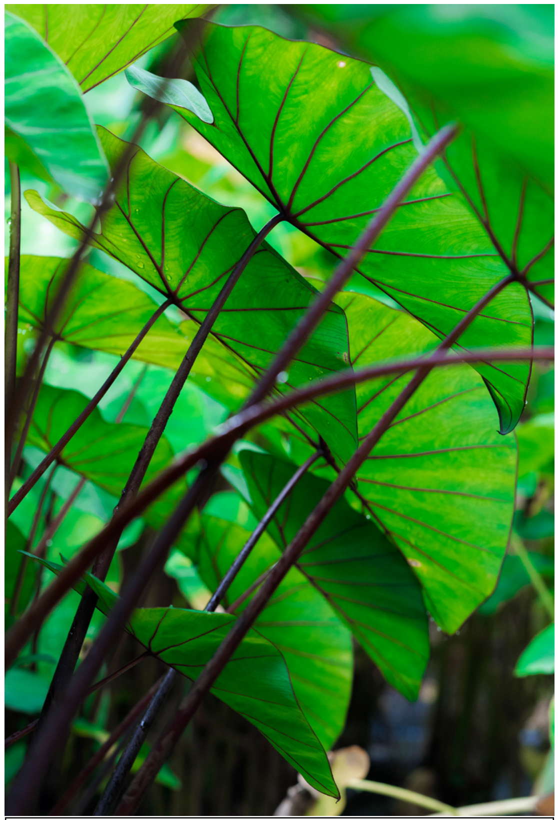
College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa

Four Taro Cultivars Compared for Leaf (Luau) Production

At A Glance: Although there is much published information about taro corm production, there is virtually no information about taro leaf production. This report presents data on taro leaf production of four cultivars in an on-farm experiment. Results indicate the economic potential of taro leaf production. Results also highlight the potential for future expansion.



A taro patch at Lyon Arboretum in the back of Mānoa Valley, Oʻahu.

Taro (kalo in the Hawaiian language) is a plant with great cultural significance in Hawaiʻi and the Pacific Islands. Taro leaves (*luau* in Hawaiian; *luau* is also a traditional Hawaiian party or feast) are an essential ingredient of *laulau* and other popular dishes in the Pacific Islands, Asia and the Caribbean. *Laulau* is a Native Hawaiian dish that contains pork and taro leaves. Although there is much published information about the production of taro corms, there is virtually no information about taro leaf production. This report presents data on taro leaf production of four cultivars in an on-farm experiment. Results indicate the economic potential of taro leaf production.

The Taro Plant

Taro is an herbaceous, perennial, tropical plant belonging to the family Araceae. Taro plants can be cultivated under upland or under flooded conditions for both corm and leaf production. This section will provide a generalized description of how the taro plant grows when cultivated under upland conditions for leaf production. There will be some variation, due to differences in cultivars and growing conditions. In Hawaiʻi, taro is typically propagated through vegetative means using planting material called *huli* (Figure 1). *Huli* are typically made from taro plants growing at the farm. Each *huli* is a portion of the taro stalk with a small piece of the corm or cormel (Teves, 2015). Growers often take measures to help ensure clean planting material, such as trimming off diseased portions of the corm and dipping in a disinfectant (Uchida et al., 2002).

The *huli* is planted into the ground and the plant goes into an establishment phase in which roots develop first and later, leaves begin emerging. The leaves photosynthesize and the plant accumulates starch in the corm or underground stem. The plant then goes into a rapid vegetative growth phase and the mother plants reach a maximum height (Figure 2). The mother plant (*makua*) produces secondary plants (*oha*) via suckers or stolons. These secondary plants accumulate starch into their cormels.

July 2023
Subject Category: Vegetable and Root Crops, VC-10

Randall T. Hamasaki
Department of Plant and Environmental Protection Sciences

Steven K. Fukuda
Susan Miyasaka
Russell S. Yost
Department of Tropical Plant and Soil Sciences
miyasaka@hawaii.edu

This information has been reviewed by CTAHR faculty

Figure 1. A taro *huli*, created by cutting part of the stalk with the top portion of the corm or cormel, is propagation material used by growers in Hawai`i.

In the cultivar Bun Long, suckers begin to appear at three months after planting. The plant density of the crop increases over time as more plants are produced through through the formation of new *oha* from the *makua* as described above. Bun Long is known to be a cultivar that produces a lot of suckers. The production of the foliage peaks at five months and then begins to decline on the mother plant while the corm increases in size. When grown under upland conditions, foliage production of the mother plant was maximum at five months after planting (Miyasaka, et al., 2003). At this stage of the crop, the plants are at their tallest height and the leaves are large. Over a crop cycle of approximately nine months, a taro plant may produce as many as 28 leaves. At maturity, the neck of the corm narrows and the top of the plant (foliage) becomes greatly reduced in size (Prasad and Singh, 1992).

For luau production, leaves of the main plant are removed periodically. Over-harvesting the leaves can cause the plant growth to decline rapidly. The grower needs to implement a harvest policy that balances crop yield with the need to keep the plant healthy by having an adequate amount of foliage for photosynthesis. There is no one-size-fits-all when it comes to the harvest policy among farms due to differences in growing conditions, market needs, pest pressure, etc. The leaf size of the secondary plants are typically smaller and the plant height is shorter compared to the mother plants (Figure 3).

Figure 2. Mother (*makua*) plants developed from huli grow into tall plants with large leaves.

Figure 3. Shown here, the mother (*makua*) plants have declined and the plant density has increased due to the production of the secondary *oha* plants (suckers).

Crop growth and yield can be reduced significantly due to stresses, such as a lack of water, nutrient imbalances, insect pests, diseases, and competition from weeds, as well as over-harvesting the leaves. Some insect pests of taro in Hawaiʻi include the taro root aphid, melon aphid, and taro planthopper (Vargo, 2000). Some diseases of taro in Hawaiʻi include taro leaf blight, root and corm rots caused by various organisms, rootknot nematodes, and several plant viruses (Long, et al., 2016).

Descriptions of Four Cultivars

In Hawaiʻi, the cultivar ʻBun Longʼ (also known as ʻBin Langʼand ʻBun-long-wooʼ) and commonly referred to as "Chinese taro" in Hawaiʻi, has been one of the preferred cultivars for luau because of the large size of the leaves, tenderness, and relative nonacridity when cooked (Whitney, et al., 1939). The sliced corms of ʻBun Longʼ taro have purple strands in a whitish background color of the corms that resemble sliced areca [betel] nuts (bin lang in Chinese) (Hu, 2005). Bun Long is a tall, spreading plant with 15-20 suckers. The leaf blades are 20 to 24 inches (50 to 60 cm) long, 14 to 18 inches (35 to 45 cm) wide, ovate, drooping, dark green, piko large and purple (Figure 4). Piko is the Hawaiian word for the navel, which on the taro leaf is the junction of the petiole and the blade, as viewed from the upper leaf surface. The plants may grow to 4 to 5 feet (123 to 152 cm) tall under high fertility, upland conditions (Silva and Sato, 1993). However, the plants are generally shorter when the leaves are intensively harvested.

In the 1990s, Dr. Eduardo Trujillo introduced disease-resistant taro varieties from the Republic of Palau, including P1 'Ngesuas', P5 'Ochab' and P10 'Ngeruuch'. The "P" followed by a number were designations assigned by Dr. Trujillo to facilitate labeling of the cultivars. These cultivars were promising due to their resistance to taro leaf blight. Taro leaf blight, caused by the oomycete pathogen

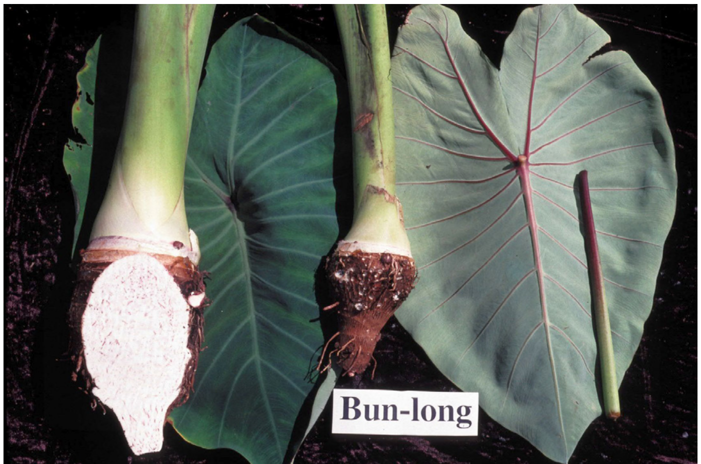


Figure 4. 'Bun Long'

Phytophthora colocasiae, is historically the most important and damaging disease of taro worldwide and is responsible for major taro yield losses globally (Miyasaka et al., 2013). Taro leaf yield losses of up to 95% have occurred in Hawai'i with susceptible varieties (Nelson, et al., 2011). The purpose of this experiment was to compare the leaf yield of 'Bun Long', 'Ngesuas', 'Ochab' and 'Ngeruuch' in a replicated, on-farm conditions.

Figure 5. 'Ngesuas' (P1)

P1 'Ngesuas': The plants are 20-39 inches (50-100 cm)

in height with 11-20 stolons. Leaf blades are green with purple leaf margin and a purple piko. The petiole is purple from base to top. The corm flesh is pink with pink fibers. (Figure 5)

P5 'Ochab': The plants are 20-39 inches (50-100 cm) in height with 11-20 stolons. The leaf blades are dark green with a red piko. The petiole is green from base to top. (Figure 6)

P10 'Ngeruuch': The plants are 20-39 inches (50-100 cm) in height with 6-10 stolons. The leaf blades are green with a yellow piko. The corm flesh is light yellow with yellow fibers. (Figure 7)

Figure 6. 'Ochab' (P5)

Site and Field Preparation

The trial was conducted under upland (not flooded) conditions at a cooperator's farm near Poamoho, Island of O'ahu. The site is at an elevation of 869 ft. (265 m) and the soil type is Kunia silty clay. Chicken manure was broadcasted at a rate of 50 tons per acre and tilled into the soil one month prior to planting. Weeds can be a major problem in upland taro production, however, this grower did not use chemical herbicides. The grower's practice was to control weeds using a weed blocking fabric and polyfilm, as shown in Figure 2. The polyfilm was later removed to allow the suckers to develop. The field was drip irrigated daily for two hours, as per the grower's standard practice for taro leaf production. Chemical fertilizers and pesticides were not applied.

Figure 7. 'Ngeruuch' (P10). Note the long stolons ("runners") that are developing on this young plant.

Planting: The taro huli were planted on January 15, 1998. Taro huli were planted into the black polyfilm in the row, as shown in Figure 1. Plants were spaced 1.5 feet apart in rows spaced four feet apart. There were 15 plants per plot at the start of the experiment. The plots were arranged in a randomized complete block design with three replicates. The experimental plot was surrounded by 'Bun Long' taro, which was the cooperator's standard cultivar.

Harvesting

Weekly harvesting commenced on June 6, 1998, and continued through April 20, 1999, for a total of 135 harvests. The weather was mostly favorable for taro leaf production during the experiment, and taro leaf blight was not a major problem. Although taro is considered to be a perennial plant, growers typically end cropping when the leaf size becomes too small and the yield is reduced due to overcrowding and other factors.

Harvesting was done manually using a knife. The harvested product was the leaf blade and approximately 6-8 inches of the petiole. There is another variation of luau used by other growers in which only the leaf blades are harvested. Fully expanded leaves were harvested but the unfurled shoot and the first expanded leaf were left on the plant in order to sustain production. The leaves were packed into plastic bags that held 20 pounds and were delivered to a laulau factory the same day. The leaves were rinsed at the factory before processing.

Yield

Table 1 shows the mean weekly yield (pounds fresh weight) per 90 square feet plot for the four cultivars. Diseased or otherwise unfit leaves were not included in the measured yield. There were 15 plants per plot at the beginning of the experiment, but the plants grew and multiplied over time. An analysis of variance was conducted using JMP software (A division of SAS, Cary, NC).

Table 1. Mean weekly yield (pounds fresh weight) of luau harvested per plot of 90 square feet.

Cultivar	Yield, lbs/plot +
Bun Long	2.89a
'Ochab' (P5)	3.04a
'Ngeruuch' (P10)	3.06a
'Ngesuas' (P1)	3.48a

+Means followed by the same letter were not significantly different.

The weekly leaf yields were not statistically different among the four cultivars (Table 1). The lack of differences between a taro leaf blight-susceptible cultivar (Bun Long) and taro leaf blight-resistant cultivars (Palauan) could be attributed to the low disease pressure during the study. Another important factor to be considered in the lack of statistical differences among the four cultivars is the high variability in yield of a particular cultivar grown in different replicated plots (Figure 8). For example, 'Ngeruuch' (P10) had the lowest leaf yield in Plot 1, but the highest leaf yield in Plot 2. And 'Ochab' had the highest leaf yield in Plot 1 but the lowest yield in Plot 3. Ideally, the weight of leaf yield should be similar for each cultivar in different replicated plots. The reasons for this variability in yield are uncertain, but could be related to different growth conditions within a plot. Perhaps reduced water flow occurred due to obstructions in the irrigation drip lines, or a soil-borne disease occurred in a particular location that reduced growth.

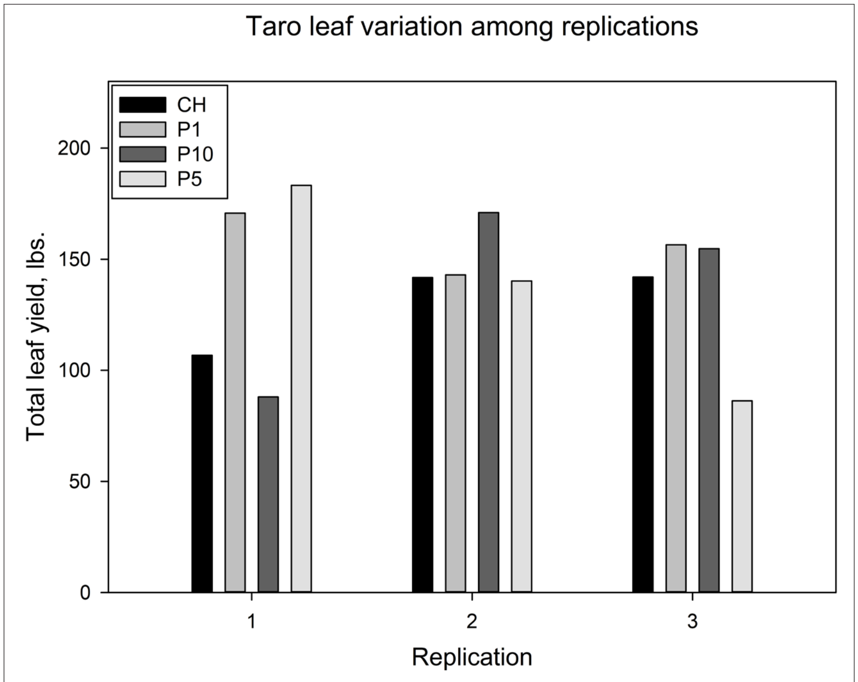


Figure 8. Variation in total leaf yield (pounds, lbs.) between replicated plots (1, 2, and 3) of four taro cultivars.

A yield of 2.89 to 3.48 pounds per 90 square feet per week is equivalent to 1,398 to 1,684 pounds per acre per week. On the retail market, depending on the season, a pound of fresh taro leaf can be priced at $4 to $5 per pound. There was no farm gate value of taro leaves listed in the 2022 Pacific Region - Hawai'i Vegetable and Melon Crops Report, but if one assumes it would be approximately half of the retail prices, then farmers could gross $2,800 to $4,200 per acre per week. It must be kept in mind, however, that this range of *luau* yield is probably higher than typical due to the high planting density, intensive harvest schedule (weekly) and favorable weather conditions.

A characteristic of the Palauan cultivars 'Ngesuas', 'Ochab' and 'Ngeruuch' is they produce "runners" (Figure 7) or lateral stolons (Del Rosario et al. 2015, Miyasaka et al. 2012) rather than the suckers that are closely attached to the mother corm as in the 'Bun Long' cultivar (Figure 9). The stolons ranged in length from 1 to 2 feet and grew into the aisle of the planted rows and interfered with farm operations. The cooperating grower preferred the 'Bun Long' cultivar because it did not produce such stolons and were more easily managed. Interestingly, new taro cultivars have been bred conventionally that are resistant to taro leaf blight without long stolons (Paudel et al., 2023), and they could be evaluated for leaf production in the future.

Summary

Fresh weight leaf yields of four taro cultivars ranged from 1,398 to 1,684 pounds per acre per week. Using an estimated farm gate value of $2 to $2.50 per pound, production of taro leaves could result in gross farm income ranging from $2,800 to $4,200 per acre per week, indicating the economic potential of this crop. No differences were found in total leaf yields between four cultivars, perhaps due to favorable weather conditions that didn't result in taro leaf blight. The cooperating farmer preferred commercial cultivar 'Bun Long', because of its absence of long stolons ("runners").

Analysis of wide yield variability between replicated plots of a particular cultivar demonstrated the importance of ensuring that plots are uniform so that experimental treatments (such as cultivars) can be determined.

Acknowledgements

We acknowledge that research with this plant (kalo) was carried out with due respect to the impressively great cultural significance of this plant in Hawaiian and Polynesian culture. The authors would like to express their sincere appreciation to Mr. David Shiraki who was the cooperating grower on this project. The authors also thank Jari Sugano and the late Ronald F.L. Mau who coordinated the Western Region Integrated Pest Management Program Funds (a Smith-Lever

Figure 9. Suckers developing on 'Bun Long.'

3(d) Extension IPM grant) that made this project possible during the first year and a grant from the CTAHR VIP Program which made this project possible during the second year. Finally, the authors would like to thank Dr. Michael B. Kantar and Anna McCormick for their thoughtful reviews of this publication.

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