Table 1. Farm 1 hue values (h°).

Treatment	Day 1	Day 7	Day 11	Day 18
NS-1	29.7	29.7a	31.2a	35.6a
NS-2	29.7	30.9a	32.5a	36.9a
Control	29.7	31.7b	34.0b	39.6b
	NS	*	*	*

*P < 0.05, NS means not significantly different.
h° = hue angle (0° = red-purple, 90° = yellow, 180° = bluish-green, 270° = blue).

Table 2. Farm 2 hue values (h°).

Treatment	Day 1	Day 7	Day 11	Day 18
NS-1	30.6	31.3a	33.0a	36.9a
NS-2	30.6	32.1a	33.9a	38.9b
Control	30.6	33.2b	36.0b	40.7c
	NS	*	*	*

*P < 0.05, NS means not significantly different.
h° = hue angle (0° = red-purple, 90° = yellow, 180° = bluish-green, 270° = blue).

the ice was avoided. All fruit was transported to Orlando on the same day as harvest.

At the EcoScience lab in Orlando the fruit was destemmed and prepared for treatment. From the sample populations collected by farm, 30 fruit samples were selected at random for each treatment. Each treatment was repeated 3 times. As such, there were 90 total fruit per treatment for each farm. The treatments imposed were experimental Nature Seal 2000 #R3417-143-1 (NS-1), experimental Nature Seal 2000 #R417-139-1 (NS-2), and an uncoated control. All treatments were imposed on 9 June. Fruit were stored overnight at 16C and initial evaluations were done on 10 June. Color evaluation was done with the Minolta Chromameter 300 (Osaka, Japan). The LCh scale was used in order to facilitate interpretation and statistical analysis. Evaluations were made on days 1, 7, 11, and 18 following coating.

Results and Discussion

Upon coating, both Nature Seal formulations caused a decrease in hue angle values of lychee pericarps from Farms 1 and 2 (Tables 1 and 2). Chroma and lightness were not effected by either Nature Seal coating at the outset of the trial. Due to the initial difference in hue angle values, the treatment means for hue angle were significantly different on the first day of the trial. As such, the data were subjected to covariance analysis in order to allow for meaningful comparisons of treatment means.

The data indicate that there were significant differences between the two Nature Seal experimental coatings and the uncoated control. On the treatment lychees from both farms, the experimental formulations of Nature Seal had lower hue angles over time as compared with the uncoated control. Visually, however, none of the lychees were considered marketable with respect to color after day 11 due to pericarp browning across all treatments. The experimental Nature Seal formulations did reduce changes in hue angle, but not to the extent desired by producers wishing to maintain the fruit color at harvest for several weeks. While there is still promise for reducing the rate of pericarp browning in lychee with the use of polysaccharide coatings, further formulations development and field testing are required.

Proc. Fla. State Hort. Soc. 107: 351-354. 1994.

AN UPDATE ON GRAFTAGE METHODS FOR LYCHEE

Roy O. Nelson
23705 S.W. 157th Avenue
Homestead, Florida 33031

Additional index words. Rootstocks, cultivars, cambium, anatomy, *Litchi chinensis.*

Abstract. **A resurgence of interest in growing lychee (*Litchi chinensis* Sonn), both in Florida and other parts of the world, has created a need to learn grafting techniques developed in the past for this fruit tree. Rootstocks that are tolerant of less than optimum soil conditions must be used to establish varieties unable to grow well on their own roots as air layers, or from cuttings. Growers who are adept at grafting will be able to hasten the process of rootstock testing, essential for determining rootstock influence on yield and quality of lychee under South Florida conditions. This information will enable us to grow new varieties on our high pH soils.**

Renewed interest in growing lychees in Florida has again brought attention to the importance of grafting newer cultivars onto rootstocks that have shown tolerance to the high calcium soils of South Florida. Although no research has been done on grafted trees on any rootstock, the major cultivars planted for fruit production, 'Brewster', 'Mauritius', and 'Bengal', are the most logical choice to test as rootstocks until other cultivars can be found. Currently, trees are grown either from airlayers or from rooted cuttings.

An example of a cultivar that does not thrive on its own root as an airlayer or rooted cutting is the famous lychee, 'No mi ts'z', considered to be one of the best in China according to Groff (1921). It is being grafted onto rootstocks that have shown tolerance for high pH soils, both in South Florida and in Israel. Another cultivar that is being grafted onto 'Brewster', 'Mauritius', and 'Bengal' is the 'Emperor'. It has been a failure when attempts have been made to establish it as an airlayer on calcareous soils.

Methods used for grafting lychee have been inarching, chip and shield budding, and side veneer grafting. Some research was reported by Cobin (1948) on cleft grafting. Groff (1921) in his famous book, *The Lychee and Lungan,* describes cleft grafting as the main method the Chinese have used to top-work large lychee trees. Nelson (1954a; 1957) described graftage methods for lychee, using chip buds, shield buds,

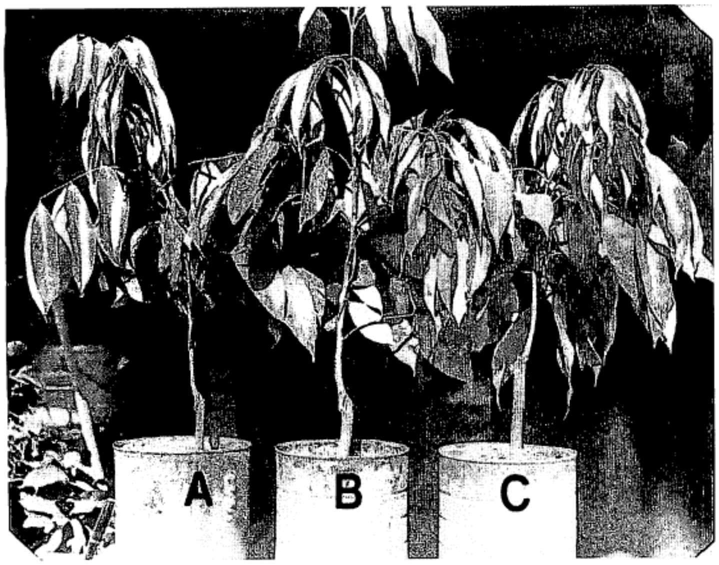

Figure 1. Grafted lychee trees, 9 months after grafting; (A) chip bud, (B) shield bud, (C) side veneer.

and side veneer grafts (Figs. 1 & 2). Cleft grafting was also recommended as sometimes advantageous. For best results, dampened moss should be placed around the scion and secured with a plastic bag. Shade was recommended to prevent overheating inside the plastic bag during the period required for union between the scion and rootstock. These techniques of grafting proved successful, and I recommend that the present group of lychee enthusiasts try them.

I recently observed some interesting grafting procedures in Egypt, while on an assignment as an international volunteer advising on mango production. One very skilled propagator used a cleft graft on stems approximately 0.4 to 0.5 inches in diameter. A terminal scion was trimmed to a wedge, fitted into the slot on the stem, and wrapped with a plastic strip. The exposed part of the scion above the wrapped area was covered by a small plastic bag. A cone-shaped paper was placed over the plastic bag to protect the scion from the extreme heat that would occur inside the plastic bag from a "greenhouse" effect. The cone-cap and plastic bag were removed in 2 weeks. The plastic wrap was left in place for about 6 weeks to insure that the scion was thoroughly united with the stock. The cone used as a cap over the scion should be of material that is waterproof if this is attempted in Florida—Egypt has less than 2 inches of rain per year in some areas, and almost no rain in most areas.

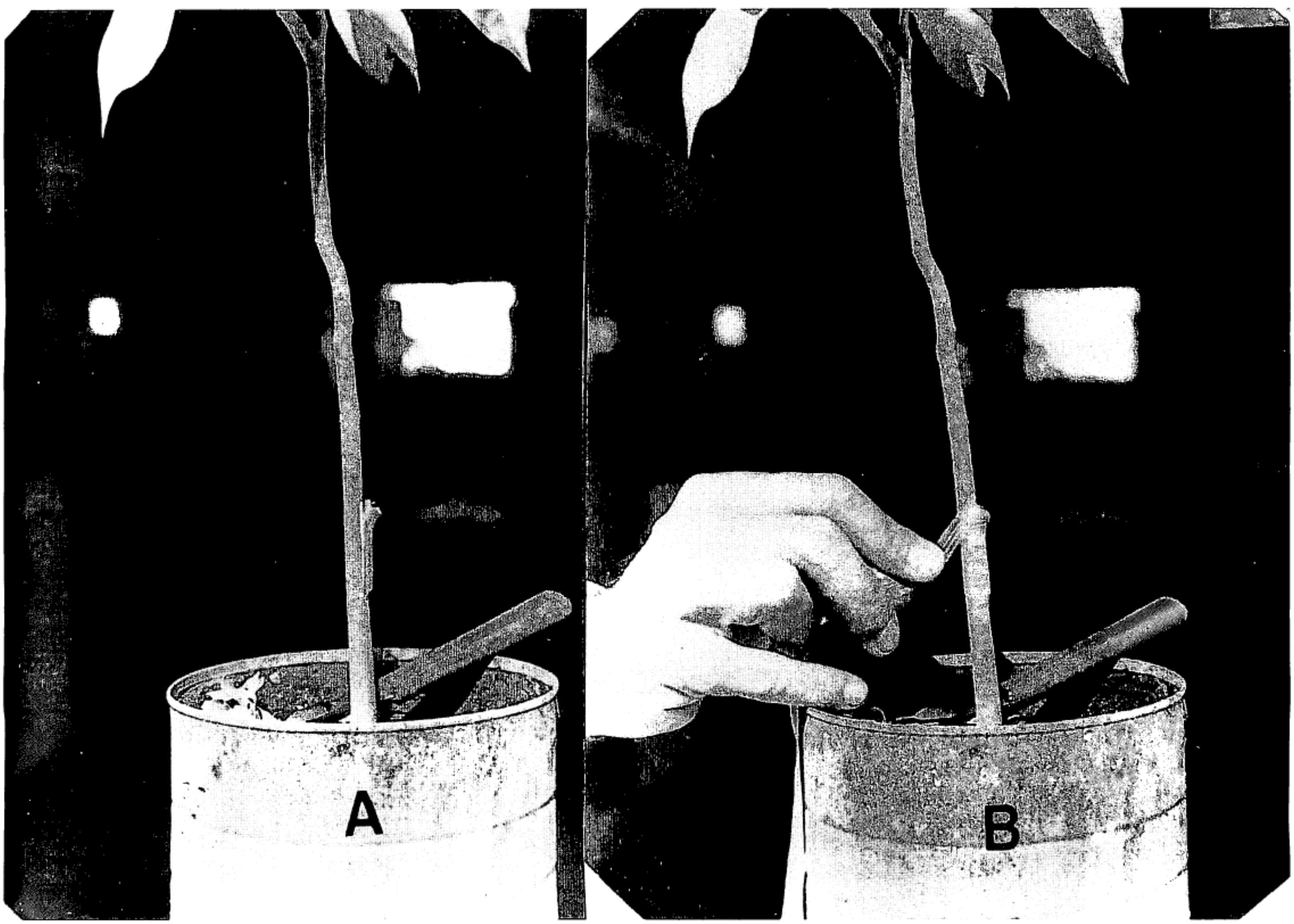

Figure 2. (A) Scion and rootstock cut similar to the side vneer method. Scion has only one lateral bud at top. (B) Vinyl film wrap with opening at top for bud emergence.

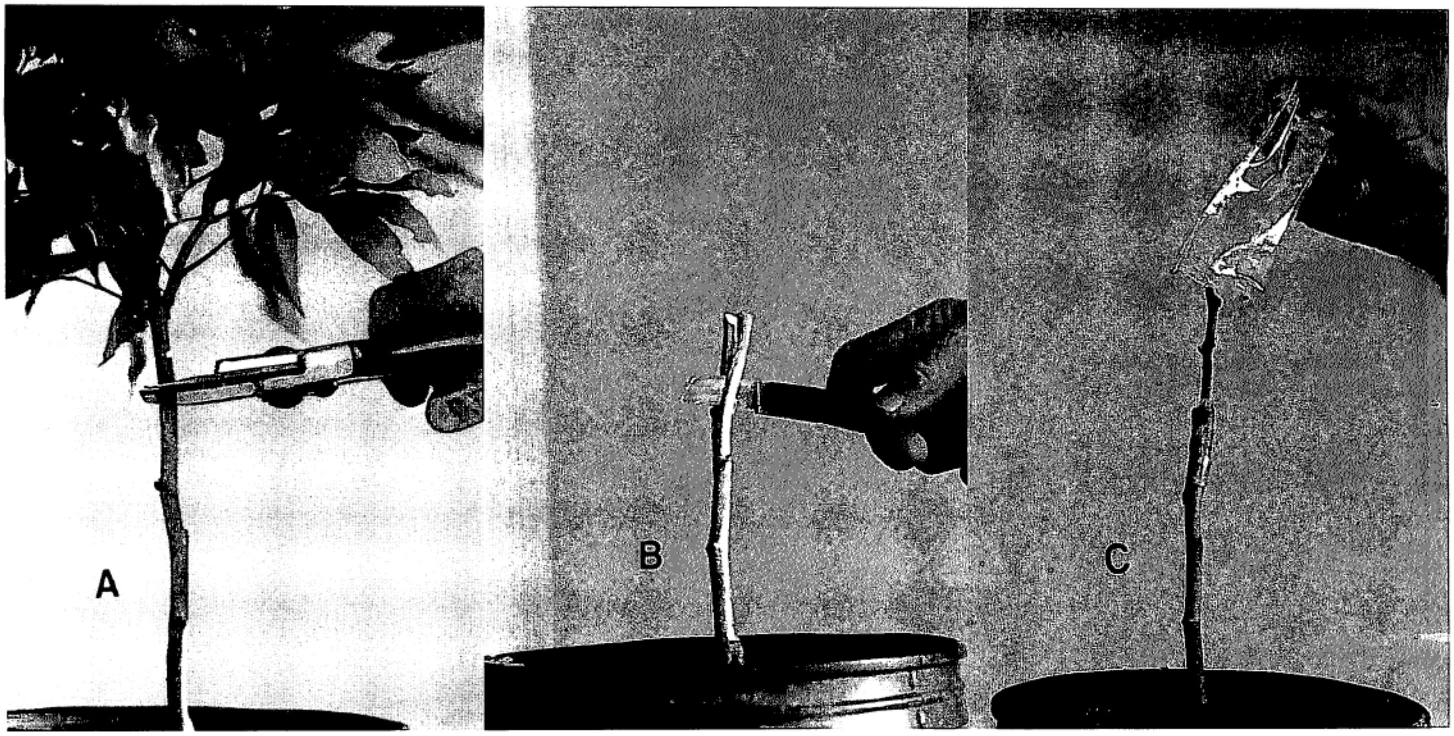

Figure 3. Cleft grafting: (A) Lychee rootstock. (B) Cut on rootstock to receive scion that is cut to a wedge. (C) Scion wrapped with vinyl film and plastic bag ready to cover exposed part of scion to prevent scion from drying.

I believe this cleft graft method should be attempted on lychee because this might allow a scion to have a greater chance of contacting active cambial cells. A more rapid growth of the scion is possible as there is very little competition if most of the leaves or sprouts are removed at the time the cleft is inserted into the stock. Cleft grafting is very successful on young avocado rootstocks and on ornamentals such as hibiscus and gardenia (Figs. 3 & 4).

The selection of graftwood is one of the most important considerations if lychee grafting is to be a success. I found that

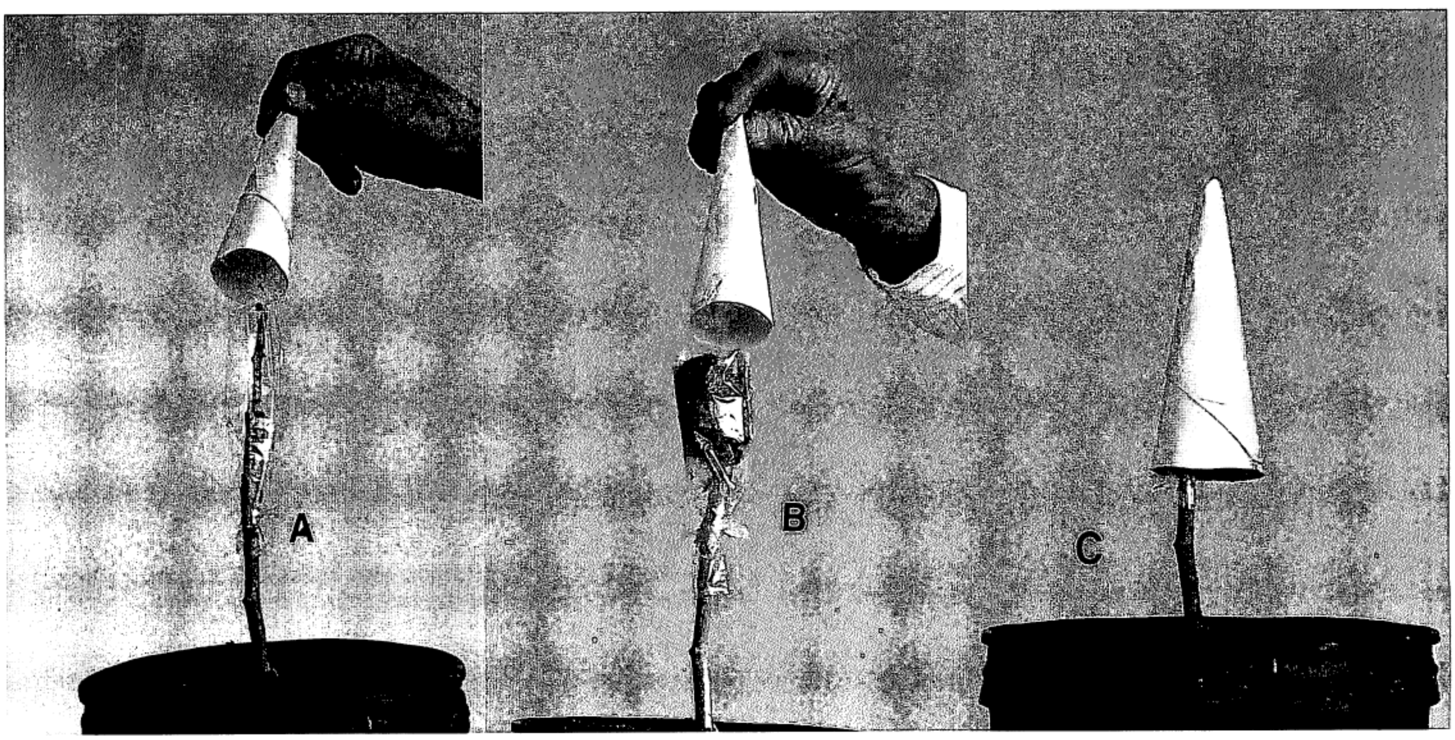

Figure 4. Cleft grafting cont'd: (A) Scion covered with plastic bag. Paper cone will be placed over the plastic bag to prevcent heating inside the plastic. (B) Another method to prevent drying of the scion is to place moss on the exposed top area, and use a plastic bag to keep the moss in place. (C) Cone is placed over the cleft graft to prevent heating inside the plastic bag.

the successful grafting of guava (Nelson, 1954b) was entirely due to using scions of vigorous, more or less undifferentiated tissue. The scions having these qualities of cell activity could not be found on older trees unless drastic pruning was done by topping approximately 1/3 of the tree selected as a scion source. With adequate nutrition and water, vigorous shoots were produced that provided scions that gave a high percentage of success.

Lychee graftwood can be improved by a similar procedure as was done to guava. Vigorous growth produces stems that provide a larger diameter scion that is easier to cut to fit onto the rootstock, hopefully providing more meristematic tissues.

Rootstocks grown from seeds should not be used because of their variability. There is a good chance that many seedlings would not have tolerance to alkaline soil, or they might have other defects that could hinder the production of a uniform and productive grafted lychee tree. Only clonal rootstocks that have a known history of tolerance for calcareous soils should be used.

Venning (1949) did the first anatomical study of lychee. His research gave a rather discouraging picture of the potential for successfully grafting lychee. He found that lychee stems as small as 0.04 inches (1 mm) in diameter show all primary tissue around the entire stem. No secondary tissues are formed at this early growth period. However, when the stem enlarges to 0.16 to 0.2 inches (4 or 5 mm) in diameter, the cambium is activated and is producing secondary tissues, but only about half of the cambium is active around the stem at any one growth period. When the stem reaches a diameter of 0.4 inches (1 cm), about 1/3 of the cambium is active during a particular period of growth. This definitely presents a difficulty when a scion is placed on the rootstock, since there is no external clue as to where the cambium activity is occurring. Venning states that at certain growth periods, however, cambial activity resumes movement around the stem. He suggests that some grafting success is possible if the scion can be kept from drying out during a period of cambial inactivity in the area where the propagator may have placed the scion. The question would be whether the cambial activity would resume soon enough to reach the scion and provide cells that would unite with the scion before it dies. High humidity under a mist system could be used to keep the scion alive (Nelson, 1953a; 1954a).

Summary

We know that successful grafting has been accomplished on lychee for many years by one technique or another. To increase the chances for successful grafting, efforts should be made to obtain graftwood from trees that have been topped, fertilized heavily, and have received all minor elements required. Graftwood selection would most likely be available several weeks following the fruit harvest. Trees will have received their heaviest fertilization as well as pruning. The growth flushes will provide suitable scions on trees that have been topped and hedged. Rootstocks should also be in a stage of active growth.

The very active, recently organized lychee growers should request some additional anatomical research to learn more about cambial activity in the graftwood and rootstocks that have been grown under the conditions I described, i.e., high rates of fertilizer and forced growth flushes by severe pruning of the graftwood source, and the use of very vigorous rootstocks.

The skill required to become a good propagator begins to develop after grafting a few thousand trees and experiencing both failure and success, while learning the art of grafting.

Literature Cited

Cobin, M. 1948. Notes on the grafting of *Litchi chinensis* Sonn. Proc. Fla. State Hort. Soc. 61:265-267.

Groff, G. W. 1921. The lychee and lungan. Orange Judd, New York. 185 pp.

Grove, W. R. 1951. The lychee is a natural for South Florida. No. 134, New Series, State of Fla. Dept. of Agric., Tallahassee.

Higgins, J. E. 1927. The lychee in Hawaii. Hawaii Agric. Expt. Sta. Bul. 44:1-27.

Nelson, R. O. 1953a. High humidity treatment for airlayers of lychee. Proc. Fla. State Hort. Soc. 66:198.

Nelson, R. O. 1953b. The use of plastic film in the graftage of tropical and subtropical plants. F. 12, Mango Forum Proc., Tropical Fruit Growers of South Florida Inc., Homestead, Fla.

Nelson, R. O. 1954a. Comments on lychee propagation, airlayering and graftage. Proc. Fla. Lychee Growers Assoc. 8-11.

Nelson, R. O. 1954b. Propagation of guavas by graftage. Proc. Fla. State Hort. Soc. 67:231.

Nelson, R. O. 1957. Suggested methods for top-working lychee. Proc. Fla. Lychee Growers Assoc. 7-21.

Venning, F. D. 1949. Anatomy and secondary growth in the axis of *Litchi chinensis* Sonn. Quart. Jour. Fla. Acad. Sci. 12(1).

Proc. Fla. State Hort. Soc. 107: 354-358. 1994.

CONFRONTING PLANT DIVERSITY WHEN PROPAGATING *LITCHI CHINENSIS*

VIVIAN G. MURRAY AND ROBERT D. MURRAY
The Treehouse
P.O. Box 124
Bokeelia, FL 33922-0124

Additional index words. Airlayers, cross-pollination, rootstocks, graftage, lychee.

Abstract. **The Treehouse (Bokeelia, Fla.) has been involved in the production of lychee (*Litchi chinensis* Sonn.) trees in parallel with a wide range of citrus cultivars for over 18 years. Many problems of the two bear a close resemblance. The effects of parentage, limb and bud sports, virus and other causes on diversity has been well researched in citrus because of its world-wide importance. The citrus investigations suggest the path future research must take to resolve the problems encountered in propagating the lychee. In addition, Groff's (1921) work is relevant to modern problems with lychee propagation. That we are dealing with a species of great genetic diversity, manifesting severe graft incompatibilities, is quite apparent. Having had to familiarize ourselves with many citrus disorders, we can only come to one conclusion—that these incompatibilities of lychee are also indicative of graft-transmissible pathogens. Thus, we view with alarm certain practices, used for**