Splice Grafting *Plumeria rubra* in Southern California

DONALD R. HODEL AND KENNY LAM

Grafting, the art of joining two separate pieces of living plants together so they will grow as one, has been an endeavor of horticulturists for over 3,500 years (Mudge et al. 2009). The Chinese performed grafting at least as early as 1516 B. C. while Aristotle (384–322 B. C.) and Theophrastus (371–287 B. C.) discussed it in their writings. During the Roman Empire grafting was popular and the Renaissance (A. D. 1350–1600) experienced a renewed interest in it. By the 17th century, grafting was used to propagate and establish entire orchards in Europe. Grafting was further popularized and perfected during the 18th, 19th, and 20th centuries and the various techniques developed then have varied little to the present day.

Nonetheless, grafting is not a propagation method one commonly associates with plumerias, which grow easily, simply, and less expensively from cuttings. However, grafting plumerias offers some advantages over cuttings. Here we discuss the principles and practices of grafting and then outline and illustrate the splice grafting method that plant enthusiast and co-author Kenny Lam has perfected on plumerias in his garden in Seal Beach, California. We have relied heavily on Hartmann et al. (2011) as a reference for our discussion of grafting.

Grafting Principles

Some Terminology

In grafting plants, the two separate pieces of living plants that join to form one plant are called the **rootstock**, which is the lower portion that contains the root system, and the **scion**, which provides a shoot or stem.

Both the rootstock and scion have a specialized layer of tissue between the bark (periderm, cortex, or phloem) and the wood (xylem), which is called the vascular **cambium**. It has cells capable of dividing and growing new cells and it lays down bark on the outside and wood on the inside. The cambium of the rootstock and that of the scion must be in close contact for a successful graft.

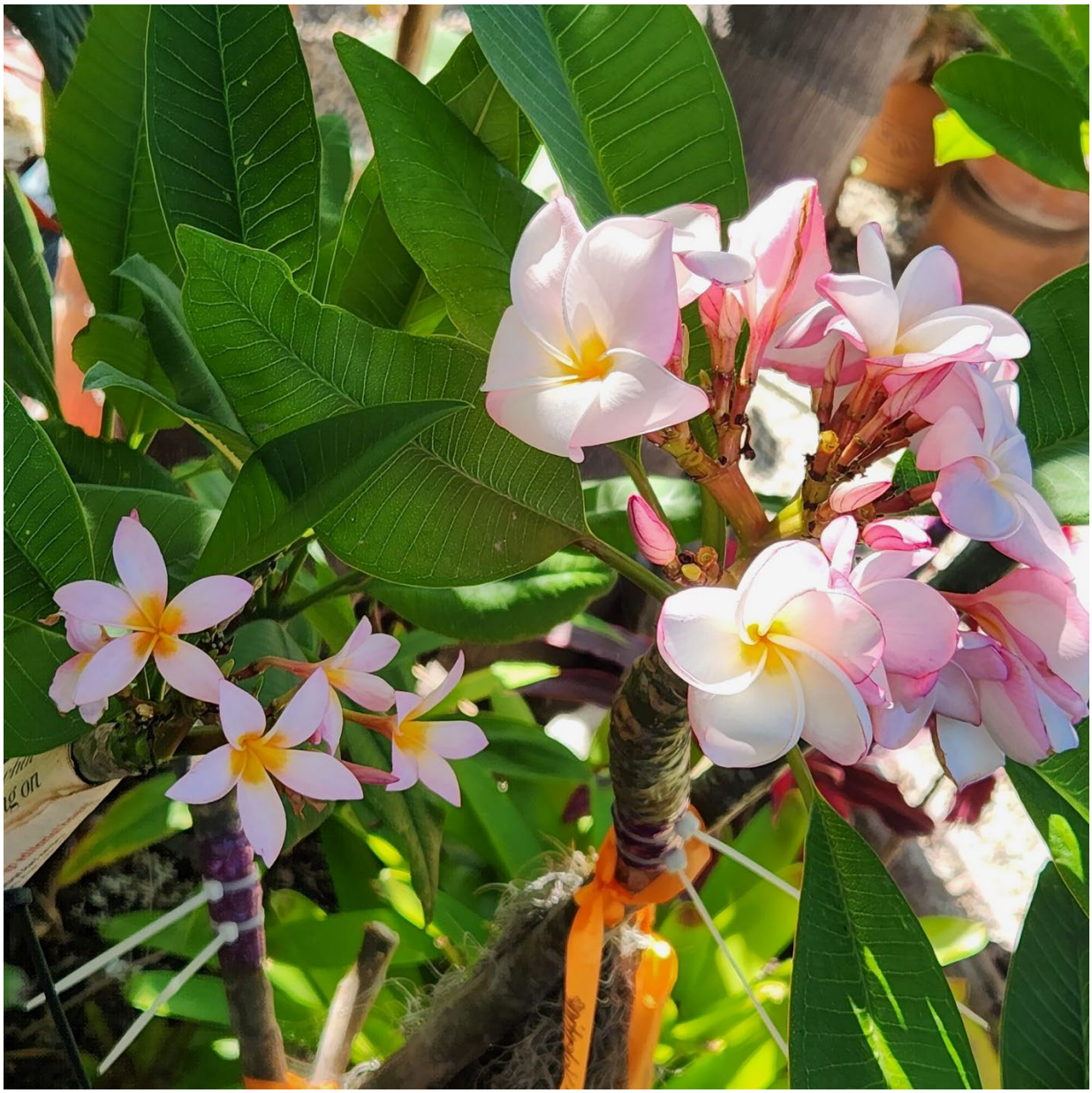
Another type of tissue critical to the grafting process is called **callus**, which is composed of simple, non-specialized cells called parenchyma, that develops from and around wounds in the covering-over or healing process, in our case, of the rootstock and scion. The production and interlocking

nature of callus tissue is critical for forming a "bridge" between the rootstock and scion and making a successful graft.

Why Graft?

Many reasons for grafting plants exist:

1. Because grafting is a form of asexual propagation, it is used to perpetuate clones (groups of genetically identical individuals). Clones are commonly referred to as cultivars or varieties but not all cultivars or varieties are clones. *Plumeria* varieties or cultivars are clones, and when we propagate them we want to do it asexually (cuttings or grafting) so that the new plant is genetically identical to the plant from which it originated.
2. Grafting provides a specific rootstock or scion that brings a specific characteristic to the new plant. For example, rootstocks can provide resistance to biotic (pests and diseases) and abiotic (specific soil types, salinity, drought, temperature) stresses. Also, they can provide size control (dwarfing, increased vigor, or increased growth rate), transplant success, or increased ease of grafting. Scions can influence growth rates, foliage, flower, and fruit characteristics, yield, and habit (for example upright vs. weeping growth). For example, with plumeria, *Plumeria rubra* 'Celadine' is typically a tough, easy-to-grow variety tolerant of adverse conditions, and it is a common variety, making it an excellent choice for a rootstock.
3. Grafting can be used to change the clone(s) of an existing plant. Grafting to change out the entire canopy of a plant with a new clone or clones is called top working. Adding multiple clones to a plant, as is often done with backyard fruit trees, increases the variety of fruits and flowers on a single plant, and is a novelty in itself. One of Kenny Lam's objectives in grafting plumerias is to have multiple varieties on one plant for esthetic reasons (**Fig. 1**). Similarly, having multiple varieties on one plant helps to preserve genetic material and save precious garden space because the multiple varieties are on one plant, not separate rooted plants of each variety.
4. Grafting can be used to repair injuries by "bridging" over large and serious wounds with much loss of bark and cambium and by assisting wounds to cover over or heal more quickly.
5. Sometimes a plant begins to rot at the base of the stem and/or roots and the remaining, upper healthy part is too small to root from cuttings, then grafting can be used to salvage the plant. Plumerias often suffer this type of rot and, because they typically root best if cuttings are at least 30 cm long, healthy but smaller shoot tips can be removed from the plant with basal rot and grafted on to a healthy plant.
6. In some plants, asexual propagation is difficult by cuttings and or impractical by other means, such as division or separation; thus, grafting is the only method to propagate them



1. Co-author Kenny Lam has grafted multiple varieties of *Plumeria rubra* on to this *P. rubra* 'Pink Pansy' rootstock. Lower left is *P. rubra* 'Gemini' and upper right is *P. rubra* 'My Valentine'. © 2023 by K. Lam.

asexually.

7. In plumerias, the Thai varieties are more difficult to root from cuttings but can be more easily propagated through grafting.
8. Grafting can be used to test for viral diseases. Because viruses are typically spread in plant sap, grafting a scion suspected of having a virus would impart that virus to the new plant,

including the rootstock. Recently, viruses have become a serious problem among plumeria growers and collectors.

9. For most people, grafting is a novel way to propagate plants, and it is fun.

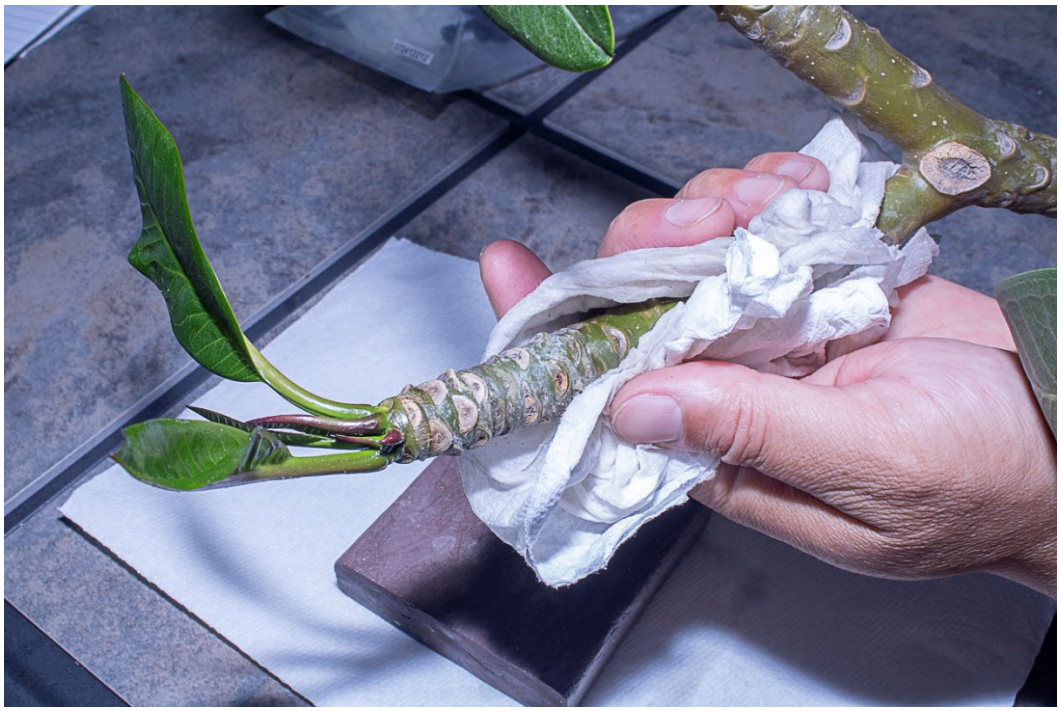
Requirements for Successful Grafting

Several requirements or factors exist for successful grafting:

1. The rootstock and scion must be compatible or capable of uniting. Generally, two closely related varieties or species are compatible. For plumerias, because we are working with one species, *Plumeria rubra*, all varieties (clones) of this species should be compatible. Furthermore, co-author Kenny Lam has successfully grafted varieties of *P. obtusa* on *P. rubra*, and others have grafted *P. pudica* on *P. rubra*.
2. The vascular cambium of the rootstock and scion must be positioned in direct contact with each other. Once placed in contact with each other, they must be held tightly together by wrapping or tying.
3. The rootstock and scion must be in a proper physiological stage, which typically means they must be actively growing (and the cambium is "slipping"). For plumerias in Southern California, the proper physiological state is at the beginning of the growing season. At this time, the plants are actively growing, and the following as-long-as-possible growing season will allow the graft union to develop properly and both rootstock and scion will produce significant growth.
4. Cut surfaces of the rootstock and scion must be protected from desiccation, which means covering the graft union with grafting tape, grafting wax, Parafilm tape, or buddy Tape.
5. Ensure post-grafting, vigorous growth of the rootstock does not over-take and "choke out" desirable scion growth.
6. Rootstock and scion should be the same or nearly the same diameter to ensure proper alignment and matching of the cambial layers, are properly hydrated, and are pest and disease free (**Fig. 2**).
7. Polarity of the scion, or which end it up and which is down, is critical for a successful graft union. The scion has an up or distal end (that end farthest from the roots of the plant from which it was taken) and a down or proximal end (that end closest to the roots of the plant from which it was taken). When placing the scion on the rootstock, it must be positioned with the down or proximal end at the graft union. When gathering scion material, carefully mark, label, or otherwise identify the proximal end.

2. The scion (top, *Plumeria rubra* 'Malika') should be the same diameter of the rootstock (bottom, *P. rubra* 'Celadine') where it will be grafted to ensure proper alignment and matching of the cambial layers. © 2023 by D. R. Hodel.

3. Thoroughly disinfect the scion with 70% to 90% isopropyl alcohol prior to making each graft. © 2023 by D. R. Hodel.



4. Thoroughly disinfect the rootstock where it will be grafted with 70% to 90% isopropyl alcohol prior to making each graft. © 2023 by D. R. Hodel.

5. Thoroughly disinfect the cutting surface and cutting tool with 70% to 90% isopropyl alcohol prior to making each graft. © 2023 by D. R. Hodel.

6. Make a slanting cut in the rootstock. © 2023 by D. R. Hodel.

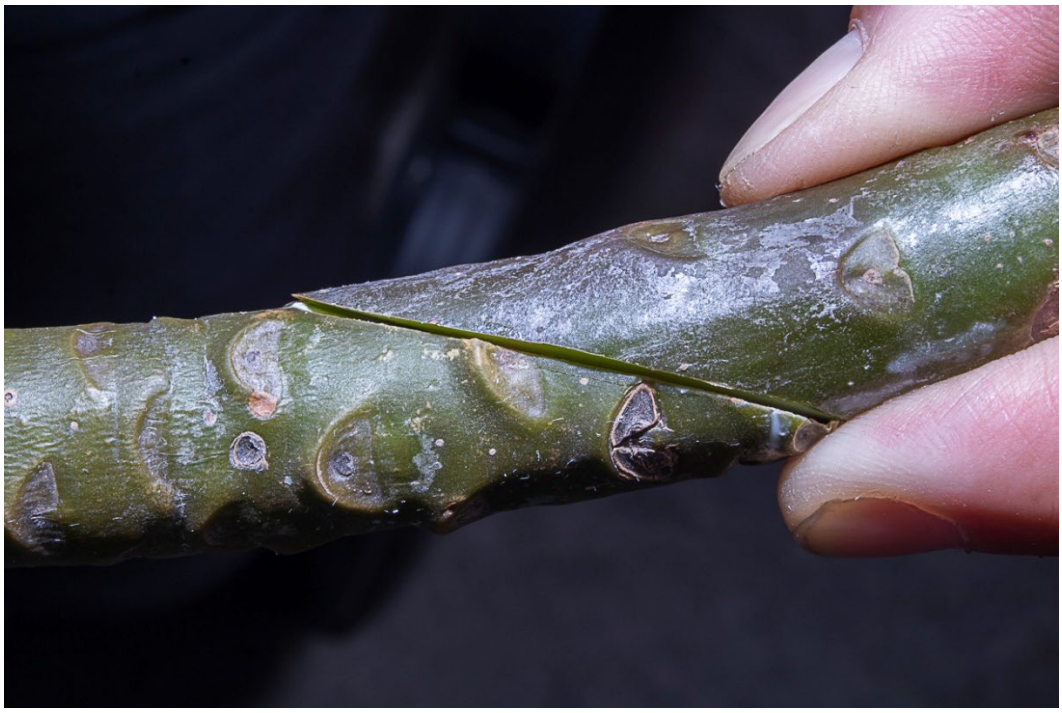
7. The slanting cut made in the rootstock. © 2023 by D. R. Hodel.

8. Hold the cut rootstock (top) next to the scion (bottom) to ensure the angle of the cut on the scion matches that of the rootstock. © 2023 by D. R. Hodel.

9. Compare the cuts on the rootstock and scion to ensure they are the same angle. © 2023 by D. R. Hodel.

10. Match the cuts on the rootstock and scion to ensure they are the same angle. © 2023 by D. R. Hodel.

11. If necessary, make final, fine cuts to ensure optimal matching of rootstock and scion. © 2023 by D. R. Hodel.



12. Match up the rootstock and scion as a final test of the fit. © 2023 by D. R. Hodel.

13. Co-author Kenny Lam cinches up the first zip tie to hold the rootstock and scion securely together. © 2023 by D. R. Hodel.

The Splice Grafting Technique

Although many grafting techniques exist, co-author Kenny Lam uses a splice graft, which is a simplified version of the common and popular whip-and-tongue graft, except that the second cut or "tongue" is not made in the rootstock and scion.

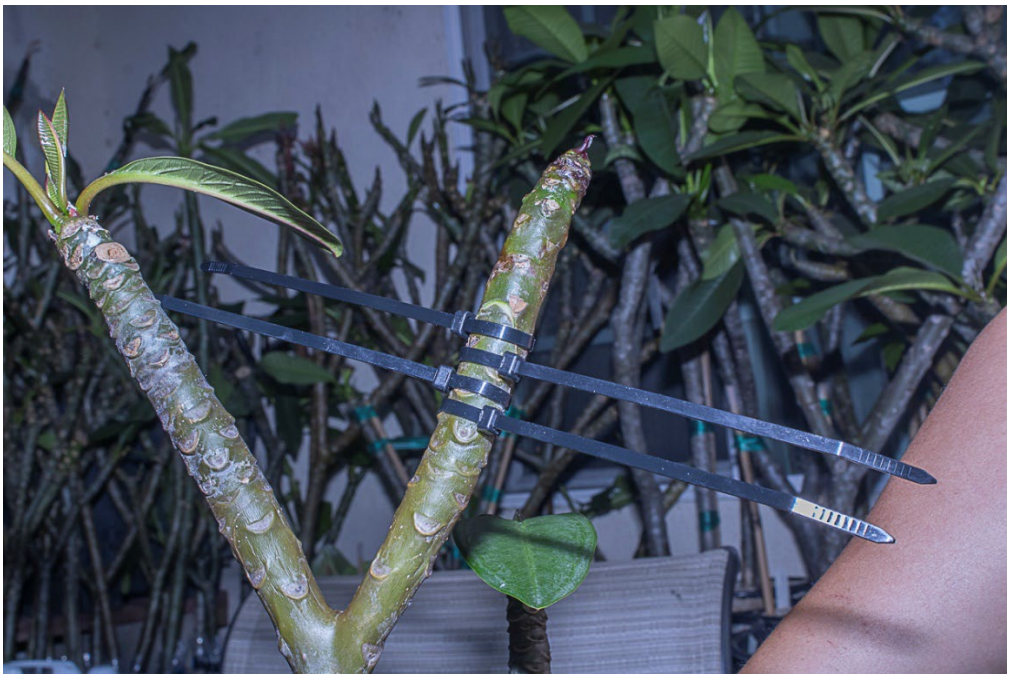
Because grafting requires a considerable amount of handling, select smaller, recently rooted (three-month old) cuttings in bags as the rootstock rather than larger plants rooted in containers or in the ground.

Disinfect all plant surfaces, cutting surfaces, and tools with 70% to 90% isopropyl alcohol prior to making each graft (**Figs. 3–5**).

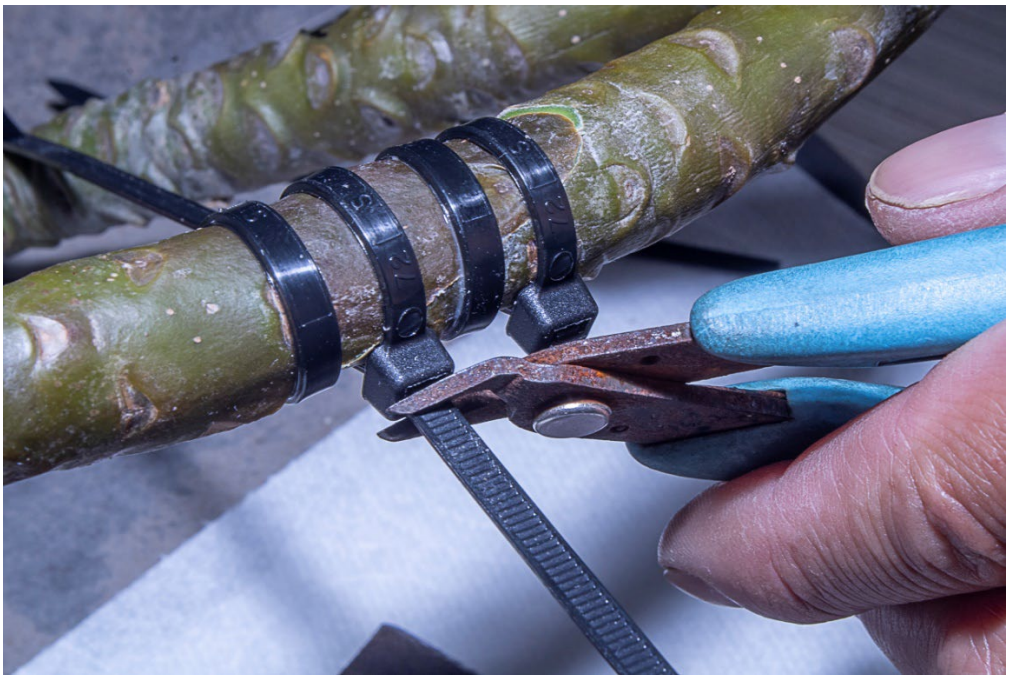
Graft plumerias in Southern California during the growing season from the end of March through August. Because grafts need about eight weeks for successful establishment, grafting much past August runs the risk of encountering cooler, inclement, weather detrimental to successful graft establishment.

Step-by Step Procedure:

1. A single slanting cut of the same angle and length is made in the rootstock and scion and the two surfaces are matched up and held tightly together. If necessary for better alignment and matching of the cambial layers, make final, fine cuts on the rootstock (**Figs. 6–12**).
2. Once matched together, clear or black, plastic zip ties are used to hold them firmly in place. Use at least three ties with alternating directions. Cinch them up tightly and securely and snip off the excess tie length (**Figs. 13–15**).
3. Wrap 2.5 cm-wide strips of Parafilm around the graft union from bottom to top, overlapping as you move upward like shingles on a roof, to prevent desiccation (**Fig. 16**).
4. Wrap 2.5 cm-wide, black electrician tape over the Parafilm for added protection. Wrap it as was done with the Parafilm (**Figs. 17–18**).
5. Then, if the new graft union will be in the sun, several layers of newspaper are tightly wrapped over and around the electrician tape and secured with another plastic zip tie for protection from the sun and overheating (**Fig. 19**). This step is unnecessary if the new graft will not be in direct sun.
6. Label the new graft with the names of the rootstock and scion and the date it was made.
7. After two months during the growing season, the graft union is typically secure and ready to be unwrapped of the newspaper, electrician tape, Parafilm, and zip ties. Do this carefully, though, especially when unwrapping the electrician tape and Parafilm because the pulling force to removed it could damage the graft union (**Figs. 20–23**).



14. Use three to four zip ties to secure the rootstock and scion. © 2023 by D. R. Hodel.

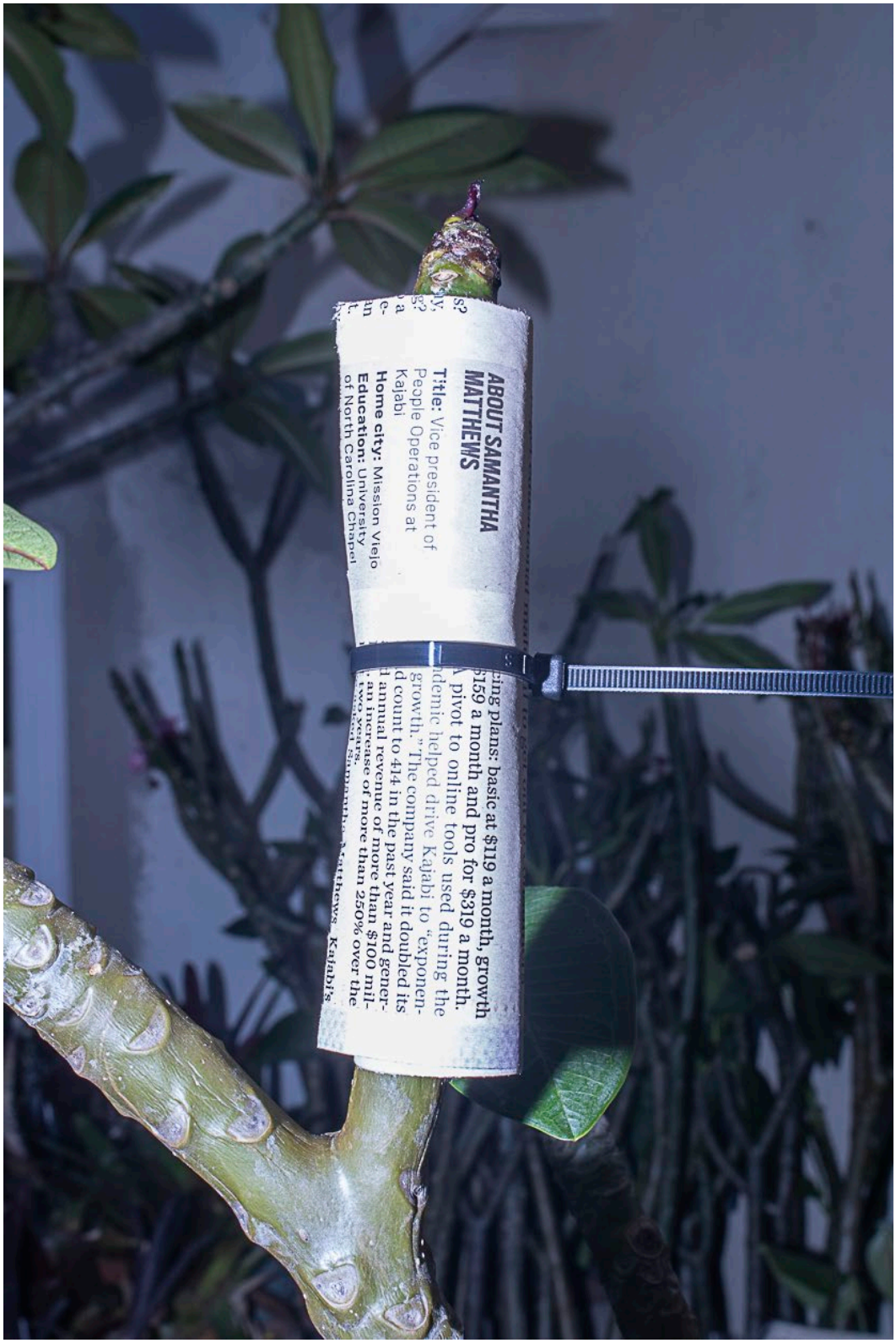


15. Closely snip off the excess zip tie after cinching them up firmly. © 2023 by D. R. Hodel.

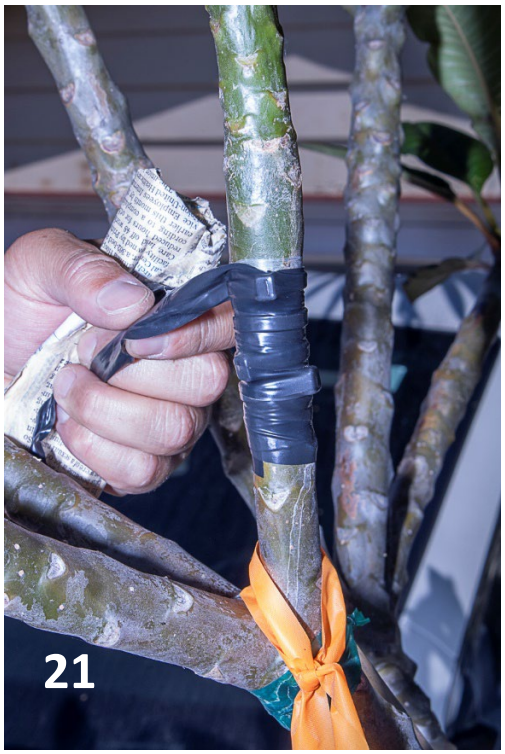
16. Wrap 2.5 cm-wide strips of Parafilm around the graft union from bottom to top, overlapping as you move upward like shingles on a roof, to prevent desiccation. © 2023 by D. R. Hodel.

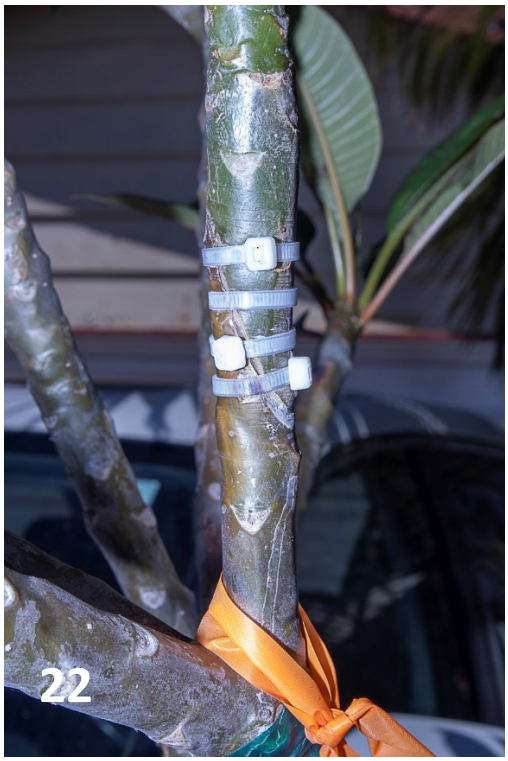
17. Wrap 2.5 cm-wide, black electrician tape over the Parafilm for added protection. Wrap it as was done with the Parafilm. © 2023 by D. R. Hodel.

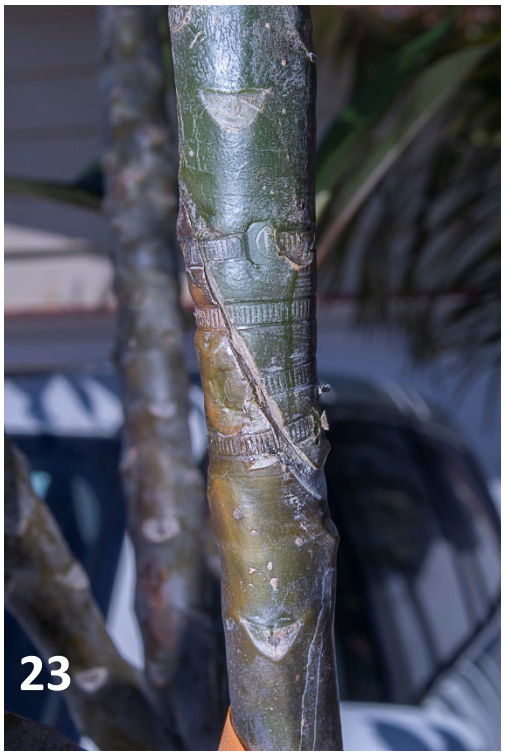
18. Securely wrap 2.5 cm-wide, black electrician tape over the Parafilm for added protection. © 2023 by D. R. Hodel.



19. If the graft union will be in the sun, securely wrap several layers of newspaper around it and cinch them tight with a zip tie to ensure it does not become too hot.
© 2023 by D. R. Hodel.



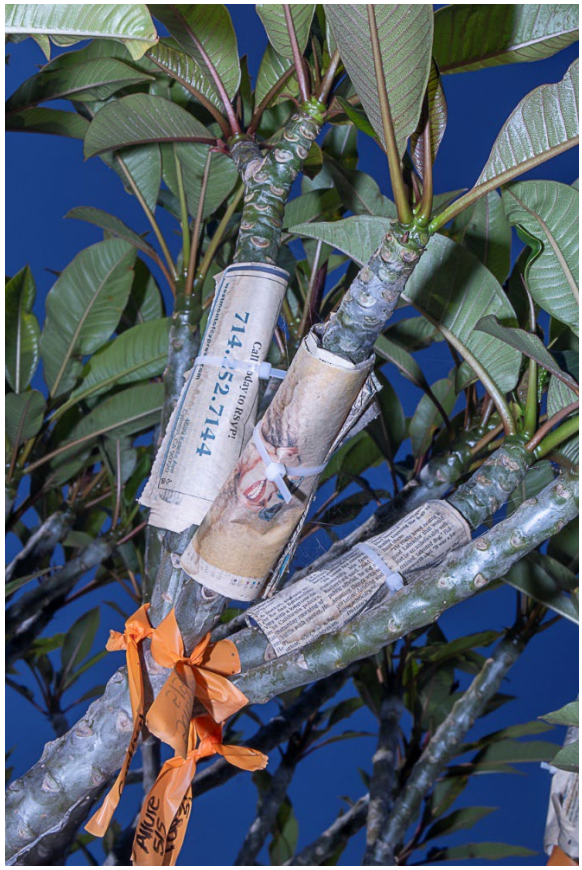




20–23. Carefully unwrap the graft union after two months. **20.** Remove the protective newspaper. **21.** Unwrap the black electrician tape. **22.** Snip off the zip ties. **23.** The graft union after two months. © 2023 by D. R. Hodel.

24. For added support and security of the new graft after it is unwrapped and uncovered, consider attaching a splint of slender bamboo or similar material. © 2023 by D. R. Hodel.

8. For added support and security of the graft after it is unwrapped and uncovered, consider attaching a splint of slender (0.6–1 cm diam.) bamboo or similar material that extends to the top of the scion and to an equal distance below the graft union. Tie it securely to the scion and rootstock with arborist tape (**Fig. 24**).



25 (left). A *Plumeria rubra* tree in co-author Kenny Lam's front yard with multiple grafts.
26 (right). Multiple grafts on a *Plumeria rubra* tree in co-author Kenny Lam's yard.
Both photos © 2023 by D. R. Hodel.

Tools and Supplies Needed for Grafting

Here is a list of the tools and supplies needed for following the suggested procedures in this article.

1. Grafting knife or heavy-duty box cutter with sturdy handle and replaceable blade.
2. Cutting board.

3. 70% to 90% isopropyl alcohol.
4. Paper towels.
5. Clear or black zip ties to hold the graft union together..
6. Wire cutters to snip off excess zip tie.
7. Parafilm to wrap around graft union as a moisture barrier. It will need to be cut into 2.5 cm-wide strips.
8. Black electrician tape for additional holding of the graft union.
9. If necessary, newspaper to wrap around the electrician tape to shade and protect it from the sun.

Literature Cited

Hartmann, H., D. E. Kester, F. T. Davies, Jr., and R. L. Geneve. 2011. Hartmann & Kester's Plant Propagation(,) Principles and Practices. 8th edition. Prentice Hall, Upper Saddle River, New Jersey.

Mudge, K., J. Janick, S. Scofield, and E. E. Goldschmidt. 2009. A history of grafting. Hort. Rev. 35: 437–493.

Donald R. Hodel is the Emeritus Landscape Horticulture Advisor for the University of California Cooperative Extension in Los Angeles and specializes in the taxonomy, selection, and management of palms and trees. *drhodel@ucanr.edu*

Kenny Lam is a plant enthusiast and collector of plumerias and palms in Seal Beach, California. *kennylamre@gmail.com*

Text © 2023 by Donald R. Hodel and Kenny Lam.
Photographs © 2023 by D. R. Hodel, except Fig. 1 by K. Lam.
Publication Date: 20 September 2023.
PalmArbor: *http://ucanr.edu/sites/HodelPalmsTrees/PalmArbor/*
ISSN 269083245
Editor-In-Chief: Donald R. Hodel
Hodel Palms and Trees: *http://ucanr.edu/sites/HodelPalmsTrees/*