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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[2]The assistance of L. Ramon-Ledon and J. Parrado throughout this study is appreciated.

This potential is emphasized by the need for genetic resistance to a new, yet undefined disease(s) of cocoyam prevalent in the Caribbean called "mal seco" and in regions of West Africa termed "cocoyam blight".

The lack of research attention to this plant group in the past can be attributed to the relative difficulty involved in making hybrid crosses, culturally establishing seedlings, the infrequency of some of the species to produce inflorescences naturally and the rather lengthy time required for maturity.

True seeds of cocoyam have been produced in Florida (17), Africa (4) and India (8). Methods have been developed to induce flowering among those cultivars that seldom produce inflorescences naturally (1, 3, 5, 6, 7, 11, 12, 19). Progenies of *Xanthosoma* grown from true seed in the first filial generation have considerable variation (7). Such variation indicates considerable heterozgosity in the parent cultivars.

Field plantings of cocoyam are established when sections of the main stem or the cormels are planted as setts. Two white-fleshed cocoyam varieties are grown in southern Florida for the commercial market. Florida White flowers abundantly under conditions in southern Florida whereas a second variety flowers infrequently. In addition to differances in cormel shape they can be further distinguished by subtle differences in leaf and petiole morphology. Other free-flowering types grown in southern Florida include one which produces orange-yellow cormels, Florida Yellow; one which produces cormels with pale violet colored flesh, Florida Violet; and a robust ornamental type which produces rhizomes without cormels, Florida Ornamental. The main corm color of our orange-yellow parental selection closely resembles Munsell Hue moderate orange yellow 7.5 YR8/8 and the color of our violet parental selection closely resembles Munsell Hue very pale violet 2.5 P 8/4 of the Nickerson Color Fan (15). Only the white-flesh cultivars are grown as a commercial food crop in the United States.

Morton (13) has suggested that Florida White should be classified as *X. caracu* Koch and Bouche. Florida Yellow may be either *X. caracu* or *X. atrovirens* Koch and Bouche and the violet flesh colored type is probably *X. violaceum.* The species designation of the ornamental type has not been determined.

The objectives of this study were to hybridize several selections of *Xanthosoma* sp. and determine the genetic variability available as a potential for agronomic improvement.

Materials and Methods

All clones used as parents were established in the field from locally collected vegetable setts. One exception was Florida White 40 which was first established as a single plant selection from seedlings of a cross between two clones out of the commercial type Florida White (Fig. 1b) (17). Single clones of Florida White (Fig. 1b) and Florida Yellow (Fig. 1a) were multiplied vegetatively to produce the parental data.

The clone designated Florida Ornamental was propagated from a selection taken at a local residence (Fig. 2). When grown under field conditions for up to 30 weeks this selection failed to produce cormels. Only rhizomes were produced.

Plants were grown in single plastic mulch covered beds spaced 183 cm apart. Plants were spaced 91 cm apart in rows. Each plant was side dressed at 4, 10 and 20 weeks after setting with 7.7 g of nitrate fertilizer and 15.4 g each of phosphorus and potassium fertilizer. The nitrate was half

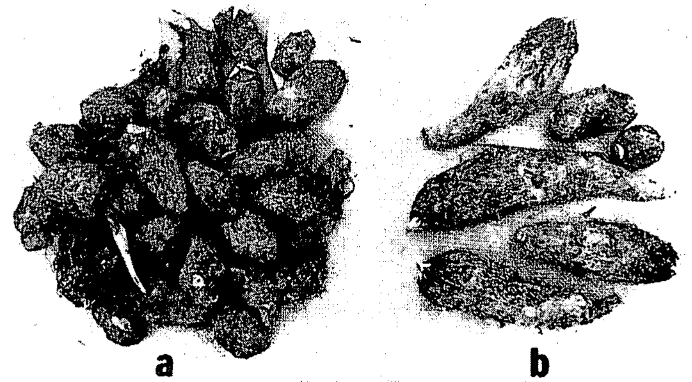

Fig. 1. Cormels of cocoyam (a) Florida Yellow produces corms with orange-yellow flesh and (b) Florida White produces corms with white flesh.

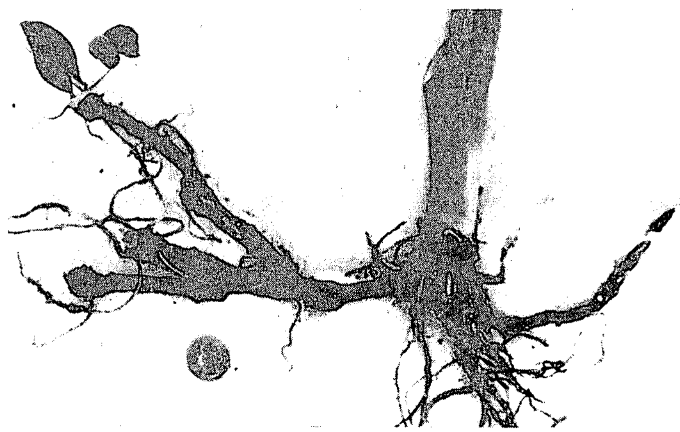

Fig. 2. Rhizome growth habit of cocoyam selection Florida Ornamental.

ammoniacal nitrogen and half nitrate nitrogen, the phosphorus was concentrated superphosphate and the potassium was applied as potassium nitrate and sulfate of potash.

All inflorescences were produced naturally in the field under southern Florida conditions. Seeds were produced from hybrid crosses according to methods reported previously (17). Seedlings were reared inside a greenhouse for 16 weeks before being transplanted to the field. Plant height was measured 28 weeks from transplanting. The plants were harvested 2 weeks later to determine the color, weight and number of cormels. Thirty parental plants of each clone were evaluated after 30 weeks of growth in the field.

Results and Discussion

Forty-five F_1 seedlings were evaluated in the cross Florida White 40 x Florida Ornamental. The progeny ranged from 90 cm to 135 cm in height and all produced cormels or rhizomes with white or cream colored flesh (Table 1). The progeny produced storage structures which varied considerably in shape, number and combined weight. Twelve plants produced pyriform shaped cormels similar to the Florida White 40 selection (Fig. 3a) and two plants produced rhizomes similar to Florida Ornamental (Fig. 3b). Thirty-one plants produced elongate cormels somewhat intermediate in shape. Of these 31 plants, 15 produced swollen rhizomes (Fig. 4a) whereas 16 produced pear shaped cormels (Fig. 4b). The mean yield was 19.6 cormels per plant with a mean weight of 811 grams (Table 2).

In the Florida White x Florida Yellow cross 228 seedlings were measured for height but only 158 seedlings were

Table 1. Distribution of plant height and color of secondary cormels in mature *Xanthosoma* sp. parents and hybrids.

Plant population	Number of plants				
	Plant height in cm				
	51-70	71-90	91-110	111-130	131-150
Florida Ornamental			4	16	10
F_1		2	14		
Florida White 40	6	15	9		
	11-30	31-50	51-70	71-90	91-110
Florida White			8	16	6
F_1	7	34	109	74	4
Florida Yellow		6	20	4	
	Color of secondary cormels[x]				
	White	Intermediate	Orange-Yellow		
Florida White	30				
F_1	23	71	64		
Florida Yellow			30		

[x]Intermediate color resembles Munsell Hue pale orange yellow 7.5 YR 9/4 and the orange-yellow color resembles Munsell Hue moderate orange-yellow 7.5 YR 8/8 (15).

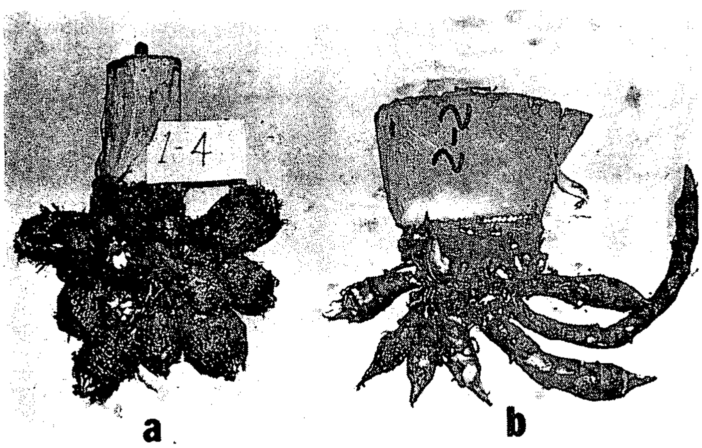

Fig. 3. Cormels produced from segregating progeny of the cocoyam cross Florida White 40 x Florida Ornamental; (a) pear-shaped cormels similar to the Florida White parent and (b) rhizomes similar to the Florida Ornamental parent.

evaluated for color variability. The progeny appeared to have segregated transgressively for height producing shorter plants than either of the parents (Table 1). The height range of the progeny was 51 to 70 cm and the progeny had a population height mean of 63.5.

In the Florida White x Florida Yellow cross 45% of the progeny produced cormels which were intermediate in color (Table 1) resembling Munsell Hue pale orange yellow 7.5 YR 9/4 (Table 1) (15). On the other hand the predominant color in the main corm was a darker orange-yellow resembling Munsell Hue moderate orange yellow 7.5 YR 8/8 (15). Only one plant produced a white main corm and 11% were pale orange yellow. The remaining main corms were moderate orange yellow. The fact that the main corms were more pigmented suggests that development of the orange yellow color intensity may be associated with physiological maturity with a darker color developing within older tissue.

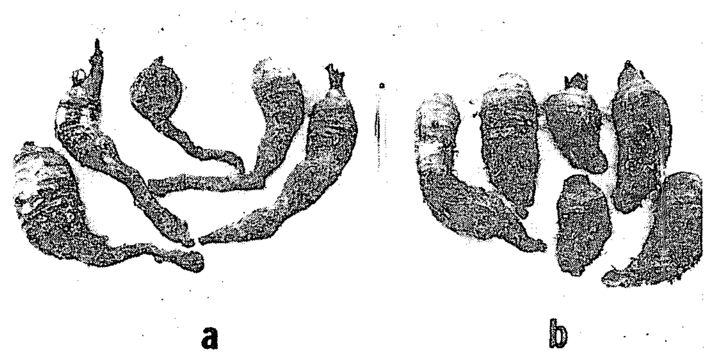

Fig. 4. Cormels produced from segregating progeny of the cocoyam cross Florida White 40 x Florida Ornamental (a) cormels intermediate in shape, unlike those produced by either parent, resembling swollen rhizomes and (b) cormels intermediate in shape resembling those produced by the Florida White 40 parent.

The clone Florida Yellow produces a large number of cormels but they are small and tend to sprout profusely even while still attached to the parent corm. These factors diminish the market desirability.

The white fleshed selection Florida White was superior in productivity to the selection segregate Florida White 40. In spite of this advantage we found it necessary to use Florida White 40 as a female parent in this particular cross because of the absence of mature inflorescences in Florida White at the time of pollen availability in the Florida Ornamental clone. The application of growth hormones, as some researchers have done, promotes floral induction and increases the success of scheduled crosses on these protogynous plants.

The use in this study of a yellow-fleshed cocoyam selection and a rhizome-producing selection made it possible to study the nature of inheritance of cormel color and type. Based on these results, both traits appear to be conditioned by multiple genetic factors which are quantitative in effect. The fact that plant types resembling the parents in cormel color and shape were recovered in relatively few progeny suggests that the genetic factors conditioning these traits could approximate four gene units, assuming no epistasis or dominance (2). The same estimated number of gene units may control plant height in the Florida Ornamental, Florida Yellow and Florida White parents.

Attempts to cross the selections described in this report

Table 2. The means and standard deviation for plant height, cormel weight and cormel number of *Xanthosoma* sp. parents and hybrids.

Plant population	Plant height (cm)		Cormel wt. (g)		Cormel number	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Florida White	85.2	7.9	913.0	138	5.1	1.2
Florida White 40	79.5	10.6	867.0	164	5.8	1.1
Florida White 40 x Florida Ornamental	112.8	11.2	811.0	442	19.6	8.7
Florida White x Florida Yellow	63.5	15.5	370.8	212	11.6	6.7
Florida Yellow	59.6	8.8	424.0	61	6.9	1.8
Florida Ornamental	114.3	9.4	—	—	—	—

with a field-grown selection of *X. violaceum* Schott. met with little success. *X. violaceum* produces a very robust plant, a moderate amount of very pale violet-fleshed cormels similar in size to those of Florida White and an abundance of inflorescences. Pollen production however is very limited under local conditions. Since hybridization attempts using *X. violaceum* as the pollen donor or as the female parent have failed to produce viable seeds it is possible that this species is more distantly related or that incompatability mechanisms are present.

A wide range of genetic diversity has been demonstrated in this investigation. Since there appears to be several genes involved in the traits evaluated it would be possible to identify and propagate new clones that have the best traits of both parents. In other studies, cocoyam seedlings produced from crosses of Nigerian-grown parents cultivars appeared to vary in susceptibility to Dasheen Mosaic Virus (DMV) (18). It is possible that genes for resistance to this and other threatening diseases are present in *Xanthosoma sp.* and through hybridization resistant genotypes can be selected.

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EFFECT OF FERTILIZER LEVELS AND SEED SIZE ON GREEN POD YIELD OF WINGED BEAN, PSOPHOCARPUS TETRAGONOLOBUS (L.) DC.[1]

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Additional index words. seedling growth, full bed mulch, dry matter content, elemental concentration.

Abstract. **Winged bean accession 'TPt-1' was grown in the fall of 1980 on raised mulched beds at a density of 9080 plants/ha at 3 fertilizer levels from 3 sizes of seeds. Fertilizer levels were 1x, 1.5x and 2x. Seed diameters were: small, 6.85-7.8; medium, 7.8-8.5; and large, > 8.5 mm. The 1x fertilizer level was 40 N, 40 P_2O_5 and 40 K_2O kg/ha. Fertilizer levels had no significant effect on number of pods per plant or on total yield. Seed size significantly affected seedling growth, number of pods per plant and total yield. Seedlings from large seeds reached transplant stage earlier and had a greater fresh weight and a higher dry matter content than transplants from medium and small seeds. Plants grown from small, medium and large seeds had 73, 85 and 98 pods per plant and yielded 3.26, 3.90 and 4.54 MT/ha, respectively. The interaction of fertilizer levels with seed size resulted in a higher percent of early yield at the 1.5x and 2x fertilizer treatments with large size seeds. Elemental concentration in plant tissues was not affected by fertilizer levels or seed size.**

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The importance of seed size and weight on emergence, growth, maturity and yield has been demonstrated on several vegetable crops. Tompkins (9) found that broccoli plants produced from large seeds were heavier and had higher early yields of center heads than plants from small seeds. Alam and Locascio (1) found earlier seed germination and faster emergence from large size broccoli and bean seeds. Large seeds produced taller and heavier seedlings than small seeds. Wester (10) found greater seedling size, higher plant fresh weight and larger number of pods per plant in lima beans grown from large seeds than from small seeds. Cameron et al. (2), found more vigorous sweet corn seedling growth and earlier ear maturity with large size seeds. With lettuce, Smith et al. (7) found greater seed vigor with heavier seeds. Plants grown from more vigorous seeds had a longer head size and a greater percent of marketable heads (8). Experimenting with onions, Hatridge-Esh and Bennett (5) found that seed size did not affect bulb dry weight or fresh weight of bulbs. Bulbs from large seed, however, had an earlier collapse of stems than bulbs grown from small seed.