro Canyon	45.0 ab,e	27.5 b,e	0 b	0.3

[x]Since the *Phytophthora cinnamomi* X flooding interaction was not significant ($P < 0.05$), infested and noninfested values were pooled for analysis. Means followed by the same letter within a column (a-b) or row (e-f) are not significantly different according to Tukey's studentized range test and t-tests, respectively, at $P < 0.05$.

[y]Foliar Fe-deficiency was rated with the system described by Young (7). Mean ratings followed by the same letter are not significantly different according to Tukey's studentized range test at $P < 0.05$.

[z]Mean recovery of the pathogen is from necrotic roots of plants in flooded and nonflooded, infested soil; means were not significantly different at $P < 0.05$ according to Tukey's studentized range test.

Performance of the rootstocks was influenced greatly by their tolerance of the alkaline, calcareous soil that was used in the experiment. Since the parent material of Rockdale fine sandy loam is oolitic limestone, the pH of this soil averages about 7.6 and Fe-deficiencies develop easily in avocados grown in the soil (4, 6). Some of the cultivars in the present study developed symptoms of Fe-deficiency, even though the plants were treated with supplemental Fe. For example, 'Parida' often developed conspicuous interveinal chlorosis in young foliage and had poorly formed and often very necrotic root systems (Table 2). Significantly smaller root and shoot systems for 'Parida', 'G1033', 'Toro Canyon', and 'Duke 7' may have also been caused, in part, by nutritional imbalances (Table 1).

All of the cultivars tested except 'Bo Borchard' are moderately to highly resistant to phytophthora root rot (1). That 'Bo Borchard' was not affected by *P. cinnamomi* was somewhat surprising and probably indicates that plants in the experiment were not challenged greatly by phytophthora root rot. Temperatures ranged as high as 39°C in the greenhouse that was used in the study, and it may have been too hot for significant disease development under these conditions. Zentmyer (8) determined that optimal temperatures for disease development range from 15-27°C and that a sharp decrease in the effects of the disease occurs at 33°C. Thus, high temperatures in the present study probably influenced disease development and a significant influence of root rot on 'Bo Borchard' rootstocks may have been detected if these plants had been incubated under more moderate temperatures. This work should be repeated under conditions in which temperature can be better controlled.

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