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Persea schiedeana and Martin Grande the Period from 1920 to 1975

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The close relative of the avocado, the coyou or *Persea schiedeana* (Figure 1), has attracted the occasional attention of avocado explorers and scientists almost as long as *Persea americana* itself. Wilson Popenoe (9) in his "Manual of Tropical and Subtropical Fruits," first published in 1920, commented on "the coyo or chinini, *P. schiedeana."* and the fact that it had been recently introduced into the United States. In 1941, Popenoe (10) briefly commented on *Persea schiedeana,* again suggesting that it was a separate species from *Persea americana* and that "this avocado-like fruit (see Figure 2) is the *chinini* of southern Mexico, the *coyo* and *chucte* of Guatemala, the *yás* of Costa Rica."

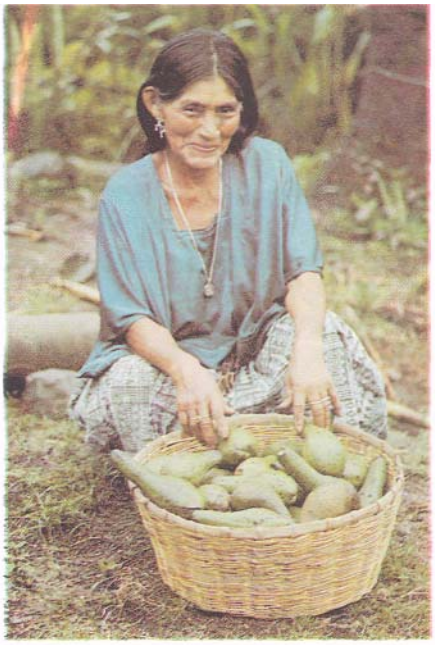

Figure 1. *Mayan lady with a basket of* coyou *fruit at Finca La Esmeralda, Tactic, Guatemala in 1986.*

Figure 2. *The* coyóu *fruit is similar to that of avocado and highly prized by the Mayan people.*

At about this same time (1940), Vincent Wager, a plant pathologist on leave from the Department of Agriculture in South Africa and working at the Citrus Experiment Station in Riverside, published his finding (20) on the cause of "avocado decline." For the first time, growers became aware of the fungus *Phytophthora cinnamomi.* By 1943, the

"avocado decline" problem had become an issue of great concern; and the California Avocado Society set up a "Research Fund" to fund a program of investigation in the hope of finding solutions to the problem (1).

From the beginning, the hope was that suitable sources of resistance to *Phytophthora cinnamomi* might be found among relatives of avocado growing in southern Mexico and Central America. In 1947, Popenoe and Williams (11) wrote an article in the California Avocado Society Yearbook in which they stated, "we know that avocados can be grafted upon *Persea schiedeana,* the *chineni* or *chinini* of Mexico, *coyo* of Guatemala, *chucte* of Honduras, and *yás* of Costa Rica. This species has received little attention in the United States; many years ago it was introduced into Florida where it was grown on avocado rootstock, but it did not thrive, for reasons with which we are not familiar. The expedition of October 1947 was particularly interested in the *chineni,* which is cultivated in gardens of the Orizaba-Cordoba region in Mexico, perhaps to a greater extent than in any other part of tropical America. We know that this species is not frost-resistant; we do not know much more about it as a possible stock plant."

In 1948, Carl Crawford. Knowles Ryerson, Wilson Popenoe, and Louis Williams visited Orizaba and sent back fifty seeds of the *chineni (Persea schiedeana)* to Honduras, where they were to be grown as rootstocks by Don Fiester at the Escuela Agricola Panamericana (12). Popenoe and Williams (12) also stated that preliminary experiments conducted by Don Fiester with budding rootstocks did not look very hopeful.

The first detailed account of attempts to use *Persea schiedeana* as a rootstock for avocados was published in the Yearbook in 1949. Don Fiester (5) described his work at Escuela Agricola Panamericana in Honduras. He brought in seedlings from Orizaba in Mexico, Coban in Guatemala, Nuevo Ocotepeque in Honduras, and San Jose in Costa Rica. The results were very encouraging. The seedlings proved to be easy to manage in the nursery, producing stronger, thicker stemmed plants than any of the avocado seedlings of the three horticultural races (Guatemalan, Mexican, and West Indian). Budding was successful, and the bud union appeared strong. It was also observed that the seedlings developed a large number of main roots which spread out below the surface of soil, unlike the single long tap root of West Indian seedlings.

Fiester (5) also reported how in 1945 seedlings of *P. schiedeana* were brought from El Rancho, Guatemala, and planted by Wilson Popenoe at Escuela Agricola Panamericana. During the rainy season of 1947 these trees did not suffer despite being flooded for two weeks. He also noted, "Our soils here are heavy clays and sandy clays with poor drainage, and these trees were growing in one of the heaviest spots." Attempts at budding these trees with avocados were not successful, though Fiester felt that these negative results were inconclusive.

By 1951, Schroeder was reporting that *P. schiedeana* had been introduced into California and that it was a vigorous grower when grafted on Mexican seedling rootstocks (16). He also noted its tenderness to frost, but stated, "it is possible that this adverse tendency could be compensated by burying the bud union under conditions where the frost hazard exists."

The following year, Schroeder (17) gave an account of how they observed trees of *P.*

schiedeana growing near Huatusco, in the state of Chiapas, in southern Mexico, growing in a heavy clay soil, saturated with moisture, "near the bottom of a small ravine which was a natural drainage basin for a considerable area." It was also noted that these trees apparently showed "some degree of frost resistance compared to the surrounding flora." In addition, Zentmyer was able to isolate *P. cinnamomi* from trees which were still in good condition in this area in 1960 (23).

In 1953, George Zentmyer made collections of budwood *of P. schiedeana* in the vicinity of Coban and Tactic in the Alta Verapaz (21). He also recovered *Phytophthora cinnamomi* from roots of an old specimen of *P. schiedeana* growing near San Pedro Carcha (Figure 3). This represented the first time that *P. cinnamomi* had been recovered in Guatemala. He noted, "It therefore seems very likely that the fungus is native in that region, which should make it a promising location for root rot resistance."

Despite this observation in the field, early glasshouse results from California obtained by Zentmyer and Schroeder (24) indicated that three collections from Guatemala and one collection from Orizaba, Mexico, were susceptible to *P. cinnamomi.* One of these collections (G20) is still growing at the South Coast Field Station (Figure 4) and in recent years has produced small numbers of fruit (Figure 5). Subsequent field tests with seedlings from Orizaba and also cuttings of *P. schiedeana* were described in the 1955 Yearbook (24). The results were again not very encouraging. By 1957, Zentmyer (22) was observing that at Escuela Agricola Panamericana in Honduras "avocados budded on *P. schiedeana* rootstock were making very poor growth." A specific study of graft compatibility (6) revealed that while *P. schiedeana* was graft compatible with *P. americana* (avocado), the growth of avocado was poor when *P. schiedeana* was used as the rootstock.

Collecting and testing of *P. schiedeana* continued. In 1966, Galindo and Zentmyer (7) reported that among four different species of *Persea* tested, which included *P. americana,* the collections of *P. schiedeana* produced the highest percentage of resistant plants which were selected. Despite these promising observations and others, a selection off! *schiedeana* with useful resistance to *P. cinnamomi* failed to emerge over the next eight years and enthusiasm for this possibility occurring eventually began to diminish.

However, in 1974 Schroeder had an article in the Yearbook (18) in which he enthusiastically described some field experiments conducted by Cookie Leon at Evonrond Estates near Tzaneen in South Africa. Budwood from a tree of *P. schiedeana* grown at UCLA, originally a collection from Guatemala, was sent to South Africa. Seedlings produced from this material were used as rootstocks and budded with Fuerte or Edranol. The trees grew vigorously, outperforming others grafted on Guatemalan seedlings, and there was no sign of any bud union problems. In fact, the trees continued to produce good crops for many years until they finally grew so large that it was uneconomical to continue picking them. Schroeder (18) stated a "reconsideration should be given this species as a possible rootstock particularly when increased vigor is an objective."

Figure 3. Persea schiedeana *growing on the river bank at San Pedro Carchá.*

Figure 4. *The G20 tree at South Coast Field Station producing fruit in 1987.*

Figure 5. *One of the fruit of G20 and a seed shown for comparison.*

Figure 6. *The original G755C seedling grafted onto a Topa-Topa rootstock growing at South Coast Field Station in 1981. The tree was only about 2 years old and demonstrates the vigor potential of this unique selection.*

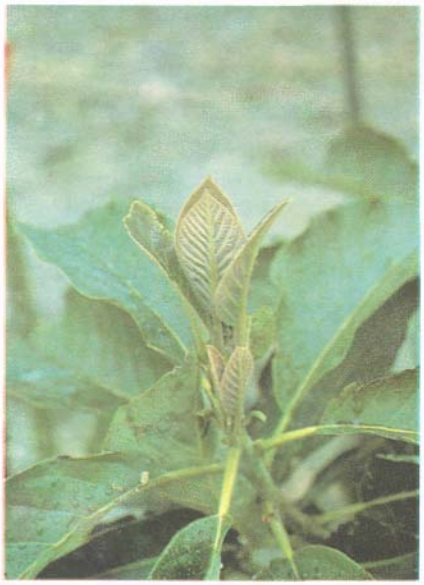

Figure 7. *New growth on the G755C selection. It has a pronounced reddish coloration.*

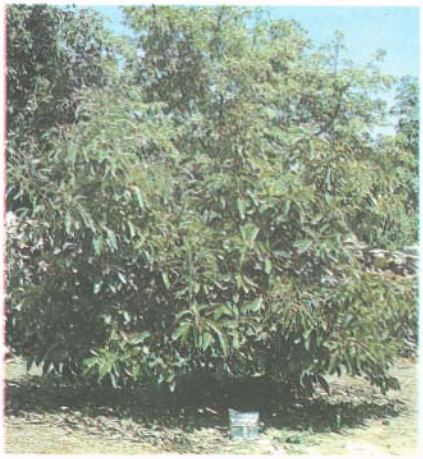

Figure 8. *Hass on a G755B rootstock in July 1986, two years after planting. The location was in Fallbrook in a grove with* Phytophthora *root rot.*

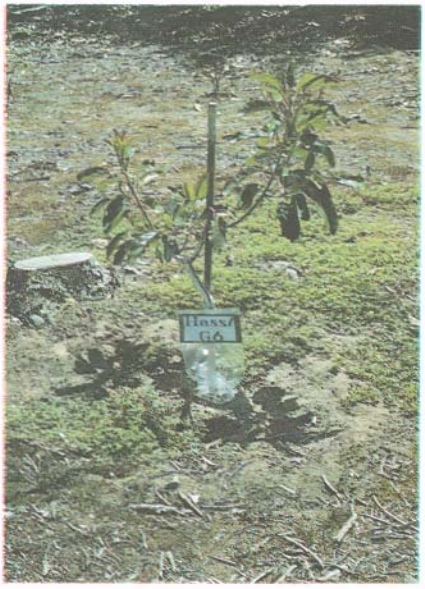

Figure 9. *Hass on a G6 rootstock in July 1986 at the same grove in Fallbrook. The tree is severely affected by* Phytophthora *root rot.*

The Martin Grande Era

Finally, the most important breakthrough came on a collecting trip in September 1975 to the Coban area of central Guatemala by Gene Schieber and his Mayan assistants, the late Martin Cumes S. and Martin Cumes M. (3, 28). A small collection in the market in

Coban proved to be the most significant. In 1977, this collection was recognized as a probable hybrid between *P. schiedeana* and *P. americana,* since it had the botanical characteristics of both species (Figure 7) and was also noted to be very vigorous (13, 27). Initial greenhouse and lathhouse tests demonstrated that one of these seedlings, G755C (Figure 6), probably had moderate resistance to root rot (26). Three seedlings of this collection were maintained as G755A, G755B, and G755C, G755C was subject to the most rigorous testing with *Phytophthora,* whereas G755A and G755B, which were not tested, were ultimately propagated to raise budwood, the majority of which was useful in large-scale field testing.

The original observations made on the three surviving seedlings of the G755 which indicated they might be hybrids were substantiated in 1986 (4). Isozyme patterns based on five diagnostic loci demonstrated that G755A, G755B, and G755C were most likely a hybrid species with a combination of avocado and *P. schiedeana* patterns. Since the avocado race which predominates in the Alta Verapaz region of Guatemala where G755 was located is the criollo or Guatemalan type, this is believed to be the avocado parent. Ongoing research and testing with all three G755 selections continues to indicate that they all have similar moderate resistance to *P. cinnamomi.* In a planting made in 1983 at Fallbrook, small numbers of G755B and G755C (Figure 8) grafted with Hass proved to be superior to both Duke 7 and G6 (Figure 9) over a three- to four-year period. Fungicides were used to help establish and maintain the health of these trees. A planting made at South Coast Field Station in 1986 has demonstrated that G755A, G775B, and G755C have superior root rot resistance to most other rootstocks, including Duke 7, G6, and Toro Canyon when grown *without fungicides being applied.* The only rootstock which performed as well as G755 in these severe tests was Thomas.

The G755 rootstocks have been collectively named Martin Grande, in honor of the Mayan Martin Cumes S., from Santa Catarina Palopd on the shore of Lake Atitlan (Figure 10), who assisted Gene Schieber in their collection. His tragic death in September 1981 (Figure 11) was recorded in the Yearbook (14).

Large-scale field plantings were first made in 1984 with all three selections. The most promising of these are still doing well in root rot tests at the Spaulding Ranch in Carpinteria and at the Embarcadero Ranch in Goleta (Figures 12 and 13). During the 1989 season, it is hoped to obtain the first information on fruit production. At both sites, fungicides (Aliette or Ridomil) have been used and the trees are planted on mounds. Irrigation is now with minisprinklers, though in both cases drip irrigation was used in the first few years after planting.

The California Avocado Society requested the release of Martin Grande for commercial use in 1984, and this was granted by the University of California. Obviously, the threat of root rot and the need to plant a good resistant rootstock will override any doubts about the ultimate horticultural qualities of a rootstock in the minds of many growers. Since 1985, many thousands of trees grafted on Martin Grande have gone out. In general, the feedback so far has been positive and most growers have expressed initial satisfaction with the product. Obviously, there is still much to learn and a long way to go before we will know how good a rootstock Martin Grande is.

There have been some failures with Martin Grande, as there have been with other

rootstocks such as G6 or Duke 7. In general, the failures have been less than in the past with those earlier rootstocks. Obviously, part of the increased success can be attributed to improved cultural practices (mounding, mulching, more frequent irrigation) and increasing use of new fungicides (Aliette, Ridomil). However, the rootstock itself has certainly made a significant contribution. Successful plantings have been made in many root rot situations, where previously other rootstocks such as Duke 7 had failed miserably even when fungicides such as Ridomil were used. Plantings on heavy soils in Ventura and Santa Barbara Counties are doing well. In San Diego County, where clonal rootstocks such as Duke 7 have had a very poor track record, the Martin Grande is sometimes doing exceptionally well.

Another factor that is often overlooked is the role of the nurseryman in this process. The Martin Grande rootstock has proven to be relatively easy to propagate, by avocado rootstock standards, compared to early selections such as Duke 7 and especially G6. Martin Grande typically produces a well-rooted and vigorous growing stock. Various scions have been used (Hass, Fuerte, Gwen, Pinkerton) with good success. No evidence of bud union incompatibility has been seen.

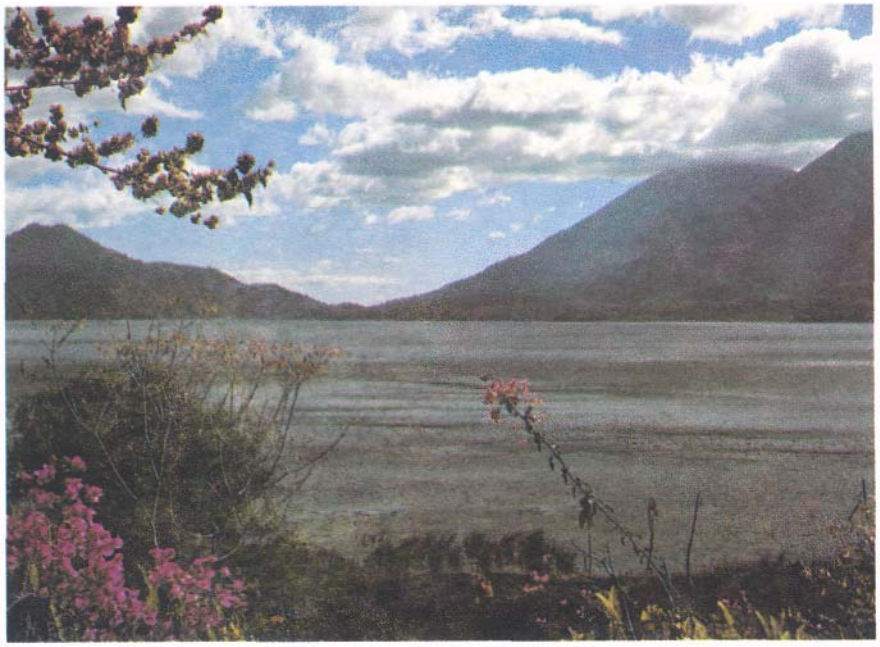

Figure 10. *Lake Atitlan in Guatemala.*

Figure 11. *At the graveside of Martin Grande at Santa Catarina Palopó in December 1987.*

Figure 12. *A three-year-old planting in 1987 at Embarcadero Ranch in Goleta. All three G755 rootstocks are being tested in this severe root rot situation.*

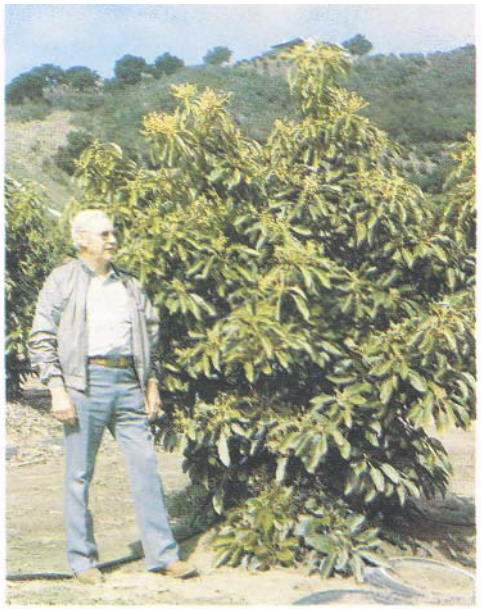

Figure 13. *George Goodall in March 1987 standing by a three-year-old Hass on G755B rootstock at Embarcadero Ranch in Goleta.*

There are some potential problems. Martin Grande is more frost sensitive than a Mexican rootstock such as Thomas or Duke. In the very cold winters that we experienced in the previous two years, there were adverse effects on some nursery stocks. During those extremely cold periods, the nursery trees suffered more than their Mexican counterparts. In such situations, the nurseryman may have to wait longer, allowing the trees to recover from this cold shock and produce a healthy new root system, before he can feel comfortable with releasing them to growers. One encouraging feature was the fact that the majority of one- and two-year-old field plantings of G755 did not suffer unduly, despite these extremely cold conditions in 1987/88. In summary, it would appear that Martin Grande has sufficient cold-tolerance to be used as a rootstock under Californian conditions.

In the field, some cases of "chlorosis" have been observed, especially in the Ventura and Santa Paula areas. One theory that has emerged is that these rootstocks are not well adapted to limy soils, as compared to some Mexican rootstocks (e.g., Thomas). This has yet to be tested in a rigorous experimental manner. Certainly, in at least one case, replanting sites where Martin Grande failed with more trees of the same type did not reveal the same problem, and a soil analysis did not show the presence of excess lime. The extent of the problem may have been exaggerated, and certainly in some cases it would seem to be difficult to reproduce when further trees of the same stock were planted in the same sites. It may simply reflect differences in quality of different batches of trees. However, it is something to be aware of; and whenever this rootstock is being planted for the first time, we would advise that the numbers used should be limited. Once it has proven itself with a few years in the ground, this is the best time to consider planting larger numbers.

The general horticultural properties of this rootstock appear quite good. It produces a

vigorous tree under good cultural conditions. It appears quite well-adapted to different soils and appears sufficiently frost-resistant to be used as a rootstock in most parts of southern California. While data on fruit production are not yet available, the general vigor, reasonably good color of the Hass scion, and level of resistance to *Phytophthora* (where fungicides are also used) would indicate that it should be quite satisfactory. Obviously, when it comes to a choice between rootstocks, there are at present severe limitations imposed on choice. Only Thomas has moderate *Phytophthora* resistance equivalent to Martin Grande based on our short term tests.

There is also some preliminary indication that Martin Grande may have some superior properties with regard to salt tolerance (8). Tests were conducted in sand culture. The effect of increased salinity on G755C was small and comparable to Borchard, a *Phytophthora*-susceptible rootstock already believed to be well adapted to saline soil conditions (2). High salinity levels (4.5 ds/m) had little effect on growth of Hass budded on G755C. In contrast, growth was greatly reduced where rootstocks such as Duke 7 or G6 were used under these same saline conditions. Some debate has emerged in the last few years over the relative merits of the three G755 selections. In our own limited comparative tests, no clear differences have emerged between A, B, and C. This includes recent assessments of the level of *Phytophthora* resistance in laboratory and greenhouse tests and limited two- to four-year-old evaluations in the field, with and without root rot present. However, some growers who have planted both G755B and G755C, have observed that G755B has proven superior in growth. It is possible, however, that such differences merely reflect a difference in the health and vigor of a particular batch of nursery trees and not a heritable trait of a particular rootstock line. Certainly the majority of trees sold by nurseries between 1985 and 1987 were G755C, and consequently it would be expected that more cases of failure with G755C would occur. We are keeping a close eye on this situation, but since the majority of our test data so far has been obtained with G755C, it is difficult to make any more definite comment at this time.

The Ongoing Search for New Sources of Resistance

The success of Martin Grande has encouraged us to keep searching for that ultimate rootstock that might have sufficient resistance to *Phytophthora* to be grown without the help of fungicides. One source of such resistance may be *P. schiedeana.* Although we do not yet know from which parent the resistance in the hybrid Martin Grande came, the earlier indications of some resistance in selected lines of *P. schiedeana* (7, 17, 21) give encouragement to this being an important potential source. We have already begun to test seedling progeny of the original G755C selection (Figure 14). In recent years, further experimental evidence has. begun to accumulate that suggests that new selections of *P. schiedeana* (UCR 2007 and UCR 2008) may have significant resistance to *P. cinnamomi.* At present, greenhouse and lathhouse tests are being carried out, and plans are in hand for trees to be propagated with Hass scions for initial field tests, probably beginning in 1991 or 1992. At the same time, the quest for further sources of *P. schiedeana* resistance continues, with more collections being made in Guatemala and ongoing testing being conducted at UCR. Recent reports from Mexico (19) indicating that various selections of *P. schiedeana* have superior tolerance to both clay

soils and excess chlorides (salinity) are also very encouraging.

Figure 14. *Fruit and seed from G755C in March 1986. This is one of three from which seedling progeny are now being grown for testing for their rootstock properties.*

Finale

Martin Grande has emerged since 1984 as a useful rootstock for planting in root rot situations in California. Interest in this rootstock has developed throughout the avocado world. Its compatibility with various important commercial scions such as Hass, Gwen, Pinkerton, and Fuerte has been demonstrated. In addition, there is preliminary evidence that it will tolerate high salinity, unlike rootstocks such as Duke 7 or G6. It has proven to be a vigorous rootstock, appears sufficiently frost-resistant for even severe Californian winters, and has quickly found acceptability with many growers and nurserymen. While occasional reports of failure, some apparently attributable to a severe chlorosis condition, have caused mild concern, the overall track record with most growers since 1985 has been quite favorable. It is obviously still very early to predict the final outcome, however. The rootstock was only collected in late 1975. By 1984, it was released to growers in California and now many thousands of trees of these rootstocks are planted and many appear to be thriving. The critical tests of its performance will come from the fifth or sixth year after planting. Then its full potential will be critically tested. Will it emerge as a rootstock capable of producing moderately good crops in root rot situations? Meanwhile, our effort continues to find more rootstocks with suitable levels of resistance to *Phytophthora* diseases, heavy soils, waterlogging, high salinity, and frost conditions.

Acknowledgments

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