Hawaii Cooperative Extension Service

HORTICULTURE DIGEST

HITAHR · College of Tropical Agriculture and Human Resources
U. S. Department of Agriculture Cooperating

Department of Horticulture
University of Hawaii at Manoa

In This Issue: FLOWER AND NURSERY INFORMATION
No. 98, November 1992

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15 WAYS NOT TO GO BANKRUPT

These are the times that try men's souls, etc. may be appropriate words for the economy in 1992. This editor felt that the following excerpts from Will Carlson's article (see references) presented appropriate warnings for the current economic climate.

Undercapitalization—taking on too much debt, too many accounts receivable, not enough operating capitol.

Not Knowing the Business—I suggest that a person work in a greenhouse to gain experience and to determine if the work is satisfying before going into business.

Selling to Someone Who Doesn't Pay—It is difficult to turn away business, but do not be left holding the empty bag. Slow pay/no pay clientele do not help you. You are not in the banking business. Unfortunately there are people who go from grower to grower and play the slow pay/no pay game.

Too Much Overhead—I urge growers to "Make Your Mistakes on Paper," not in your wallet. Be realistic when starting or expanding. The greenhouse venture has to be profitable to continue.

Poor Quality Product and Service—The old adage "Quality Sells" is as true today as when it was first uttered. Quality and service should be paramount in your business.

Noncompetitiveness—Keep an open mind on product, sales, price, etc. If sales decline, determine why. Do not stick your head in the sand and keep blundering on.

Product Liability—Carefully evaluate your products for potential liability. That's what drove John Mansville into bankruptcy (asbestos scare, etc.).

Environmental Restrictions—Do some policing of your own operation before it is legislated upon you. Keep abreast of local ordinances, etc. Anticipate, rather than play the catch-up game. Be an environmentally good neighbor.

New Technologies Making Products Obsolete—Subscribe to one or more trade magazines and/or Extension newsletters, attend seminars, short courses and trade shows. One idea, product or technique learned will more than pay for the trip and registration fee.

Fraud—Be vigilant in your money handling transactions. Make sure that your accounting system has ample checks and balances to make it impossible to steal company funds.

Foreign Competition—Keep your business competitive. Locally, we know that floral products are readily shipped into this market from Canada.

Depressed Market Conditions—We are now experiencing this in the northeast. You must be particularly cautious during these uncertain times and not get overextended.

Being Underinsured—Do you have fire, flood or wind insurance? Any one of these calamities could put you out of business.

Overexpanding—Do not expand yourself into bankruptcy. When you expand, do it in a financially responsible way. Do proceed at a slow, steady growth rate. Don't be tempted to toss caution to the wind.

Owners Drawing Excessive Salaries—Some owners take all the money they can from the business, because they do not care about the

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greenhouse business.

These 15 mistakes that Dr. Carlson brings to our attention will, hopefully, prevent you from declaring bankruptcy.

References

Carlson, W. 1991. 15 Ways Not To Go Bankrupt. *Greenhouse Grower*, Vol. 9, No. 5:38,39,41.

Botacchi, A. C. Excerpts from talk to R.I. Greenhouse Growers. January, 1992.

Allen C. Botacchi
Connecticut Greenhouse Newsletter

EDITOR'S NOTES:

An article in the Thursday, August 6, 1992 edition of the Honolulu Star Bulletin shows that nearly five times as many local Hawaii business have called its quits during the first half of 1992 than during the first six months of last year to lead the nation in this category. Maybe some of Mr. Botacchi's suggestions can help you to still be in business next year.

PLUMERIA KEEPING QUALITY

The University of Hawaii has maintained a collection of plumerias as a source of germplasm since the 1960s. At various times, flowers have been harvested for studies of their keeping qualities with the goal of finding cultivars with long life for use in leis. Another potential use of plumeria flowers could be in wedding bouquets where their delicate colors and fragrance would be appreciated much as is the stephanotis. Mainland use of plumerias for this purpose would require a much longer keeping life than flowers strung locally for leis.

In the course of conducting the keeping quality work, two different methods of determining the keeping life were used. In both years (1988, 1991), the day-old flowers were held in plastic bags in dark refrigerated walk-in reefers (50°F in 1988; 55°F in 1991). In the HALF LIFE method, flowers were discarded as they became unacceptable and the number of days was recorded when only one-half of the original 10 flowers per bag remained. MEAN DAYS of keeping quality were determined by counting the number of good flowers remaining each day until all flowers were discarded. The number of flower-days was divided by the original number of flowers (10) to determine the mean flower lifespan. In Table 1, the keeping quality value is the average of three replicates of each cultivar (10 flowers per bag). For comparison, flowers of the 'Common Yellow' (= 'Celadine') plumeria were collected each time.

This work was supported by a grant from the Plumeria Society of America.

Richard A. Criley
Professor of Horticulture

COMING EVENTS

GreenTECH Show

GreenTECH, the 14th Annual Landscape Industry Show, will be held at the Long Beach Convention Center, February 24–25, 1993. Contact the California Landscape Contractors' Association, 2021 N St., Suite 300, Sacramento, CA 95814. (916) 448-2522.

Tissue Culture Conference

The Plant Tissue Culture Conference I sponsored by the Hawaii Plant Tissue Culture Association will precede the Ornamental Short Course at the King Kamehameha's Kona Beach Hotel on Monday, March 22, 1993. Mainland speakers include Mr. Kenneth Torres, Sigma Chemical in St. Louis and Irwin Chu of Twyford International. Contact Rachael Keolanui, HPTCSA, P.O. Box 4072, Hilo, HI 96720 (808-959-0225) for information.

Ornamental Short Course

The 16th Annual Ornamental Short Course sponsored by the Cooperative Extension (CTAHR) in cooperation with various commodity organizations is scheduled for the Big Island, March 23–24, 1993 at the King Kamehameha's Kona Beach Hotel in Kailua-Kona. Prominent mainland speakers that have been lined up are Henry M. Donselman (Rancho Soledad Nurseries), James F. Knauss (Grace-Sierra Chemical Co.), and Harry K. Tayama (Ohio State University). The morning general session on Tuesday will feature "What's New" with concurrent sessions in the afternoon for Nursery Production and Landscape Management. An industry tour is scheduled for Wednesday, March 24 for the Kona Coast. For further information contact Fred D. Rauch (808) 956-7256 or David L. Hensley (808) 956-2150, 3190 Maile Way, Honolulu, HI 96822.

Table 1. **KEEPING QUALITY, UNIVERSITY OF HAWAII PLUMERIA COLLECTION BY COLOR AND CULTIVAR.**

COLOR	CULTIVAR	KQ (DAYS)	METHOD-OF-DETERMINING KQ
LIGHT PINK	SLAUGHTER PINK	18.2	MEAN DAYS KQ
PINK	RUFFLES	16.4	MEAN DAYS KQ
PINK	GI PLASTIC PINK	16.3	MEAN DAYS KQ
PINKISH	MAYAGUEZ	16 3	MEAN DAYS KQ
PINK	TILLIE HUGHES	15.4	MEAN DAYS KQ
PINK	ANGUS SELECTION	13.0	MEAN DAYS KQ
PINK	CARTER #2	12.4	MEAN DAYS KQ
PINK/WHITE	PEACHGLOW SHELL	12.0	HALF LIFE
PINK	TOMLINSON PINK	11.9	MEAN DAYS KQ
PINK	THORNTON LILAC	11.7	MEAN DAYS KQ
PINK	ANGUS SELECTION	10.5	MEAN DAYS KQ
PINK	CARMEN	10.3	HALF LIFE
PINK	TILLIE HUGHES	10.2	MEAN DAYS KQ
PINK	ANGUS SELECTION	9.3	HALF LIFE
PINK	TOMLINSON PINK	9.2	MEAN DAYS KQ
PINKISH	RUFFLES	9.0	HALF LIFE
PINK	PLASTIC PINK	8.7	HALF LIFE
PINK	KIMI MORAGNE	8.5	MEAN DAYS KQ
PINK	GROVE FARM	8.3	HALF LIFE
LIGHT PINK	COURTADE PINK	8.0	MEAN DAYS KQ
PINK	MELA MATSON	7.3	HALF LIFE
PINK	ESPINDA PINK	7.3	MEAN DAYS KQ
PINK	MANOA BEAUTY	7.0	HALF LIFE
PINK	LORETTA	6.7	HALF LIFE
RED	IRMA BRYAN	15.3	HALF LIFE
REDDISH	PAUAHI ALII	11.7	HALF LIFE
RED/WHITE	RED SHELL	10.0	HALF LIFE
REDDISH	ANGUS #3	9.1	MEAN DAYS KQ

COLOR	CULTIVAR	KQ (DAYS)	METHOD-OF-DETERMINING KQ
RED	SCHMIDT RED 24-4	9.0	HALF LIFE
RED-ORANGE	KAUKA WILDER	9.0	HALF LIFE
REDDISH	DONALD ANGUS	8.7	HALF LIFE
REDDISH	MARY MORAGNE	8.6	MEAN DAYS KQ
RED/YELLOW	PUAHI ALII	8.4	MEAN DAYS KQ
RED/YEL/OR	JEAN MORAGNE JR	8.1	MEAN DAYS KQ
REDDISH	KONA HYBRID 26	7.6	MEAN DAYS KQ
REDDISH	JAPANESE LANTER	7.3	MEAN DAYS KQ
RED	SCOTT PRATT (JL)	7.3	MEAN DAYS KQ
RED/YEL/OR	KATIE MORAGNE	6.9	MEAN DAYS KQ
REDDISH	CERISE	6.7	HALF LIFE
RED/PINK	REDDISH MORAGNE	6.6	MEAN DAYS KQ
REDDISH	EWC #3	6.5	MEAN DAYS KQ
REDDISH	DUKE	6.3	HALF LIFE
DARK RED	HILO BEAUTY	6.0	MEAN DAYS KQ
RED/PINK	MORAGNE #9	5.8	MEAN DAYS KQ
RAINBOW	LEI RAINBOW	8.3	HALF LIFE
ORANGE	KIMO	12.8	MEAN DAYS KQ
ORANGE	KIMO	6.0	HALF LIFE
WHITE	ELENA	12.0	HALF LIFE
WHITE/YEL	SML YELLOW EYE	11.7	HALF LIFE
WHITE	18-41 CLONE	9.7	HALF LIFE
WHITE	GARDENIA	8.3	HALF LIFE
WHITE	SINGAPORE	8.0	HALF LIFE
WHITE	SAMOAN FLUFF	7.7	HALF LIFE
WHITE	OP SINGAPORE	7.7	HALF LIFE
WHITE	SAN GERMAIN	7.4	MEAN DAYS KQ
WHITE	MINIATURE WHITE	7.3	HALF LIFE
WHITE	DAISY WILCOX	7.3	HALF LIFE
WHITE	MADAME PONI	7.0	HALF LIFE
WHITE	KING KALAKAUA	6.7	HALF LIFE

COLOR	CULTIVAR	KQ (DAYS)	METHOD-OF-DETERMINING KQ
WHITE	OP SAMOAN FLUFF	6.7	HALF LIFE
WHITE	SHERMAN WHITE	6.3	HALF LIFE
WHITE	DWF SING. 16-4	6.3	HALF LIFE
WHITE	MAUI PICOTEE	5.0	HALF LIFE
DARK GOLD	PAUL WEISSICH	9.7	MEAN DAYS KQ
GOLD	ROADSIDE GOLD	9.7	MEAN DAYS KQ
GOLD	GOLD SEEDLING	9.2	MEAN DAYS KQ
GOLD	NEBEL'S GOLD	4.7	HALF LIFE
GOLD	MOILIILI GOLD	4.3	HALF LIFE
YELLOW	#7-5	14.6	MEAN DAYS KQ
YEL/WHITE	WHITE SHELL	11.7	HALF LIFE
YELLOW	CELADINE (CY)	11.3	HALF LIFE
YELLOW	CELADINE (CY)	11.2	MEAN DAYS KQ
YELLOW	#7-5	10.6	MEAN DAYS KQ
YELLOW	CELADINE (CY)	10.2	MEAN DAYS KQ
YELLOW	HEIDI	9.0	MEAN DAYS KQ
YELLOW/WHT	MELE PA BOWMAN	8.4	MEAN DAYS KQ
YELLOW	CELADINE (CY)	7.7	MEAN DAYS KQ
YELLOW	CELADINE (CY)	7.5	MEAN DAYS KQ
YELLOW/WHT	MORAGNE YELLOW	7.5	MEAN DAYS KQ
YEL/PINK	SALLY MORAGNE	7.4	MEAN DAYS KQ
YELLOW	SUNSHINE	7.4	MEAN DAYS KQ
YEL/RED/OR	JEAN MORAGNE JR	6.7	HALF LIFE
LT YELLOW	MORAGNE #27	5.9	MEAN DAYS KQ
PALE YELLOW	THORNTON LEMON	5.1	MEAN DAYS KQ
YELLOW	YELLOW SHELL	4.7	HALF LIFE

HALF LIFE determinations made in 1988 at 10°C in plastic bags. Half life is the number of days until only one-half of the original 10 flowers per bag remained. There were three replications for each cultivar.

MEAN DAYS KQ determination were made during the summer of 1991 at 13°C in plastic bags. The number of good flowers remaining was determined each day until all flowers were discarded. The number of flower-days was divided by the original number of flowers (10) to determine the mean flower lifespan.

Turf Midterm Conference

Plans are underway for the 1993 Midterm Conference and Trade Show sponsored by the Hawaii Turfgrass Association at the Pacific Beach Hotel, Honolulu on May 27–28. The trade show is planned to be a more hands-on, lab-type of format, dealing with turf types, machinery maintenance, grounds renovation techniques and various green industry products. The Golf Tournament will be held May 26 at the Ala Wai Golf Course. Contact David Klawitter at (808) 695-7227 (code-a-phone/FAX) for information.

Computer Workshop

Preliminary discussions are underway for a Computer Workship to be held in Honolulu in June of 1993 on the University of Hawaii campus. This would include lectures and demonstrations of hardware and software, such as Landcadd for the Green Industry.

Golf Superintendents

The Hawaii Golf Course Superintendents Annual Conference is tentatively scheduled for July, 1993.

Hort Society

The Annual Meeting of the American Society for Horticultural Science (ASHS) will be held at the Opryland Hotel, Nashville, TN July 24–29, 1993. Call Christine Radiske at (703) 836-4606 for information.

Unthirsty Plant Sale

The Friends of Halawa Xeriscape Garden will host the 5th Annual Unthirsty Plant Sale and Open House of the Halawa Xeriscape Garden on Saturday, August 7, 1993. The Board of Water Supply will also hold its annual open house with tours of the Halawa tunnel that day. Volunteers are needed for the plant sale and should contact the sale chairperson Alice Kadowaki at 988-6664. For further information contact the Friends at 527-6113.

Pan Pacific Show

The second annual Pan Pacific Green Industry Conference and Trade Show is scheduled for the Sheraton Waikiki Hotel in Honolulu, September 1–3, 1993. The Trade Show will be redued as the facility can only accommodate 190 booths. Contact the LICH office, (808) 545-1533, 1085 S. Beretania St., Suite 203, Honolulu, HI 96814.

Plant Propagators

The Western Region of the International Plant Propagators Society will hold their Annual Meeting at the Red Lion Inn, Bellevue, Washington, September 8 to 11, 1993.

Turf Conference

The Hawaii Turfgrass Association is planning to hold the 1993 Annual Conference on Kauai at the Coco Palms on October 28–29, 1993. The Golf Tournament will be held on October 27.

Shigo Workshop

Tentative plans are underway to hold another workshop with Dr. Alex Shigo on "Tree Care" in January, 1994 on the Big Island.

AN UPDATE ON THE MINERAL NUTRITION OF PALMS

Palms are important and conspicuous elements of the outdoor landscape in warmer regions and in the interiorscape just about everywhere, and are projected to become increasingly popular in the near future.

Unfortunately, relatively little is known about the culture of ornamental palms especially as it relates to nutrition and fertilizers. Also, much of the available information about palm nutrition from traditional sources is outdated and of little or no use.

Dr. Timothy K. Broschat of the University of Florida has recently been investigating the nutrition of ornamental palms and has come up with some new and, at times, startling information that bears summarizing here.

This article will discuss the causes, symptoms, and diagnosis and treatment of nutrient deficiencies in palms, as well as provide a nutrition guide and a fertilizer program for palms in containers and the landscape based on some of Dr. Broschat's findings.

Causes of Nutrient Deficiencies

There are several factors to consider in determining the cause of a nutritional deficiency. In most situations, elements exist in sufficient quantities in the soil for proper growth, and it is more likely that the deficiency is due to external factors, such as chemical interactions, root problems, temperature, and nutrient imbalances that render the element unavailable to the plant or limit the ability of the plant to take up the element. However, in some cases, macronutrients, especially nitrogen, potassium, and magnesium, may simply be present in insufficient quantities.

For example, if a grower neglects to add dolomite to the potting mixture because the pH is at an acceptable level, deficiencies of magnesium will result. Nitrogen, potassium, and magnesium are readily leached from sandy soils, such as those in some areas of Southern California, and in these cases, a complete fertilizer program is necessary.

Since most of the now out-dated fertilizer recommendations for palms emphasized the application of large amounts of nitrogen and gave little attention to potassium, palms are often found deficient in this latter element. Adherence to sound cultural practices and a complete fertilizer program are essential to avoid nutrient deficiencies and to attain optimal growth of palms.

Chemical Interactions

Chemical interactions affect the solubility of elements and their subsequent availability to plants. Organic soils tend to fix copper. High soil pH decreases the solubility of zinc, iron, copper, and especially manganese, tying them up and rendering them unavailable to the plant, a not uncommon occurrence in the alkaline heavy clay soils of some parts of California. Generally, the best solution is applications of sulfur, incorporation of organic materials, and the use of mulches. Soluble forms of phosphate fertilizers can also tie up iron, manganese, and zinc.

Root Problems

Root problems due to poor aeration, disease, mechanical damage, temperature extremes, and improper planting inevitably lead to nutritional disorders since damaged or low-respiring roots are unable to take up essential elements. In fact, root damage is one of the leading causes of nutrient deficiencies in palms, especially of some micronutrients.

In seedlings and young plants, root diseases caused by the fungi *Pythium*, *Phytophthora*, and *Rhizoctonia* damage root surfaces, directly leading to decreased uptake of nutrients. Also, damaged roots will not take up as much water, resulting in oxygen-poor and/or waterlogged soil that limits the ability of the roots to take up micronutrients, especially iron and manganese. Planting too deeply results in the same problems as oxygen-poor or waterlogged soils. Anytime root respiration is reduced, root activity decreases, leading to decreased uptake of iron and manganese and deficiencies of these elements.

Mechanical injury to roots caused by improper handling at potting, repotting, planting, or transplanting will also lead to nutrient deficiencies. With damaged roots, the first symptoms and, in some cases, the only symptoms that appear above ground are those of iron and manganese deficiencies.

Cool temperatures limit root activity also, resulting in decreased uptake of eater and nutrients. Usually cold-induced deficiencies appear in the late winter or early spring as active growth resumes and root activity is low, relative to that of the foliage. The solution is to fertilize year-round and especially in the fall before growth begins to slow down.

Nutrient Imbalances

Sometimes too much of one nutrient in relation to another can cause problems even though the deficient element is still present in the soil. For example, high nitrogen, calcium, or magnesium to potassium ratio can lead to a deficiency of the latter element. If potassium is provided in a soluble form but nitrogen is supplied by a controlled-release material, more potassium than nitrogen will be leached from the soil and an imbalance between the two elements will occur. The result will be potassium deficiency.

On the other hand, high levels of potassium and calcium may induce magnesium deficiency. For example, regular applications of a potassium fertilizer but not magnesium may lead to a deficiency in magnesium even though the latter element may be present in the soil. The solution here is to treat for potassium and magnesium deficiencies simultaneously.

Insufficient Nutrients

Soils vary greatly and sometimes fail to supply in sufficient quantity all the nutrients required for the best growth of palms. Generally, soils contain most of the elements known to be essential to plants, so one only needs to add those that are deficient in the area.

For example, nitrogen is naturally low in many soils in California and additional amounts of this element are needed for optimal growth of palms. Also, sandy soils are usually very deficient in potassium, magnesium, and manganese. Macronutrient deficiencies are often due to inadequate levels of the element in the soil but, as noted above, it is not so for micronutrients.

Age and Establishment

A newly planted or transplanted palm will require a substantial amount of time to establish itself in the landscape. In warmer climates, as in Florida or Hawaii, the establishment period may be as little as a year while in cooler areas, like coastal California, it may take up to two years. During the establishment period the plant requires special care while the roots develop to the point where they have moved out of the original ball and into the surrounding soil and begin taking up nutrients. If palms are improperly planted or poorly cared for after planting, then problems with nutrient deficiencies can arise.

Soil Type

Naturally, sandy soils are going to hold fewer nutrients than those with adequate clay or organic matter. Environmental factors, such as high rainfall and warm temperatures, will tend to exacerbate the problem. On the other hand, as noted earlier, heavy, poorly-drained soils with excessive irrigation or rainfall can contribute to root problems.

Diagnosis and Treatment

Treatment of nutritional deficiencies is a last resort; prevention is superior to correction. Practice proper fertilization, maintain good drainage and aeration, implement sound horticultural practices such as proper planting depth and irrigation, and maintain proper pH.

Macronutrient deficiencies usually can be treated by simply supplying the needed elements to the soil. As noted earlier, micronutrient deficiencies are usually traced to a cultural or environmental problem. To correct micronutrient deficiencies, in most cases, the grower must alleviate the cultural or environmental cause prior to corrective application of fertilizers. Failure to do so will result in only temporary and incomplete control of the deficiency.

Remember that many micronutrient deficiencies occur because of damaged or inadequate roots. Soil applications of fertilizers may therefore, be very slow to correct the deficiency. In these cases it may be more advantageous to apply a foliar spray of micronutrients along with a soil application until complete recovery is achieved.

In many instances, non-nutritional disorders may exhibit symptoms similar to those of nutrient deficiencies. See the accompanying table for more details.

Since symptoms of potassium and magnesium deficiencies occur on older leaves, they may be confused with those of naturally senescing leaves. However, the orange or yellow translucent flecking of spotting (potassium deficiency) and chlorosis (magnesium deficiency) occurring toward the tips of the leaflets or leaf segments with the center of the leaf and rachis remaining green distinguish the nutrient disorders. Also, the naturally senescing leaves usually become uniformly yellow and brown throughout, the discoloration not concentrated toward the tips.

Palm Nutrition Guide

Palms will suffer quickly due to insufficient or incorrect fertilization. Since they are relatively slow-growing plants, palms take longer to recover than many plants when suffering from a nutrient disorder. The prolonged, relativley cool winters and springs of coastal California further slow any recovery. A good fertilizer program is essential to establish a palm rapidly in containers after repotting or in the ground after planting.

Controlled- or slow-release forms of nutrients from either organic sources (blood, bone, or fish meal) or chemically treated (sulfur- or resin-coated) inorganic forms are preferred to highly soluble, quick-release inorganic materials since the former provide a steady stream of nutrients over a longer period rather than the short bursts of fluctuating dosages of the latter.

Palms seem to respond best to a steady, constant supply of nutrients, and it is no wonder since this is how they are provided in the wild from the decay of organic matter in the forest.

Controlled-release inorganic fertilizers are formulated with specific release periods, such as 3, 6, 9, or 12 or more months at soil temperatures of 22 C. (70 F.). Higher soil temperatures speed up the release of nutrients and lower ones slow it down.

The best fertilizer ratio for palms is 3-1-3 (for example a 15-5-15 or 12-4-12) of nitrogen, phosphorous, and potassium. Also, fertilizers should contain magnesium at one-third the rate of potassium. It is preferable that the fertilizer have nitrogen and potassium in the controlled-release form to prevent potassium deficiency and subsequent problems related to nutrient imbalances.

Container Fertilizer Program

Palms produced in the nursery are usually grown in soilless media or potting mixtures composed of one or usually more ingredients. Some of the commonly used materials include sand, peat moss, perlite, shavings, volcanic cinders, and ground bark, among others. As long as drainage and water- and nutrient-holding capacity are excellent, palms can be grown in just about any of these materials or combinations thereof. In fact, there are as many different potting media as there are growers, and most mixtures are more than adequate.

In each cubic meter of mixture selected, the grower should thoroughly incorporate 4.2–6 kg (7–10 lbs/cubic yard) of dolomite and 0.3–0.9 kg (0.5–1.5 lbs/cubic yard) of a complete micronutrient blend. Dolomite supplies magnesium (a nutrient needed in relatively large amounts by palms and difficult to provide by other means) and calcium as well as adjust pH to proper levels.

Incorporation of superphosphate to potting mixtures was a common recommendation and practice in the past, although there is recent evidence that it may have harmful effects to growth of plants, particularly palms, by tying up micronutrients, especially manganese, and making them unavailable. Also, the use of composted manures and sewage sludges can have a similar effect. Nitrogen, phosphorous, and potassium are best supplied at planting time, or supplementally later, but not incorporated into the potting soil.

It is best to fertilize container-grown plants at the time of potting or repotting since this is an opportunity to place the fertilizer where it will do the most good. Dibble or place the recommended dosage of a controlled-release fertilizer of 3-1-3 ratio in a little mix at the bottom of the container and then plant the palm. The fertilizer is then where the roots can come into immediate contact with it. Improved growth offsets the extra time and labor needed to place fertilizer during repotting in this this manner. On the other hand, fertilizer placed on top of the mix after potting must be leached downward into the root zone, delaying the benefit of the nutrients.

Also the nitrogen in the mix in the upper part of the pot will contribute to the premature breakdown of organic matter, leading to a decrease in aeration, and then root problems and nutritional deficiencies.

Plants in containers may need periodic, additional fertilization depending on the release period of the fertilizer. Then, of course, fertilizers must be applied as a top dressing or in liquid form. Since calcium and magnesium in the form of dolomite and micronutrients were incorporated in the potting mixture, it is usually not necessary to reapply these nutrients again. The plants will receive a new dose of these with the fresh potting mixture at each repotting.

For growers on constant liquid feed, 150 ppm of nitrogen and potassium and 50-75 ppm of magnesium are recommended. Decrease rates of fertilizers in all programs when soil temperatures drop below 17 C. (65 F.).

Landscape Fertilizer Program

For established plants, apply a complete, controlled-release fertilizer of 3-1-3 ratio, preferably one containing magnesium and micronutrients. Broadcast at the recommended package rate and frequency, mixing into the soil thoroughly where possible and water in well. Take care not to place the fertilizer against the stem where newly emerging roots may be injured. If using soluble or rapid-release, inorganic fertilizers, a good rule-of-thumb is to apply half the recommended label rate but at twice the frequency. Soluble fertilizers need to be applied more frequently to light, sandy soils than heavy, clay ones although the total amounts are not too different over a period of time.

Nutrient deficiency symptoms and their possible causes, and other disorder that may display similar symptoms, are summarized in the accompanying chart.

Most Common Nutrient Deficiencies of Palms

The most commonly deficient nutrients are listed below. Symptoms of deficiencies on palms may be difficult to diagnose since they are often different than on other plants and symptoms of several deficiencies may overlap. Symptoms are the same whether the plant is container-grown or in the landscape although the causes may be different. An excellent color reference of nutrient deficiency symptoms in plams is *Diseases and Disorders of Ornamental Palms* (edited by A. R. Chase and T. Y. Broschat and available from the American Phytopathological Society, St. Paul, MN).

Nitrogen: An overall and uniform light green color and a decrease in growth characterize nitrogen deficiency. It is relatively easy to correct with applications of nitrogen fertilizers. Nitrogen deficiencies may be fairly common in landscape, especially on light or sandy soils, but deficiencies of other elements, such as potassium, magnesium, and manganese, can be much more prevalent and severe. Nitrogen is the most commonly deficient nutrient in container-grown palms.

Potassium: Recent research has revealed the important role of potassium in a well balanced nutrition program for palms. Palms need potassium in large amounts, equivalent to that of nitrogen. Yellowish or range flecking or spots which are translucent when viewed from below mottled or discolored pinnae, and tip and/or marginal necrosis characterize potassium deficiency on palms. Symptoms appear on the oldest leaves first but newer leaves will be affected as the disorder becomes more severe. Affected leaves will not recover; the palm must produce a new crown of new, healthy leaves.

Potassium is highly soluble and readily leached from light, sandy soils and container media subjected to heavy, frequent irrigations. In fact, potassium deficiency can be the most widespread and severe disorder in palms. *Chrysalidocarpus lutescens* (Areca palm), *Caryota* spp. (fishtail palms), and especially *Howea forsterana* (Kentia, sentry palm) seem to be susceptible to potassium deficiency during container production.

The use of fertilizers with controlled- or slow-release nitrogen but water-soluble potassium accentuates potassium deficiency on sandy soils and in container media. While the nitrogen supply will last for several months or more, heavy rain or one or two irrigations will leach the potassium completely from the soil.

Heavier landscape soils can retain potassium against leaching, hence potassium deficiency is less common in palms in the landscape, especially where soils are heavier. Potassium deficiency in these cases is usually due to low potassium content of the fertilizer or inadequate fertilization. Palms planted in or near lawn areas often exhibit potassium deficiency due to heavy, frequent irrigation and use of fertilizers high in nitrogen but with little or no potassium.

Symptoms of potassium deficiency are not uncommon on landscape plantings of *Syagrus (Arecastrum) romanzoffianum* (queen palm), *Butia capitata* (pindo palm), *Rhapis* spp. (lady palms), *Brahea* spp. (fan palms), *Trachycarpus fortunei* (windmill palm), and *Sabal* spp. (palmetto).

Potassium deficiency is easy to correct and palms respond quickly to treatment. Applications of controlled-release forms of potassium four times per year plus half as much magnesium sulfate to prevent a potassium-magnesium imbalance and resulting magnesium deficiency are usually sufficient.

Magnesium: Palms are heavy users of magnesium and deficiencies are frequently seen in palms on sandy soils. As in potassium, symptoms of magnesium deficiency appear on oldest leaves first and progress up the canopy.

A broad yellow band around the margin of an otherwise green leaf characterizes magnesium deficiencies. Landscape plantings of *Phoenix* spp. (date palms), *Syagrus (Arescastrum) romanzoffianum*, *Butia capitata*, *Livistona* spp. (fountain palms), *Trachycarpus fortunei*, and *Sabal* spp. (palmetto) occasionally display classic symptoms of magnesium deficiency in California.

Treat palms preventatively for magnesium deficiency since affected plants are slow to respond to post-symptom treatment. Affected leaves will not recover and the plant must replace them with new, healthy ones, a process that could take as long as two years.

The use of sufficient quantities of high grade dolomite in the potting mixture and soil applications of magnesium sulfate at the rate of 1–2 kgs (2–4.5 lbs.) per tree plus controlled-release potassium four times a year to palms in the landscape should prevent magnesium deficiency.

Manganese: Symptoms of manganese deficiency appear on the newest leaves first. New leaves are chlorotic, weak, reduced in size, and/or have necrotic streaking. As the deficiency progresses, new leaves emerge withered, frizzled, or "scorched," finally appearing only as necrotic petiole stubs.

Manganese deficiency is primarily due to the element's insolubility at high pH, making it unavailable in plants. Due to the high pH of alkaline soils, manganese is one of the most frequently deficient elements of palms in southern Florida and, to a lesser extent, in Southern California. In Florida the deficiency is called "frizzletop" because of the frizzled look of the new leaves.

Adjustting soil pH, applying monthly foliar sprays of 5 ml of manganese sulfate per 3.8 liters of water (1 teaspoon/gallon), or applying manganese sulfate to the soil 2–3 times a year should correct the deficiency and prevent its recurrence.

Manganese is usually not deficient on container-grown palms since the element is more available at the lower pHs of potting mixtures. However, poor drainage and/or cool soil temperatures during winter that result in reduced root activity and uptake of micronutrients may

NUTRIENT DEFICIENCY SYMPTOMS AND POSSIBLE CAUSES

Symptom	*Possible Cause*
Chlorosis	
entire plant	nitrogen deficiency, high light.
young leaves	poor soil aeration; salinity; iron or sulfur deficiency.
older leaves	nitrogen or magnesium deficiency; overwatering; poor soil aeration.
leaf margins	salinity; magnesium deficiency.
intervenal	iron or manganese deficiency.
irregular spots	cold temperature.
Necrosis	
water-soaked areas	cold temperature.
tips or margins	potassium deficiency (old leaves); boron toxicity (old leaves); salinity temperature extremes; desiccation; low humidity; root damage.
center of leaf	sun-scorch; cold; nutrient toxicity; ethylene toxicity (poorly or unvented greenhouses).
Leaf Deformation	
leaves abnormally small	micronutrient deficiency; salinity; high light; root-bound or -damaged plants.
petioles elongated	low light.
holes in leaves	mechanical injury; slugs, snails; insects.
new leaves stunted	manganese or other micronutrient deficiency; salinity; poor aeration; overwatering.
Stem Deformities	
rot at soil line	salinity; fertilizer placed against stem; overwatering; poor aeration.
wilting	salinity; high temperature; desiccation; low humidity; low soil moisture; root damage.
thin, spindly, weak	low light; crowding of plants.
Root Abnormalities	
slow development	salinity; soil temperature extremes; plant too deep; poor aeration; overwatering.
poor/rotted roots	salinity; overwatering; poor aeration.
Stunted Plants	fertilizer extremes; nutrient deficiencies; extremes of light; overwatering; poor aeration; poor roots.

cause manganese deficiency, particularly in soils where the element is already marginally deficient.

Frizzletop will occur as air temperatures rise in spring and growth of foliage commences yet roots are still inactive in the relatively cool soil. Soil temperatures tend to lag behind those of the air, remaining cooler in the spring and warmer in the fall. The affected palm will usually grow out of the problem when soil temperatures finally rise and root activity increases.

Iron: Symptoms of iron deficiency, as in manganese, appear first on the newest leaves. Interveinal chlorosis, tip necrosis, and stunted new leaves characterize iron deficiency. Iron deficiency in palms is not due to a lack of iron in the soil, and rarely is it due to high pH, as in many other plants.

Iron is nearly always present in the soil in sufficient quantities; it is mainly poor aeration that causes deficiencies of this element.

Waterlogged and poorly aerated soils, or palms planted too deeply, are the primary causes of iron deficiency.

Foliar sprays of 2.5 ml iron sulfate or chelate per 3.8 liters of water (1/2 teaspoon/gallon) may offer temperary correction; poor aeration or improper planting depth must be corrected or the problem will continue to recur.

Preventive treatment by planting and repotting at the correct depth in a well drained soil or potting mixture is the only permanent solution for iron deficiency. Also, dibble, rather surface apply, fertilizers to containers and use a potting mixture that is resistant to rapid break down.

Sulfur: Symptoms of sulfur deficiency are similar to those of iron. Sulfur deficiency is uncommon in palms and would probably only occur in container-grown plants when sulfate fertilizers are not used.

Deficiencies of phosphorous, calcium, copper, zinc, boron, and chlorine rarely occur if one adds dolomite and micronutrients to potting mixtures and uses a complete, controlled-release fertilizer. Boron toxicity could be a problem in areas where irrigation water contains high amounts of this element.

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AVAILABLE PUBLICATIONS

The following recent publications are available from the University of Hawaii by contacting the author directly.

PROTEA

Drs. Philip J. Ito and Philip E. Parvin have prepared a series of Commodity Fact Sheet on some of the Protea's from the University of Hawaii's breeding program. Contact Dr. Ito at Beaumont Research Center, 461 W. Lanikaula Street, Hilo, HI 96720 (935-2885) or Dr. Parvin at Maui Branch Station, P. O. Box 269, Kula, HI 96790 (878-1213).

Title	Number
'Pohaka La Hawaii'–The Hawaiian Sunbeam Protea	**PRO-3(A)**
'Hoku Hawaii'–The Hawaiian Star Protea	**PRO-3(B)**
'Mahina Hawaii'–The Hawaiian Moon Protea	**PRO-3(C)**
'Kathryn'–A Bright Yellow Sunburst Protea	**PRO-3(D)**
'Rachel'–A Salmon-Orange Sunburst Protea	**PRO-3(E)**

DRACAENA

HITAHR Brief No. 103, Dracaena Decline and Root Rot by J. Y. Uchida, C. Y. Kadooka, and M. Aragaki is available. This publication contains information on the disease and symptoms, causal organism and spread, and control and spread. Contact the authors at the Plant Pathology Department, 3190 Maile Way, Honolulu, HI 96822. (808) 956-2828.

COMPOSTING

Composting at a glance, CTAHR Instant Information No. 17 by James Tavares is available from the author at Maui County Extension Office, 310 Kaahumanu Ave., Bldg. 214, Kahului, HI 96732. (808) 244-3242. This provides basic information on what composting is, the advantages, the process, and how to do your own backyard project.

STEPHANOTIS AND PAKALANA–Lei Flowers With Added Potential

The following information was presented at a lei flower workshop on Molokai in early 1990 and has been up-dated with more recent research results.

STEPHANOTIS

Stephanotis is a waxy, white, fragrant trumpet-shaped flower in the milkweed family. It is said to be native to Madagascar and sometimes is called Madagascar Jasmine. Flowers are produced in umbels on new growth of vigorous vine in the spring and summer. They are widely used on the Mainland in wedding bouquets.

Stephanotis flower prices in the San Francisco and New York flower markets show only slight variation year-round. The high-price season tends to be winter when supplies are low. In San Francisco, the prices range from about $0.24 to 0.30 and in New York from 0.35 to 0.50 **per flower**. In other cities, prices tend to be a little higher. One local grower reported an off-season request from Dallas, Texas, for 200 flowers for which the wholesaler was willing to pay 55 cents apiece.

In past years, stephanotis was produced laregely by rose growers. The plants were trained on trellises at the ends of the rose houses. With the increasing numbers of imported roses, fewer rose growers exist in the USA and fewer of these are putting any effort into stephanotis production. On the east coast, supplies are being received from Holland.

The individual flowers have a long lasting life—10–14 days when held in plastic bags.

Here in Hawaii, production tends to be very high for a few weeks in the spring and sporadic flowering then occurs through the summer. If Hawaii growers were to try to meet off-season product demands, here are a few considerations, based largely on work at UCLA (Kofranek and Kubota, 1981; Kofranek and Criley, 1983) and in Europe (Wikesjo, 1982) on potted stephanotis plants.

1. Temperature. Below 65 F (nights), the plants grow slowly. This is apparently the minimum temperature for flower initiation (Post, 1956). Flower initiation can be triggered under high light conditions by a 10–14 day heat shock at 80–85 F, following which 75 F temperatures are provided for 2–3 weeks until buds are visible. Another 2–3 weeks at 68 F is used to bring the flowers into bloom. From the smallest visible bud stage to flowering can take as little as 5 weeks, but 6–7 weeks is more common. At a constant night of 70 F, severely pruned plants took 90–100 days to come into bloom when lights were provided. At very warm temperatures, say 80 F or higher, the flowers develop quickly, but are misshapened and off-color. ***Take-home message***: Grow the stephanotis in warm areas for winter production. At least a 65 F night, and preferably a 70 F night should be provided. To time a crop, you will need to know your night temperatures. A high temperature shock might be provided by covering the plants with plastic for the required time period.

2. Light. Stephanotis is regarded as a long-day plant. At 8-hour daylengths, few flowers are produced except at cool temperatures. More flowers are produced with a 16-hour day than at a 12-hour day The day can be extended or the night can be interrupted with 3 to 5 hours of light in the middle of the night. Either fluorescent or incandescent lights can be used, but 25 to 40 W/m^2 with the light about 30 inches away from the plants is recommended. Long days can also overcome the effect of 60 F nights, but is still slow.

For winter flowering, lighting should begin in early October and be maintained continuously through flowering.

Stephanotis can be grown with fairly high light intensities, although they will obviously grow under light shade since rose houses are shaded. Excessive leaf canopy may shade parts of the plant to an extent that the plant's carbohydrate reserves go into maintaining the shaded portions rather than producing flowers. Which brings us to the next point, pruning.

3. Since flowers are borne on new growth, it is advisable to prune to get new growth of a type suitable for flower initiation. Mature plants may be pruned severely to stimulate new branches. Depending on the size of the plant and the structural support system, you may wish to allow the development of a set number of branches, say 10 per plant (as do the grape growers who must prune and thin to a desirable canopy density).

When to prune is a good question. In California, a later September or early October pruning was recommended for winter flowering, but a double pruning was also effective (May–June for new vine growth and August for a light pruning). Lighting was started as the new shoots began to grow out.

In Hawaii, it may be worthwhile to consider a severe pruning just after flowering as new shoots then have the high light period of summer in which to grow. A lighter pruning might be geared towards the fall to stimulate new branches. Lighting may or may not be necessary, but should probably be tried, along with different pruning times to determine response in a given location. A later pruning may push back flower initiation and production into the June wedding season.

4. Stephanotis is rather sensitive to chemical sprays, especially those used for mite control. Plictran has given good results. It has been reported (Evans, 1991) that foliar sprays applications of Cycocel and B-nine at 100 ppm causes earlier and more abundant flowering than untreated controls, but labelling for these retardants do not include their use for promoting flowering on stephanotis.

5. Harvest. Usually whole clusters are harvested. Flowers are broken from the umble, but the stem is left attached. Either whole clusters may be bagged to give about 50 flowers per bag, or individual flowers are bagged at 50/bag. They will stand the cold of a regular refrigerator, say to 45 F as long as they are prevented from drying out.

6. Populations grown from seed may show some variation. Characters I have noticed which vary include waxiness, size of the open trumpet, length of the corolla tube, pink streaking of the corrolla tube, internode length (I have never seen a bush form; all have been vines). It is likely that there may be variation in time of flowering, but most plants in a given location seem to come into bloom at the same time, given the natural conditions.

7. Plants may be started easily from seed. Cuttings will propagate easily if taken from firm, green shoots rather than mature, woody stems. A rooting compound is used, say 3000 to 4000 ppm IBA, on single node cuttings. Either mist, or high humidity, is used during rooting. Root systems are brittle, so Jiffy-7's, foam blocks, or individual pots are recommended over community flats.

In Conclusion

We have the potential here in Hawaii to produce stephanotis year-round. Individual locations should concentrate on learning what conditions will bring about timed bloom for that location as temperature and exposure and time of pruning will affect the flower crop. Lighting will probably be necessary to assure good flowering in the winter months.

Producing the flower may be the easy part. It still must be harvested, packed, and sold. Identify a market and be sure that you can produce reliably for that market. There is not a large demand for stephanotis, despite its popularity in weddings, so we do not know what volume would saturate the market and drive the price back down to the 11 cents per flower price of the 1950's and 60's. Still, we can always use the flowers locally in leis when the demand is low on the mainland.

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PAKALANA (*Telosma cordata*)

The pakalana is related to the Stephanotis; they are in the same family. Flowers are borne in dense clusters in the leaf axils of new shoots. The plant habit tends to vine, but it will spread out on a flat surface if given no uprights to climb. It blooms seasonally through the high light period of the year. In Hawaii, the principal use is as a lei flower.

A few years ago, I became interested in the seasonal flowering of pakalana and placed 6 pots with trellised vines under the long days of a chrysanthemum stock plant bed. About 2½ months later, flowers were found on a couple of plants, very out-of-season. This work has been repeated several times and winter flowering has been consistently achieved. Both extended days and night break lighting are effective. We used a 60 watt incandescent light bulb placed about 30 inches away from the plants. Weaker lighting may also be effective, but we did note that fewer shoots and flowers developed on the side of the plant farthest away from the light. In recent work in growth chambers, plants produced flowers readily on 16 hours of light but did not initiate flowers on 8 hours of light. Twelve hours seems close to the critical as flower buds did initiate under these conditions, but development was sensitive to temperature.

The plants have to be in a vigorous state of growth, but LD seems to stimulate such growth, as well as the associated flowering. Our plants have responded under shaded conditions (about 6000 ft-c), as well as full sun.

Temperature affects the rate of flower development. We observed flowering in the greenhouse within 4 weeks of starting the lights, but an outdoor set of plants took up to 10 weeks, with some plant-to-plant variation. Our most recent work in temperature-controlled growth chambers showed that flower formed at temperatures of 65 F and higher, but developed very slowly at 65 F. Probably night temperatures of 70 F or higher are preferable.

Pakalana vines can be trained onto vertical supports, but it would be interesting to experiment with plants in large tubs raised to above head height and with a horizontal trellis for the plants to drop their branches from. Harvesting might be easier, and pruning would be very easy to do to stimulate new shoots.

Although work remains to be done on the nutritional requirements of pakalana, they respond to heavy feeding with vigorous growth.

Pakalana can be propagated from seed, by layers, or by cuttings. Seed is the easiest and may afford some opportunities to select for plant habit, flower size or color variations. Vines which run along the ground root into the soil and can be cut apart to establish new plants.

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