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TRIALS OF IPOMOEA AQUATICA, NUTRITIOUS VEGETABLE WITH HIGH PROTEIN- AND NITRATE-EXTRACTION POTENTIAL[1]

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Abstract. Ipomoea aquatica **is an aquatic vegetable widely cultivated in southeast Asia. It has been backyard cultivated in Florida and sold as a fresh vegetable in stores specializing in Oriental foods. Because it is now listed as a prohibited aquatic plant by the Florida Department of Natural Resources, canned** I. aquatica **is being imported to meet local demand. We have been growing** I. aquatica **under a DNR permit for several years as part of our continuing effort to evaluate various aquatic plants for cultivation in the Everglades. Our studies have shown** I. aquatica **to be a highly productive summer-growing crop capable of achieving high protein levels. Dry matter production during an 8-month period has exceeded 20,000 kg/ha and has averaged 12% crude protein. Leaf protein averaged 25%. However,** I. aquatica **is very frost sensitive and is host to many insects. In addition to marketing as a fresh summer vegetable, it has potential as a protein crop and our studies have shown it might be especially useful for removing nitrogen from drainage water.**

Throughout the world organic soils are destroyed by oxidative decomposition whenever they are drained to permit upland agriculture. For example, the surface elevation of the Everglades Agricultural Area has decreased (subsided) ca. 2½ cm annually. In more tropical regions, such as Indonesia or Malaysia, annual subsidence rates greater than 6 cm have been observed (8, 12). Flooding stops subsidence by excluding oxygen. Soils that have severely subsided are likely to be flooded in the absence of active drainage since in most cases their surface elevation will be lower than that of adjacent surface and ground water. Everglades farmers may find it advantageous to retain water on their land during the summer rainy season in order to augment their water supply during the dry season. For these reasons we have suggested that aquatic crops be evaluated for production on organic soils (15). This paper represents a detailed look at one of these crops.

A member of the morning-glory family, Convolvulaceae, and a close relative of the sweet potato, water spinach, *Ipomoea aquatica* Forsk (syn. *I. reptans* Poir.), is one of the most popular of green vegetables throughout the tropics of the Old World. Therefore, it has numerous regional names including kangkong, ung-choi, ong-tsoi, tung sum tsoi (China, Taiwan, Hong Kong); kankoong (Java); tangkong, cancong, balangog (Philippines); rau muong (Vietnam); phak bong (Laos); tra kuon (Cambodia); gka-lam-pok (Thailand); kalamisag, karmi, nali (India); batatilla acuatica, batatilla de puerco (Latin America); and is also called Chinese spinach, Chinese morning-glory, swamp cabbage, swamp morning-glory, water convolvulus, or bindweed plant.

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Description

I. aquatica is an annual or perennial, fast-growing herb with smooth, succulent, hollow stems that root at the nodes in wet ground. Leaves are alternate, long-stemmed, triangular or lanceolate, and heart-shaped or hastate at the base, 5 to 15 cm long, 2 to 5 cm wide. Petioles may be pale-green or purple. The funnelform flowers, 4 to 7.5 cm long and 5 cm wide, borne singly or in clusters of 2 to 7 in the leaf axils, may be all-white, white with a magenta or purple throat, or all-pink, lavender or purple (Fig. 1). The smooth, brown, ovoid seed capsule, 7 to 9 mm across, is cupped by the 5-pointed calyx and contains 2 to 4 round, smooth or velvet-coated, brown seeds, 4 mm wide.

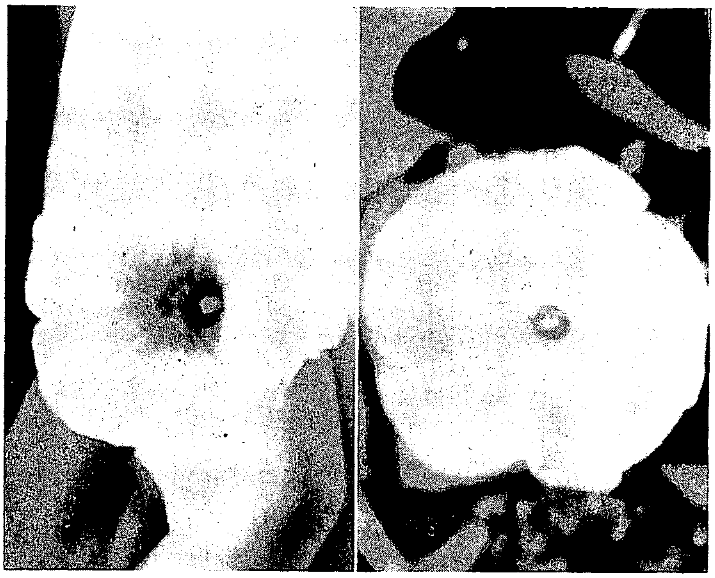

Fig. 1. *I. aquatica* flowers showing the purple throated type (left) collected in Banjarmasin, Kalimantan, Indonesia and the all white type (right) collected near Kuching, Sarawak, Malaysia. (Photo by G. H. Snyder)

Origin and Distribution

The earliest known record of *I. aquatica* cultivation is in a Chinese work of the 3rd century A.D. It is extensively grown in China from the Yangtze River southward and is found domesticated throughout southeast Asia, India, Malaysia and Oceania. It is believed to have been introduced into Hawaii by Chinese immigrants sometime before 1888 (6). It is raised as a vegetable in tropical Africa. Chinese doubtless carried it to Brazil, the Guianas, Central America, Trinidad, Jamaica, Cuba and other islands of the West Indies. In Puerto Rico, it is naturalized to a limited extent in the Lajas Valley near Guanica. Professor Roy Woodbury (29) says it is not spreading and not competing with the native vegetation. It is regarded as native in Costa

Rica where it occurs on the banks of streams and borders of marshes (23).

Cultivars

A number of cultivars have been identified (Fig. 2). Javanese distinguish two types, 'Kankoong beeasa' having dark-green leaves and stems and purple flowers; 'Kankoong nagree with yellowish-green leaves, yellowish stems and white flowers (17). In Hong Kong the preferred cultivar, with white stems, is distinguished as 'Pak Quat' (Fig. 3). The less succulent 'Ching Quat', with green stems, is somewhat hardier and, for that reason, grown in spring and early summer before the preferred kind can be planted.

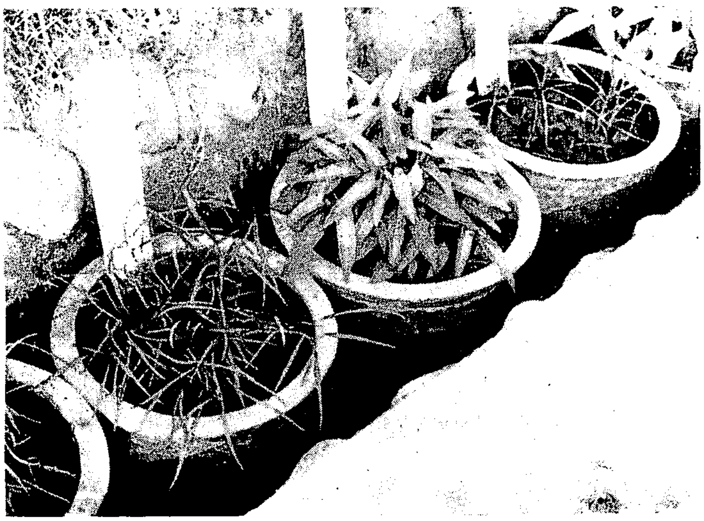

Fig. 2. Several *I. aquatica* cultivars showing extreme variations in leaf morphology, from a collection of over 40 types maintained by Dr. Tsung-dao Liou, Assistant Horticulturist, Fengshan Tropical Horticultural Experiment Station, Taiwan Agricultural Research Institute, Fengshan, Kaohsiung, Taiwan, Republic of China. (Photo by G. H. Snyder)

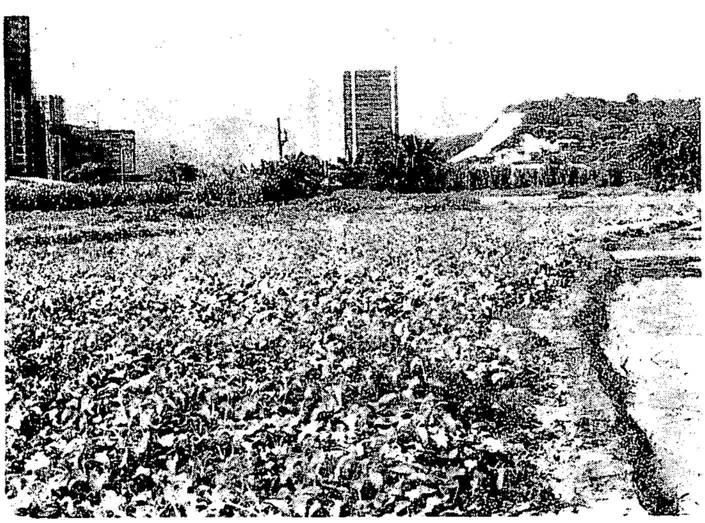

Fig. 3. A commercial planting of *I. aquatica* in the New Territories, Hong Kong. This farm produces watercress (*Nasturtium officinale* R. Br.) during the winter and water spinach in the summer. (Photo by G. H. Snyder)

Cultivar and Harvesting

Heavy clay and waterlogged soils, unsuitable for most purposes, are ideal for this crop (22). *I. aquatica* can be grown from seeds, which are sold in this country in Chinatown, New York City, and in California, but cuttings are often used and root quickly. In China, cuttings are stored in cellars during the winter and set out in the spring (9).

The plant can withstand very light frost which affects only the outer leaves, but is killed by heavy frost (27).

Two different commercial systems of cultivation are employed: dryland and wetland. In the dryland system, plantings are established on raised beds between irrigation ditches. Seeds may be planted on the beds or in a nursery and the seedlings transplanted to the beds where they are spaced 0.9 m apart. With heavy fertilization, careful weeding, and ample watering, the crop will be ready to harvest in 50 to 60 days. The tops may be cut for use several times during the growing season.

In the wetland system, seeds are sown in a moist field and, 6 weeks later, the tops are cut and set in mud in flooded flat land bordered by low dikes. Between 10,000 and 25,000 cuttings are needed per hectare. Water depth is 3 to 5 cm at first and later increased to 15 or 20 cm. Deeper water is detrimental to growth. Without standing water, the vine roots at every node, becomes woody and inedible (22).

With plentiful fertilizer, the above-water tops are ready for cutting in 30 days and harvesting can be repeated every week or 10 days until the end of summer. Then the fields are drained, the plants are allowed to flower and fruit. The fruits are picked, dried, and crushed to free the seeds which are kept in dry storage till spring (9). The shoots are tied in bunches of about 16 for market and they are sold in great abundance wherever the crop is grown.

Homeowners merely plant seeds or cuttings on the banks of freshwater ponds, pools, streams or ditches. The stems will extend out over the water and form half-floating mats. Seafarers used to grow the plant in pottery jars to provide fresh greens aboard ship on long voyages (9).

Trials in Florida

Except for scattered, small-scale plantings by Chinese farmers and other Florida residents of Asiatic descent, *I. aquatica* received little attention here until a demonstration tankful was established and briefly maintained at the University of Miami by Dr. J. J. Ochse in 1951 (16). In June 1976, cuttings were rooted in greenhouse beds at the AREC, Belle Glade, and, after tripling of growth, they were moved to an outside tank in late September.

Since it never was possible to obtain a permit from the Florida Department of Natural Resources (DNR) for field studies of *I. aquatica*, all outdoor evaluations at the AREC had to be conducted in concrete tanks 1.37 x 2.75 x 1.5 meter deep, filled with Pahokee muck soil and flooded with tap water, using float valves to maintain a 5-10 cm deep flood.

Yield Trials

To determine yield potential, *I. aquatica* was grown in two concrete tanks in 1977 and in four in 1980 and 1981. One of the 1977 tanks (#1) was planted in late September 1976, but the planting was severely damaged by the record cold weather of Jan 18-20, 1977, during which ice briefly formed on the water surface. However, by late March 1977, considerable regrowth was observed. The second tank (#2) was sprigged with greenhouse maintained planting material on March 15, 1977. Tank #1 was fertilized with $Ca(NO_3)_2$ at the rate of 80 kg N/ha on June 1, June 20 and June 23, 1977, and the above water plant material was harvested June 29th. Both tanks were fertilized with urea at the rate of 50 kg N/ha on July 6 and 13, and were harvested on August 17 and Oct. 7, 1977. In 1980, four tanks of *I. aquatica* were planted March 21 by sprigging on 20 cm centers. On March 24 they were fertilized with urea at 100 kg N/ha and with the following nutrients at the indicated rate (kg/ha): P-40, K-200, Mg-40, Fe-20, Mn-20, Zn-8, Cu-2, B-0.4, and Mo-0.4. Urea was again applied at 50 kg N/ha on May 27, June 13, June 26, July 11, July 30, Aug. 8, Aug. 20, Sept. 10, Sept. 21, Oct. 8 and Oct. 22. Other nutrients were applied at ¼th of the March 24th rate on June 13 and July 30. Harvests of the above water plant material were made monthly from June through November, 1980 (Fig. 4). In early 1981, the DNR required that the *I. aquatica* tanks be screened to exclude birds and insects which might disperse plant tissue and seeds. Aluminum window screen (7 wires/cm) was used for this purpose. The screen cut solar radiation (measured with an Eppley model 8-48 Pyranometer) by about 25% when directly overhead, and by about 45% when at a 45-degree angle. Since the four *I. aquatica* plantings were severely damaged by cold weather during the 1980-81 winter, the tanks were sprigged with indoor cultured plant material on April 28, 1981. Thenceforth they were fertilized with urea bi-weekly at 50 kg N/ha and with other nutrients monthly at ¼th of the March 24, 1977 rate. Harvests were made monthly from June through September, 1981.

Fig. 4. Augusto Blanchard harvesting *I. aquatica* as part of the 1980 test conducted at the AREC. The cultivar used in these studies resembles the 'Pak Quat' type. (Photo by G. H. Snyder)

The results of the 1977, 1980 and 1981 harvests are presented in Table 1. Since *I. aquatica* can no longer be grown outdoors in Florida without screening, it is difficult to determine whether or not the yield reduction observed in 1981 was due to the shading effect of the screen. However, we are unaware of any other environmental factors that were markedly different in 1981 from previous years. Whole plant (above water) dry matter content was determined on several occasions to be about 11% of fresh weight. Nitrogen content of the leaves alone was not determined for each harvest, but when determined generally ranged from 3.5 to 4.5%. Whole plant (above water) averaged 1.9% N (11.9% crude protein).

The yields obtained in our south Florida trials appear to be as high or higher than those obtained in other regions. For example, test plantings in muddy soil in hothouses at the Agricultural University, Wageningen, The Netherlands, indicated that fresh weight yields of 70 to 100 tons/ha might be expected, and sixty tons would be conservative (21). In Hong Kong the total annual fresh weight yield averages 90 tons/ha (9).

Table 1. Yield (above water portion) and N content of *I. aquatica* in trials conducted at the AREC Belle Glade.

Harvest date	Dry weight yield	N content	N yield
(M/D/Y)	(kg/ha)	%	(kg/ha)
6/29/77	3960	—	—
8/17/77	6082	1.6	97
10/7/77	6205	1.4	87
1977 Total	16247	—	—
6/13/80	4382	1.8	79
7/11/80	3021	2.0	60
8/8/80	2923	2.4	70
9/10/80	5127	2.0	103
10/8/80	3448	2.2	76
11/13/80	2638	2.2	58
1980 Total	21539	—	446
6/23/81	1570	1.9	30
7/23/81	2923	2.0	58
8/27/81	1828	1.9	35
9/28/81	1930	2.6	50
10/30/81	1780	2.8	50
11/30/81	1060	3.9	41
1981 Total	11091	—	264

Reducing N Content of Water

In November, 1978, a water pump was fitted to each of four tanks (two fallow, two with *I. aquatica*) to provide lengthwise circulation of flood water. A single tube at one end of each tank was used for water withdrawal and a PVC pipe placed lengthwise across the other end was drilled with 5 evenly spaced holes to provide water return. About 4 hours were required to completely recirculate the floodwater in each tank. On November 6, 1978, each withdrawal tube was placed in separate solutions containing 243 g $Ca(NO_3)_2$ (100 Kg N/ha). Nitrate-N was monitored near the withdrawal tubes several times daily for four days, and daily thereafter. In the fallow tanks detectable levels of nitrate (0.5 ppm N) were observed for over 2 weeks, whereas in the *I. aquatica* tanks not only was the maximum nitrate load less than ¼th that of the fallows tanks but in addition no nitrate was detected after 6 days (Fig. 5). Clearly, *I. aquatica* could be useful for removing nitrate from contaminated water, such as farm drainage or municipal waste.

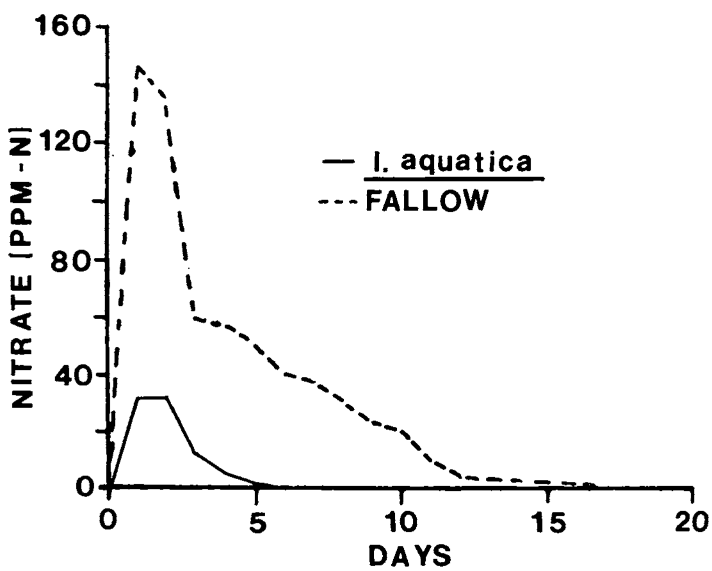

Fig. 5. Floodwater nitrate-N concentration in fallow and *I. aquatica* cropped systems following applications of $Ca(NO_3)_2$ at 100 kg N/ha.

That even in the absence of *I. aquatica* most nitrate eventually disappeared indicates that denitrification was active in these soil-water systems, as would be expected from work conducted by Terry and Tate (26). No doubt denitrification accounts for some of the nitrate loss in the *I. aquatica* systems, too. The *I. aquatica* probably contributes to the process by consuming oxygen in the water and by exuding easily degradeable organic compounds which are necessary for denitrification. But it appears that considerable N can be taken up by the plant as well. For example, in 1980, 650 kg N/ha was applied and 446 was removed in the harvested top growth (Table 1). These data support the suggestion by Bruemmer and Roe (3) that *I. aquatica* be considered by agriculturists and sanitary engineers for reducing nitrate levels in runoff and waste waters. (All plant material harvested in our trials was sent to these workers to further their protein extraction studies). It is unfortunate that current DNR regulations prohibit field testing this possibility. In Malaysia and Fiji, *I. aquatica* is raised in tanks enriched with swine effluent and the harvested plants are fed to swine and cattle (2). Once the stems cover the surface of the tanks, harvesting is easily achieved by cutting a square in the center of the mat, rolling it up, and removing it. The hole is quickly filled by regrowth from both sides. As the plant is mildly laxative in the raw state and greedily consumed by the animals, it has been found necessary to combine it with napier grass (*Pennisetum purpureum* Schum.) to avoid scouring. In an experimental project at the Sigatoka Agricultural Station, Fiji, *I. aquatica* and fish (*Tilapia mossambica*) were produced together in a swine-effluent pond for the purpose of feeding swine both of the products. In the first 12 months, 90 tons of the fresh, wet plant were harvested (18).

Pests

Ipomaea aquatica is attacked by a wide range of host specific (to Convolvulaceae) and general feeder insects. These by presence of insect bodies, foliar damage, and accumulation of fecal wastes, even under moderate population levels, can render the foliage unmarketable as a vegetable under any reasonable damage tolerances. Probably some insecticidal protection would be required during most seasons. The plant grown as a protein source would probably be little affected by insects except under extreme population pressure.

Damage during 1977 and 1978 was much more evident than in 1980. During that season much more insect parasite and predator activity was noted on the plants. In addition, the common anole (*Anolis carolinensis* Voight) and green tree frog (*Hyla cinerea* (Schneider)) were noted ranging the foliar canopy. Undetermined frogs (*Hyla* spp.) were also noted in numbers. The water in the tanks contained large numbers of tadpoles. Under high insect population conditions, mockingbirds (*Mimus polyglottos* L.), Smooth-billed Ani (*Crotophaga ani* L.) and Palm Warbler (*Dendroica palmarum* (Gmelin)) were observed taking insects from the plants.

Among the nearly 50 insect and mite species that attacked the plant, 15 or 20 should be considered economically injurious or potentially injurious, bearing in mind that the foliage is harvested and therefore can only tolerate very limited damage or insect presence. The sweet potato hornworm (*Agrius cingulatus* (F.)), sweet potato leafroller (*Pilocrocis tripunctata* (F.)), *Spodoptera latifascia* (Walker), salt marsh caterpillar (*Estigmene acraea* (Drury)), sweet potato fleabeetle (*Chaetocnema confinis* (Crotch)), Argus tortoise beetle (*Chelymorpha cassidea* (F.)), banded cucumber beetle (*Diabrotica balteata* Lec.), goldbug (*Metriona bicolor* (F.)), an agromyzid leafminer (*Liriomyza* sp.), green peach aphid (*Myzus persicae* (Sulzer)), two-spotted mite (*Tetrancychus urticae* Koch) and olive green swamp grasshopper (Paroxya clavuliger (Serville)) are considered to be the top dozen arthropod pests of the crop. The sweet potato hornworm, *Spodoptera latifascia,* salt marsh caterpillar (all larvae) and olive green swamp grasshopper adults and nymphs are gross feeders capable of devouring large quantities of foliage. The sweet potato leafroller larvae fold and tie the leaves and feed both within and without these shelters. Argus tortoise beetles and goldbug, adults and larvae, and adult banded cucumber beetles eat variable sized holes in the leaves. The adult sweet potato fleabeetle cuts elongate grooves in the leaves while the vegetable leafminer larvae make their characteristic, serpentine, steadily enlarging, silvery mines between the leaf surfaces. Green peach aphid is often noted as causing leaf cupping and promotion of sooty mold and clustering of the small yellowish-green nymphs and adults. They suck the plant juices. Two-spotted mite produces a fine stippling that results in a silvered hue, particularly on undersides of leaves where the mites feed on the plant juices. Table 2 lists the major pests, years, population conditions, and natural enemies observed for a three-year period. In addition, the Florida Bureau of Plant Industry has identified a flea hopper, *Halticus bractatus,* that pierces the leaves (7).

White rust (*Albugo Ipomoeae-aquatica*) is a serious fungal disease in Hong Kong, where such leaf spot diseases as *Alternaria, Cercospora, Cercosporella,* and *Phomopsis* spp. also are found (11). However, these diseases were not routinely observed in the AREC plantings.

Weed Potential

In May 1979, the Bureau of Aquatic Plant Research and Control, Department of Natural Resources, discovered a small patch of water spinach that had been planted on a canal bank near Homestead by a veteran of military service in southeast Asia to supply greens which he and his Thai wife enjoyed. The floating stems had spread out over the surface of the canal and there was no evidence of winter damage (24). It was therefore assumed to be a dangerous aquatic weed capable of spreading like the water hyacinth (*Eichhornia crassipes* Solms). However, it is now obvious that water spinach is by no means as hardy as water hyacinth. The prolonged cold weather of last January was lethal to the water spinach in our tanks and completely eliminated the small patches maintained by Oriental residents. In India the plant is valued as a soil binder on the rims of silt retention ponds and percolation tanks with no indication of spreading beyond banks (22). In Guyana, it is grown in drainage and irrigation ditches for greens. It does not seriously decrease the carrying capacity of these structures even though no control measures are used. However, occasionally it is killed by 2-4,D runoff from application to sugarcane (30).

Food Uses

The young shoots and leaves are eaten raw in salads, are steamed or boiled like spinach, or cooked in vegetable curries. In the Chinese cuisine, a piece of garlic is cooked in peanut oil, a little water and water spinach cut into 5 to 7.5 cm lengths are added and the mixture is fried for 5 minutes. Salt or soy sauce may be applied before serving (5). In Hong Kong, the water spinach is pre-fried and shrimp sauce is added to the oil before the greens are put in, then cooking proceeds for 10 minutes (10). The stems enter into

Table 2. Status of phytophagous insects associated with water spinach (*Ipomaea aquatica*) grown in outdoor concrete tanks—AREC, Belle Glade, Fl., 1978-80.[z]

Common name	Species	Family	Years	Pop.	Natural enemies
			(Lepidoptera)		
Sweet potato hornworm	*Agrius cingulatus* (F.)	Sphingidae	1978	VH	*Podisus maculiventris* (Say)
			1979	VL	*Zelus bilobus* (Say)
			1980	NO	*Anolis carolinensis* Voight, Tachinid flies.
Sweet potato leafroller	*Pilocrocis tripunctata* (F.)	Pyralidae	1978	L-H	*Caleida decora* (F.), *Z. bilobus* (Say)
			1979	L-H	*Sinea diadema* (F.), *Z. bilobus* (Say)
			1980	L-H	
NCN	*Spodoptera latifascia* (Walrn)	Noctuidae	1978	VH	*Stiretrus anchorago* (Say)
			1979	L	*Zelus bilobus*
			1980	M	
Saltmarsh caterpillar	*Estigmene acraea* (Drury)	Arctiidae	1978	M	Smooth-billed Ani (*Crotophaga* ani L.)
			1979	L	*Z. bilobus* (Say)
			1980	H	
			(Coleoptera)		
Sweet potato fleabeetle	*Chaetocnema confinis* Crotch	Chrysomelidae	1978	H	
			1979	H	
			1980	VL	
Argus tortoise beetle	*Chelymorpha cassidea* (F.)	Chrysomelidae	1978	VL	*P. maculiventris, Z. bilobus*
			1979	M	
			1980	FH	
Goldbug	*Metriona bicolor* F.	Chrysomelidae	1978	VL	*Hyla cinerea* (Schneider)
			1979	L	
			1980	M	
Banded cucumber beetle	*Diabrotica balteata* Lec.	Chrysomelidae	1978	FH	*P. maculiventris, Z. bilobus*
			1979	H	
			1980	FH	
Spotted cucumber beetle	*Diabrotica II-punctata howardi* barber	Chrysomelidae	1978	M	*P. maculiventris, Z. bilobus*
			1979	M	
			1980	FH	
			(Hemiptera)		
Southern green stinkbug	*Nezara viridula* (L.)	Pentatomidae	1978	M	*Trichopoda pennipes* (F.)
			1979	M	*Z. Bilobus*
			1980	FH	
NCN	*Edessa bifida* (Say)	Pentatomidae	1978	NO	*Z. Bilobus*
			1979	M	
			1980	L	
Negro bug	*Galgupha denudata* (Uhler)	Cormelaenidae	1978	NO	
			1979	FH	
			1980	L	
Leaf-footed bug	*Leptoglossus phyllopus* (L.)	Coreidae	1978	L	
			1979	M	
			1980	FH	
			(Homoptera)		
Green peach aphid	*Myzus persicae* (Sulzer)	Aphididae	1978	H	*Cycloneda sanguinea* (L.)
			1979	H	*Hippodamia convergens* (Guern.)
			1980	H	*Scymnus* sp.
Sharpshooter	*Oncometopia nigricans* (Say)	Cicadellidae	1978	M	
			1979	M	
			1980	FH	
			(Orthoptera)		
Atlantic grass-hopper	*Paroxya atlantica* Scudder	Acrididae	1978	L	
			1979	M	
			1980	M	
			(Diptera)		
Vegetable leaf-miner	*Liriomyza sativa* Blanchard	Agromyzidae	1978	H	Chalcidoidea, *Condylostylus* sp.
			1979	H	
			1980	H	
			(Aranea)		
Two-spotted mite	*Tetranychus urticae* Koch		1978	H	*Stethorus* sp.
			1979	H	
			1980	H	

[z]Abbreviations: NO—Not observed; VL—Very light numbers; L—Light numbers; M—Moderate numbers; H—Heavy numbers; FH—Fairly heavy numbers; VH—Very heavy numbers; NCM—No common name.

mixed pickles in the Philippines (20). In Nyasaland, the greens are cooked with peanuts or sesame oil and enjoyed as a side-dish (28). Wetland plants are especially tender; dry-land plants richer in flavor (4).

Canned water spinach is regularly imported into the United States from the Philippines and from Taiwan and is commonly consumed by all the people of Asiatic origin, though they would prefer the fresh plant if it were available. In fact, there is a constant, active demand for the fresh vegetable. It could be a lucrative summer crop for Florida farmers.

Food Value

Water spinach is acclaimed as highly nutritious (13). Analyses in Hawaii show: water, 92.0%; protein, 2.8%; ether extract (fat), 0.3%; crude fiber, 1.2%; carbohydrate, 2.5%; ash, 1.15%; calcium, 0.04%; phosphorus, 0.052%; iron, 0.00158%; carotene, 10,600 I.U., thiamine, 80 ug, ascorbic acid (raw), 44 mg, (cooked) 10 mg, per 100 g (14). Other sources show carotene as 3,300 I.U., nicotinic acid, 0.6 mg, riboflavin, 120 ug, vitamin E, 11.8 mg, per 100 g (1), and as much as 4.6% protein (25).

A Phillipine investigator discovered a chemical resembling insulin in the buds of a pigmented variety of water spinach and recommended this type as a food for diabetics (19).

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GENETIC VARIATION IN F1 COCOYAM (XANTHOSOMA SP.) HYBRIDS[1,2]

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Abstract. **Four cocoyam (Xanthosoma sp.) cultivar selections were hybridized and their segregating F_1 progenies were evaluated for several phenotypic traits. In a cross where the parents differed widely in cormel shape the progeny also varied in cormel shape from rhizome-like to pyriform. Plant height among the progeny segregated from 90 cm to 135 cm. In another cross in which one parent produced white-fleshed cormels and the other produced yellow-fleshed cormels 14% of the progeny were white-fleshed, 45% produced cormels which were pale yellow in color while 41% produced deeper yellow colored cormels. In this cross plant height ranged from 26 cm to 106 cm and productivity varied from 3 to 36 cormels per plant.**

These agronomic characteristics were heritable but were quantitative in their inheritance and probably multigenic. The wide range of genetic diversity provides the possibility to identify and propagate new clones that have the best traits of both parents.

Cocoyams are grown in many tropical regions of the world to produce edible corms, cormels and leaves. In some locations the name cocoyam refers to plants in both the *Xanthosoma* and *Colocasia* genera. *Colocasia esculenta* (L.) Schott. is the scientific name of "old" cocoyam and *Xanthosoma* spp. refers to "new" cocoyam (9, 10, 16). The term malanga, yautia, ocumo, tiquisque, and tannia are names used in southern Florida and throughout the Caribbean for *Xanthosoma* sp. In Cameroon, West Africa the term macabo is used. In this paper cocoyam refers to plants only in the genus *Xanthosoma*. Cocoyams have an exciting potential as an underexploited, tropical food crop (14).

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