

Project 16-914
Leaf Blight Tolerant Taro Varieties: Promoting Grower Adoption and Food Processor Acceptance

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The statewide team of project investigators conducted various educational workshops, field demonstrations, and applied research projects, often in collaboration with CTAHR Researchers, Extension Specialists, Extension Agents, support staff and volunteers, and with industry cooperators. Through these activities, 434 growers and gardeners were made aware of the disease tolerant taro varieties. A total of 100 of these growers were interested, obtained starter planting material, and actually planted the blight tolerant taro varieties at their own farms for evaluation. The investigators also worked with local taro industry stakeholders such as commercial taro processors to assess and promote the blight resistant taro varieties for various uses such as table taro, chipping, luau (taro leaf), and poi. Through project activities with commercial taro processors, project investigators contacted 10 taro processing firms around the state.

Farmers	Processors		
	Island	Number Educated	# Conducted Test Planting
Hawaii	60	28	2
Kauai	32	32	1
Maui	20	5	1
Molokai	200	20	
Oahu	122	15	6
Total	434	100	10

Hawaii

Agent Dwight Sato installed a field planting of Chinese taro (Cv. Bunlong) and five Palauan taro varieties (P1, P8, P10, P13, P20) at Pepekeo, Hawaii (Elev. 300 ft. above S.L.) on May 22, 1998. The taro was grown under upland conditions. Yield and taro leaf blight incidence data were collected and the corms were tested for suitability for table taro, luau, poi, and for chipping. The investigator collaborated with a local commercial taro chip processor.

Results:

Corn Yield: P10, P20, and P1 produced the highest corm yields. In contrast, Bunlong had the lowest corm yield.

Leaf Yield: P10 and P8 had the produced the highest marketable leaf (luau) yields which were nearly 25% more than the luau industry standard variety Bunlong . P13 and P20 had nearly two times the amount of unmarketable leaves as compared to Cv. Bunlong. Taro leaf blight was the major cause of unmarketable leaves in this trial.

Table Taro: Taste test results showed that P10 and P20 were the best of the resistant varieties for table taro use. However, participants still preferred Lehua maoli which was said to have a richer taste and better texture.

Poi Processing: Poi made from P1, P10, and P20 did not compare favorably with the Lehua maoli cultivar. Flavor and color (too light) of the Palauan varieties were said to be inferior to the industry standard.

Chip processing: Corms of Cv. P8 fried well but lacked the purple flecks of the industry standard Cv. Bunlong. The chips made from P8 were also found to be acrid and the processor did not adopt this variety.

Distribution of Palauan taro varieties to interested growers: 28 growers received at least one of the disease tolerant taro varieties and began planting them on their farms.

Number of participants contacted through project activities: 60 project contacts were made. 28 interested growers received disease tolerant taro variety huli. Agent Dwight Sato presented his project findings at the statewide 52nd Annual Hawaii Farm Bureau Federation Convention in Kihei, Maui.

Conclusions: The Palauan taro varieties produced higher corm yields as compared to Cv. Bunlong. P8 and P10 produced more marketable leaves than Cv. Bunlong. P 20 and P10 produced good tasting corms but were still less preferred than Cv. Lehua for table taro. The Palauan cultivars tested were not satisfactory for poi processing nor for chipping. Further work is required to improve market acceptance.

Kauai

Propagation material (huli) of Palauan taro cultivars (P1 and P20) were distributed to members of the Kauai Taro Growers Association on March 18-19, 1998. Investigators involved were Dr. Eduardo Trujillo, Agent Roy Yamakawa, and Dr. Arnold Hara. Dr. Hara subjected the huli to hot water disinfestation treatment according to the protocol he developed for the taro root aphid. A total of 32 farms planted at least one of the Palauan taro cultivars. A total of 1,205 P1 huli and 345 P20 huli was distributed.

Agent Roy Yamakawa conducted a field assessment with two of the cooperators and reported the following:

Date Planted 3/20/98. Date Harvested: 3/8/99.

Test data plants: Ten per cultivar: P1, P20, Maui Lehua

Corm weight in grams, including 22cm stems.

Pocket rot ranking: 0-5, with 0=no rot, 5=not marketable.

Soft rot ranking: 0-5, with 0=no rot, 5=not marketable.

Cooperator: A

Cultivar: P1

	Corm Sample Number									
	1	2	3	4	5	6	7	8	9	10
Corm wt.	1178	1648	1056	1365	1881	1507	2033	1256	1585	1662
Pocket rot	0	1	2	0	1	1	1	1	1	2
Soft rot 0	3	2	3	1	0	0	0	3	0	

Cultivar: Maui Lehua

Corm wt.	214	249	549	467	705	167	578	522	512	484
Pocket rot	1	2	3	4	4	2	4	4	4	3
Soft rot 4	0	0	4	0	0	0	0	2	0	

Cooperator: B

Cultivar: P1

Corm wt.	903	1043	1438	751	1076	964	1108	1125	1158	768
Pocket rot	2	1	1	1	1	2	2	1	1	2
Soft rot 0	0	0	0	0	0	0	0	0	0	

Cultivar: P20

Corm wt.	1633	1235	1903	1766	1517	1250	1286	779	1769	1376
Pocket rot	1	1	1	1	1	1	1	1	1	2
Soft rot 0	0	0	0	0	0	0	3	0	0	

Cultivar: Maui Lehua

Corm wt.	1088	1407	1042	799	905	929	575	758	841	804
Pocket rot	2	1	1	2	1	2	2	2	2	3
Soft rot 0	0	0	0	0	0	0	0	0	0	

Overall the P1 and P20 cultivars were much more vigorous and higher yielding than the traditional Hawaiian taro varieties. A field assessment with two growers provided an indication that the Palauan taro varieties may also be less prone to taro pocket rot and soft rot. The investigator and cooperating growers also observed that the Palauan taro varieties had a longer harvest window than Lehua and could be left in the field much longer when matured. One commercial poi processor indicated that the P1 and P20 cultivars produce a light colored poi and strongly preferred the standard Lehua cultivars. A cooperator found that P1 and P20 were highly suitable for Tongan table taro preferences. Widespread acceptance for Palauan taro varieties for luau use has not occurred on Kauai.

Maui

Wetland luau trial: In November 1997, agent Robin Shimabuku conducted an on-farm field trial in Keanae, Maui (sealevel) evaluating the top five leaf blight tolerant Palauan varieties for wetland luau leaf production. The field plot was setup in a randomized complete block design

Harvest data was to consist of # marketable leaves and bulb weight per replication. Three phytophthora leaf blight observations were made during the year recording disease incidence and severity. In each observation there was no phytophthora leaf blight present in the field plots due to extremely dry conditions on Maui in the spring and summer 1998. Due to the presence of no disease, yield data was not collected and the field trial was terminated. However, the grower cooperators observed no differences in yield between the industry standard variety 'Bun long' and the Palauan varieties. In December through February of 1998, the Keanae area began experiencing the normal wet winter weather. The grower cooperators observed the Palauan varieties held up much better to the phytophthora leaf blight than Bun long. During high disease pressure, the Bun long variety had no marketable leaves, whereas, the Palauan varieties had 90% marketable leaves. Of the Palauan varieties tested, the grower felt that P1 had the best yields, P7 was also good, and P8 was the least desirable of the varieties tested. Twenty growers have gained awareness of the Palauan varieties through field days and presently, 5 growers have field planting of the various Palauan varieties for luau leaf production.

Wetland poi taro trial: In April of 1998, another on-farm field trial was setup in the Waihee, Maui to evaluate promising Palauan varieties for poi production in wetland conditions. The purpose of the trial was to have the grower/processor (Aloha Poi Company) compare the Palauan varieties to the Maui Lehua for eating quality (taste, texture, and color). The grower cooperators taro grower/ processor planted the top three Palauan varieties (P1, P10, and P20) in conjunction with industry standard variety, Maui Lehua. A total of 15 plants of each variety was planted and replicated three times. The grower/processor observed that the Palauan varieties grew more vigorously and had larger corms than Maui Lehua. However, the processor felt that the Palauan varieties did not have the eating quality comparable to the Maui Lehua and would not purchase it from taro growers.

Project contacts and huli distribution program: Agent Robin Shimabuku contacted 20 commercial taro growers through project activities. Five of the growers have planted the Palauan taro varieties at their farm.

Molokai

Background: Phytophthora leaf blight and nematodes caused significant taro crop losses on Molokai. Research reports on the Palauan taro show that they have resistance/tolerance to Phytophthora leaf blight. However, no study has been conducted on resistance/tolerance of Palauan taro varieties to root knot nematodes, *Meloidogyne javanica*.

Objectives of Molokai Palauan Taro IPM Project.

1. To demonstrate Phytophthora resistant of Palauan taro varieties for Molokai taro growers.
2. To determine the capacity of Palauan taro varieties to tolerate/resist root knot nematode infection.

Applied Research/Demonstration Trial: A dry land taro variety trial with 3 replications was conducted on Moloka'i to address the project objectives. 15 plants of each Palauan variety were planted in each replicate. The Bunlong taro variety was used for the control. 15 Palauan, (P), taro varieties were tested in the trial, including P Nos. 1,2,3, 4, 5, 6, 7, 8, 10, 12, 13, 15, 16, 19 and 20. This work is important in identifying taro germplasm with resistance to rootknot nematode which is an important production factor when taro is grown under upland conditions.

Objective #1:

The Phytophthora demonstration was conducted in 1998 and 1999. In both years dry climatic condition prevented Phytophthora infestation. Both control treatment and Palauan (P) treatments were not infected with the leaf blight. Thus, the ability of P varieties to tolerate leaf blight infection could not be demonstrated. The demonstration will be repeated in 1999-2000 growing season.

Objective #2:

Nematode infection data was collected from the trial. Root samples were collected from each taro variety in each treatment. Root knot nematode egg counts were recorded from each variety.

Results

Nematode Resistance: All the taro varieties in the trial were infected with root knot nematodes. The average number of eggs per gram of roots for Bun Long, the control variety, was 4989.7 eggs/ gram. The nematode infection rate for Palauan varieties ranged from 573.72 to 5545.1 eggs/ gram of roots. Although there seemed to be wide variances in the number of eggs found the taro roots, statistical analysis did not show any significant differences in the numbers.

Comparison of Means of Root Knot Nematode Eggs per Gram of Taro Roots

Variety	Mean (avg.) Eggs/ Gram Roots	Homogeneous Groups
P3	573.72	I
P1	1084.1	I
P5	1684.8	I
P4	1776.3	I
P16	1939.2	I
P2	2236.3	I
P20	2469.2	I
P12	2480.7	I
P13	2775.1	I
P6	2834.0	I
P10	2884.2	I
P7	3933.4	I

BLT	4989.7	I
P15	5326.3	I
P8	5545.1	I

There are no significant pairwise differences among the mean. Rejection level 0.050
BLT=Bun Long Taro

Taro corm yields (*Makua*)

The plant population of the Palauan taro variety trial was 8712 plants per acre. The yield data of the trial reflects only the weights of the main corm, makua. The corm yield ranged from 10,382 to 25,483 pounds per acre.

Comparison of Means of Corm Yield per Acre, lbs./ac

Variety	Mean (avg.) Yield per Acre Lbs./acre	Homogeneous Group					
P20	25483	I					
P13	20546	I	I				
P7	20110	I	I	I			
BLT	19241	I	I	I	I		
P12	17714		I	I	I	I	
P3	17134		I	I	I	I	
P4	17134		I	I	I	I	
P5	15682		I	I	I	I	I
P6	15173		I	I	I	I	I
P16	14157			I	I	I	I
P2	13954			I	I	I	I
P15	13141				I	I	I
P1	12415					I	I
P10	11979					I	I
P8	10382						I

There are 6 groups in which the mean corm yields are not significantly different from one another. Rejection level .05. BLT=Bun Long Taro

Field Days on nematode/blight tolerant taro demonstration trial and taro grower education in general: Annual Molokai taro field days were attended by 100 people each year. Corms from the trial were provided to S. Fukuda, R. Hamasaki, R. Yoshino and N. Kanehiro for their poi quality evaluation and taste test on Oahu at a statewide taro meeting.

Distribution of disease resistant taro varieties on Molokai: More than 800 Palauan taro huli, of various varieties, were distributed to 20 participants for grower evaluation at their own

farms/gardens. Although a recent field evaluation of the Palauan varieties show that many farmers are not aggressively sustaining or increasing their planting, the use of these varieties for use in the Polynesian table taro market shows promise.

Oahu

Oahu Project personnel contacted 122 growers and gardeners through workshops, demonstrations, farm visits, and other activities involving the disease tolerant taro varieties. Fifteen farms grow the blight resistant Palauan taro varieties on Oahu. A total of 6 commercial taro processors (lulau and poi) was contacted through project activities.. There has been some success stories such as for table taro for Tongan market and with one luau producer.

Workshop on Taro Updates and Palauan Taro Huli Distribution: Feb. 4, 1999

Taro Pocket Rot Update, Dr. Janice Uchida

Update on Taro Spacing Trial in Hanalei, Dr. James Silva

Taro crop logging, Dr. James Silva

Leaf blight resistant Palauan Taro, Agent Randall Hamasaki

Palauan taro huli distribution (P1 and P10): Agent Steven Fukuda

Table taro demo, Agent Rhoda Yoshino

Results: Participants (20 taro growers) were updated on taro pocket rot and crop spacing research. These participants learned the following: the possible causes of taro pocket rot being investigated are plant pathogens; fertilizer toxicity; snail damage, insects, crayfish or birds; and environmental/physical factors; insects and apple snails do not appear to be the causes of pocket rot,. taro pocket rot incidence appears to be unaffected by plant spacing, fertilizer management, amount of N applied, and by the use of high biuret urea. Growers also learned that taro leaf blight incidence is more severe in a closer spacing of 18 x 18 inches (a standard practice for many growers than at a wider spacing of 24 x 24 or 30 x 30 inches. Growers also learned about research findings which showed that with the 24 x 24 inch spacing, corm yield was 94-97% and corms were significantly larger as compared to that of the 18 inch spacing. Therefore, the 24 x 24 inch spacing was optimal in terms of low taro leaf blight incidence, lower cost of planting material and labor for planting and harvesting. The participants also learned that crop logging can be useful in managing fertilizer inputs for optimal yield and quality. Growers learned how to collect the proper taro tissue for plant analysis (recently matured leaf blade = 3rd leaf). Growers also learned that the use of resistant varieties is a non-chemical strategy for managing taro leaf blight. Interested growers received starter quantities of P1 and P10 huli for testing at their farms.

Numbers reached: 20

Demonstration trial for luau production

Agent Steven Fukuda compared three taro leaf blight resistant varieties (P1, P5, and P10) with the luau industry standard Cv. Bunlong under upland conditions using organic farming practices at cooperating commercial luau grower's farm in Poamoho, Oahu. Chicken manure and vegetable waste from a salad processing facility were the major source of plant nutrients applied

to the soil prior to planting. Plots containing 15 plants each were replicated three times. Incidence of taro leaf blight was very low even in the susceptible Bunlong variety during much of the harvest period. The total yield of leaves harvested on a weekly basis for the period from 6/98 to 4/99 were:

Variety	Yield (lbs.)
Bunlong	389.75
P1	470.75
P5	410.00
P10	412.75

The incidence of taro leaf blight disease increased dramatically during the period from 2/23/99 to 4/20/99 due to wet weather conditions. The table below shows the total marketable yields during this period of high disease incidence:

Comparative marketable luau yields under high blight conditions:

Variety	Yield (lbs.)
Bunlong	73.75
P1	73.75
P5	65.75
P10	67.75

The grower thought felt that the blight tolerant varieties were acceptable in terms of flavor and texture but felt that P10 was too light green in color. Most preferred was P1 and the grower is currently increasing planting material of this variety for commercial luau production.

Demonstrations with commercial laulau processors: Taro leaf is a major ingredient for making laulau, a local delicacy containing taro leaves, meat, and sometimes fish which are wrapped in ti leaves and steamed. Agent Fukuda used taro leaves produced in the field trials to conduct demonstrations with commercial laulau processors (5 firms contacted). Personnel from the processing firms served as evaluators of the cooked product. Cooked taro leaves made from the industry standard Bunlong was most favored. One fairly large grower of wetland luau taro reported that a cooked mixture of the leaves from disease resistant varieties with the industry standard Bunlong was acceptable. When the cooked product consisted only of the leaves of disease resistant varieties, there were detectable differences in texture and aroma and cooked luau made from Bunlong was most preferred.

Summary of luau trials: The yield data will be subjected to statistical analysis to determine if there were significant differences in luau yield among varieties. There has been some adoption of P1 for use as luau taro on Oahu but Cv. Bunlong still constitutes the major taro variety for this market.

Demonstration trial of wetland grown selected Palauan taro varieties for poi processing:

Agent Steven Fukuda worked with a cooperating grower/commercial poi processor to evaluate P1 and P20 under wetland culture for poi processing. The promising Palauan taro varieties were grown alongside the industry standard Lehua cultivar under identical growing

conditions. The cooperators were impressed with the outstanding vigor and superior yield of the Palauan taro varieties.

Grower education on taro leaf blight tolerant varieties: The cooperators conduct an annual workshop for its taro growers from around the state. Agents Fukuda and Hamasaki were invited to discuss the trial of the Palauan taro varieties in a workshop held on March 31, 1999. The participants asked many questions and toured the field planting. There were 17 participants in the workshop.

Corn yield results for the wetland demonstration trial:

Average corm yield per plant	Extrapolated yield per acre*
Lehua 4.0 lbs.	43,560 lbs.
P1 6.9 lbs.	75,141 lbs.
P20 7.2 lbs.	78,408 lbs.

*Assumes 24 x 24 inch plant spacing

Despite the high yield potential of the disease tolerant taro varieties, the cooperators indicated that the texture, color, and taste of the standard Lehua varieties superseded these attributes. The cooperators did not intend to convert acreages to the Palauan varieties. Also, the Palauan taro varieties had a tendency to produce long rhizomes which hampered the harvesting operation.

Oahu Success Stories: A contact person for an organized group of Tongan farmers on Oahu reported that the P1 and P20 varieties were excellent varieties for Tongan table taro preferences. These farmers grow the taro along with other crops such as cassava, yam, kava-kava, and ape (*Alocasia macrorrhiza*). They plan to increase their plantings of the blight resistant taro varieties.

Another commercial grower on Oahu has been successfully growing (upland conditions) and marketing several of the Palauan taro varieties for luau. The grower indicated that his buyers are happy with his product and he has developed a steady market.

Further project information can be accessed at:
<http://www.extento.hawaii.edu/IPM/taro/default.htm>

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