Time after Scion Harvest and Grafting Method Influence Graft Success Rate for Purple-fruited Pitanga (*Eugenia uniflora* L.)

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The pitanga (*Eugenia uniflora* L., family Myrtaceae) is a large shrub or small tree native to South America. It has considerable commercial potential, but clonal propagation is challenging. Propagation by seed is easy, but the seedlings are highly variable; the desirable, purple-fruited varieties do not come true from seed. Propagation by cuttings, air layerage, or other methods that require the formation of adventitious roots usually fails. Grafting has been successful for some propagators, but it is not common. The goals of this project were to discover a grafting method that would give an acceptably high rate of success, and to test the effect of storing budwood for several days before grafting. Scion wood of the superior, purple-fruited 'Zill Dark' cultivar was harvested in Lakeland, FL, and carried in hand luggage to Honolulu, HI, where veneer grafts and chip buds were made at the University of Hawai'i at Manoa and at the Kona Experiment Station at Kealakekua. The scion wood was stored in polyethylene bags, slightly damp, at ambient temperature (21 to 28 °C, 70 to 82 °F) until grafted. At the Manoa site, 87% of the first-day 'Zill Dark' veneer grafts were successful, whereas only 5% of chip buds survived and grew. Of second-day grafts, 50% of veneer grafts and 6% of chip buds survived and grew. At the Kona site, only 15% of third-day veneer grafts of 'Zill Dark' and no chip buds survived. It appears that the veneer graft method has the potential to give reasonably high rates of graft success for *E. uniflora*.

The pitanga (*Eugenia uniflora* L.), also known as Surinam cherry, Brazilian cherry, or Florida cherry, is a large shrub or small tree native to South America. It is very commonly grown in southern and central Florida as a hedge shrub and, to a very minor degree, as a source of dooryard fruit. It is not grown commercially in Florida for its fruit, but there is a small acreage in Hawai'i (J.L. Griffis, personal observation) and considerable production in Brazil (Bezerra et al., 2002; Franzon et al., 2008). The species displays two color types—one that ripens to orange-red, and one that ripens to a much darker purple, approaching black. Because of the purple-type's high antioxidant content (Einbond et al., 2004; Galvão de Lima et al., 2002; Griffis et al., 2009), there is interest in producing the fruit in Hawai'i and Puerto Rico, as a potential new "super fruit." Commercial production in Florida would be severely limited by the fruit's susceptibility to Caribbean fruit fly, although there was at one time some minor production for sale in southern Florida (Morton, 1987).

Asexual propagation of the pitanga will be important, since seedling populations are highly variable in their fruit color, size, flavor, productivity, and antioxidant content (Franzon et al., 2008). Yet in Florida, as in most parts of the world, the species is nearly always grown from seed, since seed-propagation is easy, whereas cuttings seldom if ever root [except as very juvenile seedlings in tissue culture (Griffis, 2006)] and, as is true of many members of the family Myrtaceae, uniformly successful methods of graftage have not been demonstrated. Franzon et al. (2008) achieved success rates of 40% to 87.5%, using cleft grafts in Brazil. They attributed the wide variability in success to genetic differences among scion varieties. They also found that date of graftage had a large effect, with success varying from 37.5% to 67.5% for one cultivar, with the highest success in September (spring in Brazil). Bezerra et al. (2002) also found scion cultivar to have a large effect on success of cleft grafting, with success rates of 20% to 81.5%, indicating genetic variability in the ability of a scion to form a graft union.

Because of the interest in commercial production elsewhere, and some interest in superior selections for dooryard fruit in Florida, this study sought to find a reliable method for graftage of the crop. The variety 'Zill Dark', introduced by Zill High Performance Plants, is the only purple-fruited cultivar commonly seen in Florida; and in Hawai'i, the 'Kawahara' and 'Stermer' selections exist but are not readily available. The experiment was set up in Hawai'i, and since the only known sources of 'Zill Dark' budwood were in Florida; hence, the interest in survival rates for budwood, over time.

There are numerous possible reasons for poor graftage success, including a genetic graft incompatibility, poor technique by the

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grafter, time and storage conditions for scion wood after harvest, stress to the newly grafted plant during the healing process, weather during the healing process as well as physiological condition of the scion wood (and therefore, season of graftage), and various pathogens infecting the new graft union. Mango (*Mangifera indica* L.) is a good example of a plant that many people find exceedingly difficult to graft, yet an experienced grafter, working in June, can get success rates of at least 65% with randomly selected scions, or over 95% with carefully selected or prepared scions (C.W. Campbell and A.H. Krezdorn, personal communication; Silver Palm Nursery and M. Manners, unpublished data). Genetic compatibility in grafting has been understood to be important since antiquity, e.g., St. Paul's Letter to the Romans, Chapter 8, in the Bible, where he compares Jewish vs. Gentile converts to Christianity to the compatibility of different olive scions on a common rootstock. In the case of *Eugenia*, the unusually stiff, hard wood in even relatively thin, young scions, as well as the extremely thin, easily shredding bark, add to the challenge of the physical process of producing a well-made graft.

Method of graftage can also be important in maximizing success. In other parts of the world, cleft grafts are often used for mango, jackfruit, and other somewhat difficult species, whereas in Florida, the veneer graft is often selected (Belerdi et al. 2008a, 2008b; Crane et al., 2008, 2009), and chip budding is popular with some propagators.

Because the 'Zill Dark' cultivar is a superior selection, and the potential for genetic compatibility problems, it was decided to graft 'Zill Dark' scions to seedlings of that cultivar, the seed having been collected from an isolated plant, to give a high probability of self-pollination and, therefore, to maximize genetic relatedness of the rootstock plants to 'Zill Dark'. The factors considered in the research reported here, then, were the effects of grafting method and time after harvest of scionwood, on graft success.

Materials and Methods

Seeds were harvested at Florida Southern College in Spring 2006 from an isolated plant of 'Zill Dark'. It is assumed that these were mostly self-pollinated, so would be genetically close to 'Zill Dark'. The seeds were cleaned of all fruit pulp and mailed to Hawai'i, damp, in plastic bags. They were planted immediately on arrival at the University of Hawai'i at Manoa, and grown onto 1-gal nursery-size plants for use as rootstocks.

Scions were collected from a plant at Florida Southern College on 7 Aug. 2007, late in the day, and flown to Hawai'i in the first author's carry-on luggage on 8 Aug. The goal at that point was to produce a population of clonal plants for a research project at the University of Hawai'i, so no attempt was made to balance population sizes nor to use any standard statistical design. Because of the first author's previous experience with grafting challenging, hard-wooded plants such as *Magnolia grandiflora* and *Mangifera indica*, it was decided to try veneer grafting, using the method most often used for mango in Florida (Young and Sauls, 1981). This method is not identical to the "standard" veneer graft, in that it involves cutting the bark away from the entire length of the scion (Fig. 1), and the whole scion is covered with the wrapping tape (Fig. 2).

Because the plants on the Florida Southern College campus from Zill High Performance Plants had been chip budded, it was also decided to try some chip buds (Fig. 3). For both graft types, the budsticks were rinsed for a few seconds with 3% hydrogen peroxide just before grafting, to reduce any bacterial or fungal

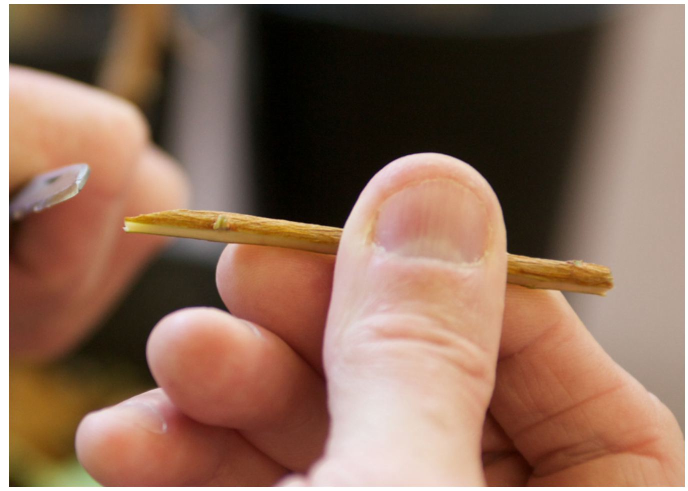

Fig. 1. Scion for a veneer graft. Unlike some versions of the veneer graft, this method removes a strip of bark the whole length of the scion, and the entire scion is wrapped with grafting tape.

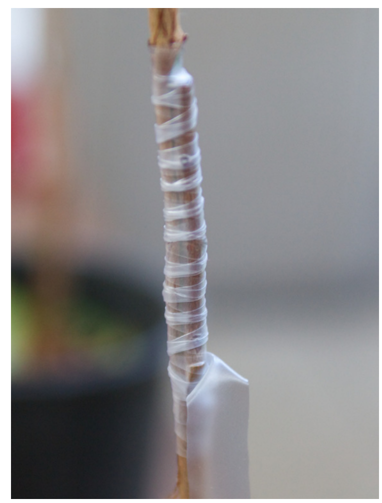

Fig. 2. Veneer graft, put together and wrapped.

Fig. 3. Chip budded pitanga.

Table 1. Date of graftage, location (University of Hawai'i at Manoa or the UH Kona Experiment Station at Kealakekua), scion wood age in days after harvest, and number of each graft type performed.

Date	Location	Days after harvest	No. veneer	No. chip
9 Aug.	Manoa	2	30	63
10 Aug.	Manoa	3	20	17
11 Aug.	Kona	4	13	16

Table 2. Graftage success rates after 6 months. In the columns listing graft type, the fraction indicates number of successful grafts over total number attempted, followed by the percentage success in parentheses.

Date	Location	Days after harvest	Veneer	Chip
9 Aug.	Manoa	2	26/30 (87%)	3/63 (5%)
10 Aug.	Manoa	3	10/20 (50%)	1/17 (6%)
11 Aug.	Kona	4	2/13 (15%)	0/16 (0%)

surface contamination. Budwood was kept damp, in plastic bags, at ambient temperature (21 to 28 °C, 70 to 82 °F) from the time of collection until it was grafted. A population was grafted at the University of Hawai'i at Manoa campus; then another population was grafted at the UH Kona experiment station at Kealakekua. Table 1 lists the numbers and types of grafts produced.

Results and Discussion

Graft success rates were determined after 6 months. Table 2 shows the results of the experiment. Chip budding produced uniformly poor results, despite the fact that the grafter had much experience with producing successful chip buds on other crop species. This lack of success might be due to the difficulty of producing a well-formed chip bud scion quickly, because of the extremely hard wood and thin, easily shredded bark of this species. It is also possible that the relatively small chip bud scion lacked enough stored carbohydrate to survive until after the formation of a graft union. If lack of carbohydrate is a contributing factor, there may be value in trying the chip budding method at cooler times of the year—the current study was done in late summer, during the time of highest annual temperatures.

Veneer grafting produced reasonably good success (87%) using 2-d-old scions, but by the third day, success was down to 50%, and to only 15% by the fourth day. There may be value in refrigerating budwood if it needs to be stored to slow the respiration rate of the scions, although care should be taken not to injure the tissue of this tropical species with cold. It is also possible that a build-up of surface pathogens occurred during the room-temperature storage, contributing to the diminution of success rates, despite the H_2O_2 rinse. Refrigeration may also be useful in preventing such microfloral growth.

It seems reasonable to expect even better success if grafting were done on the same day as scions were harvested, if a local source of scions were available, rather than waiting until the second day after, as was necessarily the case in this experiment. Also, it would be worth trying these methods in a cooler season of the year, as recommended by Franzon et al. (2008). However, the 87% success seen here may be adequate to permit commercial nursery production of this species.

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