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Promising New Taro Cultivars with Resistance to Taro Leaf Blight: 'Pa'lehua', 'Pa'akala', and 'Pauakea'

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Three new cultivars of taro (*Colocasia esculenta*) are being made available to taro growers under a licensing agreement with the University of Hawaii. One of them, 'Pa'lehua', may be a substitute for 'Maui Lehua', the main poi taro now being grown in Hawaii. The other two, 'Pa'akala' and 'Pauakea', while not suitable for poi, may be desirable for producing "table taro," taro flour, and other products. All three cultivars have been observed in trial plantings to have resistance to taro leaf blight (TLB) caused by *Phytophthora colocasiae*, and they are likely to be particularly valuable where this disease limits taro yield.

The new cultivars* were derived from plant selections made and tested since 1997 from a cross made in 1995 between 'Maui Lehua' and 'Ngeruuch'. 'Maui Lehua' is a Hawaiian-Polynesian taro that is very susceptible to taro leaf blight, while 'Ngeruuch', from Palau, Micronesia, is very resistant to TLB.

'Pa'lehua' matures in 9–10 months and has twice the yield potential of 'Maui Lehua', which takes 13–14 months to mature. 'Pa'akala' and 'Pauakea' are also high-yielding, with corm weights in test plantings averaging 6.8 and 9.1 lb, respectively. The cultivars are considered resistant to the fungal pathogen *Pythium*. They mature early, need little fertilizer, and have a thick skin for extended shelf life. Thus these cultivars represent major improvements in production opportunities for this Asian-Pacific staple crop.

Breeding and selection

Plantings at Hakalau, Hawaii, in 1995–1996 evaluated taro cultivars from Palau, Guam, and Rota for resistance to taro leaf blight and revealed that most taros from Palau were highly resistant to this disease. However, the Palau materials have the undesirable characteristic of developing suckers on rhizomes produced by long runners, whereas Polynesian taros have suckers closely attached to the *'ohā* (mother plant). Also, the eating qualities of the Palau taros differ from those accepted in Hawaii.

Crosses were made in an attempt to combine the Palau taros' resistance to TLB with the desirable eating quality of Polynesian taros. 'Maui Lehua' was the female parent, chosen for its desirable agronomic characteristics, in particular the absence of runners and the low number of suckers per plant, and its purple corm, which is desirable for making poi. 'Ngeruuch' was selected as the male (pollen) parent for its high resistance to TLB.

Because desirable traits are often controlled by more than one gene, and cross-pollination results in many genes being recombined, great variation was observed in the initial generation of seedlings (the "F_1 progeny"). For example, only seven percent of the 200 F_1 progeny field-tested at Hakalau inherited the purple corm of 'Maui Lehua'. In screening the F_1 progeny, the most careful attention was paid to TLB resistance. Other characters considered were few (< six) suckers, and closeness of attachment of the suckers to the mother plant. Five candidates were selected that had TLB resistance and desirable suckering characteristics. Once these plants were identified, each was cloned by apical meristem tissue culture to increase plants for further testing.

Further disease assessment was done in two plantings at two locations at Hakalau: April 1998, using tissue-cultured plants, and January 1999, using *huli* (suckers) from the first planting. The farm is at 600 ft elevation and receives 150 inches of rainfall annually. 'Maui Lehua' and 'Ngeruuch' were grown for comparison. Monthly disease assessment consisted of visual determination of the percent of area of taro leaf damage caused by TLB on all functional leaves of the plants. The sum of percentages of leaf area damage was divided by the

*The authors (E.T. and T.M.) named the cultivars by combining the syllable "pa" (to indicate the Palauan source of the male parent) with Hawaiian words indicating the corm colors: *lehua* (red flower of the *'ōhi'a* tree, or red poi-taro cultivar), *'ākala* (pink), and *uakea* (white as mist). In current written Hawaiian, the correct pronunciation orthographies for these names are Pālehua, Pā'ākala, and Pāuakea.

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number of leaves on the plant to obtain a disease index. ‘Maui Lehua’ was the most susceptible to TLB, and ‘Ngeruuch’ was the most resistant. Three of the five selected F_1 progeny had TLB resistance comparable to ‘Ngeruuch’.

Description of the new cultivars

All three cultivars can have “shot-hole” lesions on the older leaves when they have been invaded by the taro leaf blight pathogen, *Phytophthora colocasiae*. This characteristic is a sign that the plants are in fact resistant to systemic damage by the disease. Corms of all three are generally free of pocket rot.

‘Pa‘lehua’

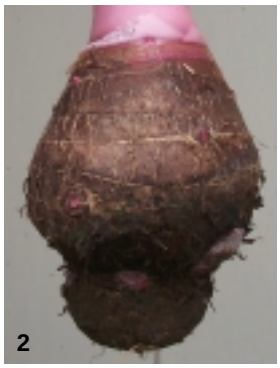
‘Pa‘lehua’ (“lehua grove or field”) is a medium-tall, slightly spreading plant with heart-shaped leaf blades drooping at an acute angle and three to five suckers.

Cross-sections of corms showing characteristic colors: left to right, ‘Pa‘akala’, ‘Pauakea’, and ‘Pa‘lehua’.

‘Pauakea’ is the taller of the three cultivars by 1 foot or so. These dryland-grown plants at CTAHR’s Waimanalo Research Station are 9 months old and above 6½ feet tall.

The leaves have a dark green lamina with an iridescent purple tinge. Veins of the youngest leaf are pinkish-purple and the lamina is light green with a peach cast. The *piko* (point of attachment of the petiole to the lamina) is dark reddish-purple in older leaves. Petioles are greenish-pink with purple margins and up to 50 inches long.

Corms of the three new cultivars: 1, ‘Pa‘lehua’ grown in wetland *lo‘i*; 2, 3, and 4, ‘Pa‘lehua’, ‘Pa‘akala’, and ‘Pauakea’ grown in dryland conditions (scale of corm size varies among the photographs).



The oblong corm weighs 3.5–6.5 lb and is almost free of pocket rot. The corm top-section is intense purple, and the roots are thick and purplish. In cross-section the corm color is as intense purple as that of ‘Maui Lehua’. The purple color of the corm intensifies at cooking, and the cooked corm has characteristics of a good poi taro with flavor similar to ‘Maui Lehua’.

‘Pauakea’

‘Pauakea’ (“touch of the white rain”) is a vigorous, tall, bright green plant with three to four suckers, one originating from a runner. The older leaves are heart-shaped and dark green with light green veins. The petioles are light green and up to 60 inches long. The corm weighs 8–14 lb and has light brown skin and stout white roots. The corm cross-section is creamy white, and after cooking it is snowy white, starchy, and slightly gummy in texture.

‘Pa‘akala’

‘Pa‘akala’ (“field of pink”) is a vigorous, tall, dark green plant with four to five suckers, three originating from runners. The older leaves are dark green and saggitate (acutely pointed), and the veins on the underside are purplish. The petioles can be up to 55 inches long and are green, tinged with purple toward the *piko*. The corm is large and has pink-brown skin and pink roots. The corm interior is pink-purplish, grayish-white when cooked, moderately starchy, and gummy-moist in texture.

Notes on cultivation and yields

To date, only preliminary observations are available on the soil and nutrient requirements, disease susceptibility, crop duration, and yield of the three new cultivars. No controlled experiments have yet been done to confirm the preliminary observations mentioned here.

The disease *Pythium* soft rot is a serious disease of taro, particularly in acidic soils, which are inherently low in calcium. The author (E.T.) has observed this disease in wetland taro in Hawaii and elsewhere in the Pacific region. On coral atolls such as Nukuoro (Federated States of Micronesia), where soil calcium levels are high, *Pythium* soft rot is rare in taro grown in pits containing compost. Taro fields on Rota (Commonwealth of the Northern Marianas Islands) are also high in calcium and free of *Pythium* soft rot. Therefore, our test plantings of the three cultivars on an acidic soil at Waialua, Oahu, were amended with lime or gypsum to increase the available calcium in the soil to 3500 ppm.

The Palau taro cultivars are believed to produce relatively good yields in soils with low fertility. On many

In the foreground are ‘Pa‘lehua’ plants, showing the shot-hole lesion caused by a hypersensitive reaction that indicates resistance to taro leaf blight. The plants in the background, lacking these lesions, are ‘Maui Lehua’.

Table 1. Yield of taro grown at Waialua, Oahu*.

Cultivar	Corm yield (lb/acre)	Average corm weight (lb)	Months to maturity
‘Pa‘lehua’	43,560	4.5	9
‘Pa‘akala’	62,920	6.5	11
‘Pauakea’	82,280	8.5	12

*Planting distance 18 x 36 inches, or 9680 plants/acre; six hours of drip irrigation per day; 150 lb of N and 300 lb of K per crop cycle. The data given are from unreplicated, unrepeated plantings and should not be used to predict future yields.

Table 2. ‘Pa‘lehua’ yield in wetland soils on Maui (Keanae), Oahu (Waialua), and Kauai (Hanalei). The fertilizer schedule for ‘Maui Lehua’ taro on the different farms was used.

Location	Soil calcium (ppm)	Taro yield* (lb/acre)	Months to maturity	Planting distance (inches)	*Pythium* rot incidence* (%)
Keanae	901	18,392	8	18 x 24	60
Hanalei	2352	23,799	9	30 x 30	43
Waialua	2432	38,169	9½	24 x 20	9
Hanalei	2748	43,890	8	30 x 22	2
Hanalei	3736	55,235	9	20 x 20	1

*Data are from four replicated plots at each site.

Pacific islands, taro farmers incorporate leaves of leguminous plants such as *Erythrina* species into the soil as the source of nitrogen (N). The amount of N from this green manure is a small fraction of the amount applied as inorganic fertilizer by Hawaii’s taro growers. Because the Palau taros seem to grow well with low levels of N, our observation plantings at Waialua of ‘Pa‘lehua’, ‘Pauakea’, and ‘Pa‘akala’ used a fertilizer low in N and high in potassium (K), with the results shown in Table 1.

In addition to the plantings at Waialua, single-plot evaluation plantings of ‘Pa‘lehua’ were done in Keanae, Maui, and at two sites in Hanalei, Kauai; these included “lehua”-type cultivars (‘Maui Lehua’ or ‘Kaua‘i Lehua’) planted in the same taro *lo‘i* (wetland field). ‘Pa‘lehua’ matured in 8–9 month when planted in January–March and 9–10 months when planted in June–August, whereas ‘Maui Lehua’ needed 13–14 months from planting to harvest. Thus, yield comparisons between ‘Pa‘lehua’ and the traditional “lehua” taro cultivars are difficult to make. ‘Pa‘lehua’ yield was highest in a Hanalei planting where soil calcium was high and soft rot incidence was negligible. These plantings also suggested that the fertilizer application practices followed for “lehua” taros may not be suitable for ‘Pa‘lehua’, which matures earlier and appears to need less fertilizer. Data collected during evaluations of ‘Pa‘lehua’ suggest an association between soil calcium level and incidence of *Pythium* soft rot (Table 2). Therefore, taro farmers, particularly those whose crops have high levels of *Pythium* soft rot, should test their field soils for calcium and other nutrients before planting ‘Pa‘lehua’ in the *lo‘i*.

Taro quality tests

Some preliminary food quality observations have been made on the new cultivars. Poi was made from ‘Pa‘lehua’ taro grown under upland cultivation with natural rainfall; taro from several such plantings was evaluated. A taste panel rated ‘Pa‘lehua’ poi as very similar to ‘Maui Lehua’ poi, except that ‘Pa‘lehua’ poi was a more intense purple. A poi company made poi with the same ‘Pa‘lehua’ taro. Peeling and removing blemishes resulted in a 20 percent weight loss, considered reasonably low, of which just under half was attributed to pocket rot damage. Taro flour made from ‘Pa‘lehua’, ‘Pauakea’, and ‘Pa‘akala’ grown under upland conditions yielded approximately 29 percent dry flour.

Availability of the new cultivars

The three new cultivars derived from a cross between ‘Maui Lehua’ and ‘Ngeruuch’ have been patented and can be purchased from the CTAHR Agricultural Diagnostic Service Center’s seed program (808-956-6706). The U.S. plant patent numbers are ‘Pa‘lehua’, PP12361, ‘Pauakea’, PP12342, and ‘Pa‘akala’, PP12772. Purchasers must sign a licensing agreement to acquire *huli* of the cultivars.

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