EXTENSION PUBLICATIONS

College of Tropical Agriculture and Human Resources
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Increasing Anthurium Productivity
in Volcanic Cinder, Using Irrigation and Nutrients

At a Glance

These experiments found that 1) Increasing the water supply to plant roots increases anthurium flower yield and quality, 2) Supplementing fertilization with triple super phosphate (TSP) to increase leaf P to 0.23% also increases yield, and 3) Fertigation increases yield, flower size, and postharvest/vase life.

Introduction

Volcanic cinder is currently the standard growing medium for anthurium cut flower production in Hawai'i (Higaki and Imamura, 1985). Although cinder is readily available, economical, reusable, and has good drainage, it also has poor water holding and nutrient holding capacity. Insufficient water and nutrients could be constraints to anthurium production in shade house, non-irrigated production systems like those most commonly seen in East Hawai'i Island. Management strategies have been shown to increase productivity in cinder-based anthurium production. The information in this publication is referenced from Singleton et al. (2014) on water and nutrient availability studies carried out on anthuriums in Kurtistown and Hilo, Hawai'i Island. The objective of these experiments was to determine if increasing water or nutrient availability would increase the production and yield of anthuriums.

Water Uptake and Irrigation

Water is required for plant growth and tissue expansion. Most of the water taken up by plants is lost through transpiration, but water serves several purposes in plants. Water pressure (turgor) in anthuriums helps to support their structure. Water is essential in both photosynthesis and the translocation of nutrients. The transpiration process also allows for gas exchange. Generally, optimum water availability will increase plant health and productivity. Singleton et al. (2014) showed that water uptake in anthuriums increases with more irrigation.

A pot experiment was established using 5-gal polypropylene growbags with three mature established 'Hokuloa' anthurium plants in 100% black cinder. Three treatments were applied at the end of the daily cycle of eight fertigation applications per day, which supplied a daily total of

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approximately 0.6 gal nutrient solution per bag. In treatment #1 (limited water), plants received no additional solution after daily fertigation and grow-bags were allowed to drain before being placed in a plastic bag. For treatments #2 and #3, the plastic bag covering the growbags functioned to capture leachate. In treatment #2, plants were drenched with 0.8 gal of nutrient solution, which resulted in an average of 0.7 gal. of leachate and provided a reservoir of solution for 48 hours. In treatment #3, (unlimited water), plants were drenched with 0.8 gal of nutrient solution, then re-watered with 0.13 gal increments of nutrient solution nine times during the daytime over 48 hours. Each bag assembly was weighed after treatment and replaced back into greenhouse beds. At the end of the 48-hr period, all bag assemblies were reweighed and total water uptake was calculated.

Figure 1. Measuring water use of anthurium growing in cinder medium.

Table 1. Daily water uptake of 'Hokuloa' anthurium under three different irrigation regimes under pot culture. Water uptake was determined during a 48-hr. measurement period.

Water Uptake	Treatment #1 (Limited water)	Treatment #2 (Increased water)	Treatment #3 (Unlimited water)
Ounces/bag/day	*5.7oz.* [b*]	7.6oz.[a]	7.9oz.[a]
Gal/planted Acre/day**	733 gal.	978 gal.	1005 gal.
Inches (in)/Acre/day**	0.027 in.	0.036 in.	0.037 in.

*Numbers followed by different letters are significantly different at P<0.05.
**Conversion of ounces/bag/day to gal/A/day and in/A/day.

When plants were provided with increased water availability (treatment #2) and unlimited water availability (treatment #3), water usage increased by 33-38% compared to plants receiving limited water (Table 1). Water uptake in anthuriums increased with more irrigation. A possible reason for this is because cinder media has poor water-holding capacity. Maximum water absorption in anthuriums may only be possible when roots have easy access to water. More frequent irrigation would provide anthurium roots in cinder more access to water and increase plant water uptake. Field capacity is the amount of water content in the soil after excess water has drained away approximately one day after being irrigated. In a previous study (Ma et al. 2012), plants irrigated at 50% field capacity in soilless media had reduced flower size compared to irrigation at 90% field capacity.

Effect of Management Practices on Anthurium Field Production

Different production practices were evaluated for their effect on 'Leilani' anthurium growing in Hilo, Hawai'i, in 75x5 foot plots with 12"-deep cinder, with six plants across and two plants per hole, under 80% shade and high average annual rainfall of 129 inches.

Treatment #1 was the standard farm practice of rainfed irrigation with slow-release fertilizer application (Apex 16-6-11). Plants in treatment #2 were subjected to the existing farm practice plus 0.25 acre-inch of overhead irrigation. In treatment #3, plants received standard farm fertilization supplemented with 323 pounds (lbs)/acre/year (yr) triple super phosphate (TSP) applied every four months (a rate of 108 lbs. TSP per application) to equal 400 lbs. phosphorus (P)/acre/yr. In treatment #4, plants were fertigated with a complete nutrient solution of 1260 µS (1.0-0.8-1.7 NPK) applied through daily 0.25 acre-inch overhead irrigation. The nutrient solution concentration was increased to 1450 µS after nine months.

Yield and flower sizes were collected weekly over a one-year period. Flower sizes were graded by size according to the Hawai'i Department of Agriculture, Division of Marketing and Consumer Services, Standards for Hawai'i-Grown Flowers and Foliage. For leaf analysis, 10 replicate leaves were collected from each bed after six months of treatment. Leaves subtending a ¾ mature flower were harvested, washed, dried, and analyzed for nutrient content.

The effect of additional irrigation and nutrition on yield and flower class size is outlined in Tables 2 and 3. Fertigation resulted in the highest total flower production. Additional irrigation and supplementing the farm fertilizer program with extra P also led to 13% and 24% increases in total flower yield over the farm practice. These practices also notably increased the production of extra-large and large flowers. Fertigation treatment

Figure 2. Farm treatment of 'Leilani' anthurium in cinder bed.

Figure 3. Fertigation of 'Leilani' anthurium in cinder bed.

Table 2. Yield and flower size class of anthuriums grown under different field production practices during a one-year period.

Treatment	Number of Flowers					
	Total	Extra Large	Large	Medium	Small	Extra Small
Farm[1]	1419	142	481	425	333	38
Farm + Irrigation[2]	1607	198	553	488	324	44
Farm + High P[3]	1762	246	596	534	346	40
Fertigated[4]	1768	265	655	580	264	4

1 Farm practice (acre/year): 276 lbs N, 77 P, 161 K applied in slow-release granules in three equal parts (every 4 months) (92 lbs N, 26 P, 54 K per application).
2 Farm fertility practice + 0.25" water/day
3 Farm fertility supplemented to equal 400lbs P/acre/year using TSP
4 1260 µS of complete nutrient solution (1.0-0.8-1.7, NPK) applied with 0.25" water daily.

Table 3. Vase life and flower size of anthuriums grown under different field production practices during one-year period. 1

Treatment	Vase Life (Days[2])	Flower Area (in^2)	Stem Diameter (in.)	Stem Length (in)
Farm	22.0 [b*]	37.0 [b]	0.27	27.1 [b]
Farm +Irrigation	24.0 [ab]	40.0 [ab]	0.28	29.1 [a]
Farm + High P	24.0 [ab]	40.6 [ab]	0.28	29.1 [a]
Fertigated	25.5 [a]	41.2 [a]	0.29	27.9 [ab]

1 Mean of 20 flowers harvested at ¾ maturity
2 Data excludes 3 days in which flowers were packed for simulated shipping prior to being placed in water. Flowers were discarded if a level of 4 of damage, on a 1-5 scale, of any one of the following conditions were met (Paull, 1982): spadix discoloration, spathe blueing, or loss of gloss. Most flowers were discarded because spadix discoloration reached the threshold for discarding $^*P<0.05$.

and farm practice treatment, combined with supplemental P, showed increase of flowers larger than medium by 43% and 31%, respectively.

Additional irrigation, high P, or fertigation improved flower quality and vase life. Vase life of flowers was extended by 10%. Flower size and flower stem diameter increased with added nutrients or irrigation over farm practice (Table 3).

Leaf content of nutrients, such as N, P, and K, affect photosynthesis. When more resources are available, i.e. increased nutrition and irrigation, plants have a higher photosynthetic capacity. Maintaining higher photosynthetic capacity of leaves subtending flowers through better management supports flower development and development of the next leaf and flower.

After a year of increased P application in the fertigation and slow release + P broadcast treatments (Table 4), leaf tissue P level rose substantially over the Hawai'i standards (Higaki et al., 1992).

Table 4. Nutrient content of the leaf subtending a flower at ¾ maturity of anthuriums grown with different field production practices during one-year period.					
	N%	P%	K%	Ca%	Mg%
Hawaii Standard	*1.87*	0.17	2.07	1.5	0.21
Post Treatment					
Farm	*2.19*	0.17	2.84	1.1	0.56
Farm +Irrigation	2.13	0.17	2.76	1.31	0.59
Farm + High P	2.22	0.23	2.89	1.13	0.6
Fertigated	2.21	0.48	3.93	1.45	0.48

Table 5. Partial budget analysis in 2021 compared to 2007 data of anthuriums grown with different field production practices during a one-year period.		
	Net increase in income due to management changes 2007	Net increase in income due to management changes 2021
	$/Acre/Year	*$/Acre/Year*
Farm Practice	$0	$0
Farm +Irrigation	$18,116	$30,553.10
Farm + High P	$45,158	$73,916.01
Fertigated	$45,406	$68,748.46

Partial Budget Analysis

Modifying management practices increased farm income compared to the typical farm practice (Table 5). The original 2007 partial budget analysis is updated to reflect costs of production and sales values for 2021. The 2021 partial budget analysis shows a net increase in income from using high P followed by fertigation, then irrigation.

It is likely that depending on where production is located, best production management practices may change, along with a change in net income. For example, producing in an area that receives a large amount of rainfall vs. production in a drier location will likely require different best management practices to maximize profitability. Increasing P application to achieve higher levels in leaf tissue above current recommended levels could be a profitable investment. Additional irrigation, even in high rainfall areas, coupled with better fertilizer management could yield a multiplicative effect over either practice alone.

Summary

Important takeaways for anthurium production in cinder media:

1. Anthurium water demand is higher than what is supplied by systems fed by rainwater only.
2. Increasing water supply to plant roots increases flower yield and quality.
3. Anthurium leaf tissue values for phosphorus (P) should be 0.23% or higher for optimum flower production and quality.
4. Supplementing fertilization programs with triple super phosphate (TSP) to promote leaf tissue P value to 23% increases yield of anthuriums.
5. Fertigation increases yield, flower size, and postharvest/vase life of anthuriums.

Even with high rainfall, crop yield can be limited by water in cinder-based production. Anthurium roots do not exploit the medium as fine roots would, and cinder is a medium that lacks the capillarity to hold and make water available to roots. Frequent irrigation, rather than high quantity of water, is more effective for production and quality of anthurium flowers. Anthurium flower production in rainfed cinder beds are better managed with slow-release fertilizer combined with irrigation or adequate P than with fertigation to maximize efficiency.

Leaf content of nutrients such as N, P, and K affect photosynthesis. When more resources are available, plants have a higher photosynthetic capacity. Maintaining higher photosynthetic capacity of leaves subtending flowers through better management supports flower development and development of the next leaf and flower. Target values for P in leaf tissue should be above Hawaiʻi's current standard of 0.17% for optimal production. Crop monitoring by leaf nutrient analysis is an important tool for maximizing flower production. Fertigation also increases farm gate value close to that achieved through fertilization using a broadcast fertilizer, but the fertigation technology costs more upfront.

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Literature Cited

HDOA. 2002. Hawaiʻi Department of Agriculture, Division of Marketing and Consumer Services, Standards for Hawaii Grown Flowers and Foliage. Accessed online May 25, 2022. https://hdoa.hawaii.gov/qad/files/2012/12/AR-42.pdf

Higaki, T. and Imamura, J.S. 1985. Volcanic black cinder as a medium for growing anthuriums. *HortScience* 20:298-300.

Higaki, T., Imamura, J.S. and Paull, R.E. 1992. N, P, and K rates and leaf tissue standards for optimum Anthurium andraeanum flower production. *HortScience* 27(8):909-912.

Ma, F., Liu, H., Wu, W., Yang, S. 2012. Effects of different drip irrigation thresholds on water use and biomass of soilless culture anthurium in greenhouse. Editorial Office of Transaction of the Chinese Society of Agricultural Engineering. 28 (8):65-70.

Singleton, P., Lichty, J. and Kim, H.J. 2014. Anthurium productivity is limited by water and nutrient availability in volcanic cinder medium. *Acta Hort*. (ISHS) 1037:445-450.

Paull, R.E. 1982. Anthurium (Anthurium andraeanum Andre) vase life evaluation criteria. *HortScience* 17 (4): 606-607.