Promotion of Flowering and Production of Seed in Cocoyam *(Xanthosoma* and *Colocasia)*

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Abstract

The improvement of cocoyam (*Xanthosoma* and *Colocasia*) through sexual propagation has become possible with the development of techniques for promotion of flowering, hand pollination, and production of seed and seedlings. Gibberellic acid (GA_3) at 500, 1000 and 1500 ppm promoted flowering with 1500 ppm giving the best result in terms of number of plants flowering and number of inflorescences per plant.

Introduction

The cocoyams *Xanthosoma sagittifolium* (L.) Schott and *Colocasia esculenta* (L.) Schott are grown throughout West Africa and are economically important in Cameroon, Ghana and Gabon where the corms or cormels and leaves are eaten. However, improvement of these crops through conventional breeding has been neglected because hybridization has been difficult and consequently, seed has not been available.

Xanthosoma and *Colocasia* are traditionally vegetatively propagated. In West Africa, they flower only sporadically, generally under conditions of high fertility and when plants have been left undisturbed for more than one year. This natural flowering is not profuse or predictable enough for breeding purposes and naturally set seed has not been found. Therefore, a method of inducing uniform and abundant flowering in a reasonable time is required. Also needed are methods for hand pollination, seed germination and seedling establishment to facilitate the production of hybrid seedling populations which would form the basis of a breeding program.

Kikuta *et al* (1938), Shaw (1975), Jackson *et al* (1977), Jos and Bai (1977) and others have reported growing *Colocasia esculenta* from naturally pollinated seed, and Volin and Zettler (1976) reported the production of seed in *Xanthosoma caracu* using hand pollination.

McDavid and Alamu (1976) and Alamu and McDavid (1978a, 1978b) have reported the use of preplating soaks and foliar sprays of gibberellic acid to promote flowering in *Xanthosoma sagittifolium* and *Colocasia esculenta* plants grown in containers.

Natural flowering in *Xanthosoma sagittifolium* and *Colocasia esculenta* and infrequent seed set following artificial pollination of *Colocasia* have been reported in Nigeria (IITA, 1976) and success in promoting flowering of *Colocasia* and *Xanthosoma* using 1,000 ppm gibberellic acid has also been reported (IITA, 1977).

The present study was conducted to further investigate the use of gibberellic acid

in promoting flowering in West Africa cocoyam cultivars grown under field conditions and to perfect methods of artificial pollination, seed germination and seedling establishment.

Materials and Methods

Two accessions of *Xanthosoma sagittifolium* and 17 accessions of *Colocasia esculenta* representing three distinct morphological types (*Colocasia* 1, *Colocasia* 2, and *Colocasia* 3) were grown in the field from head setts planted in late March near Ibadan, Nigeria. Plants were spaced 1.5 x 1.5 m and to insure vigorous growth were fertilized in May at the rate of 50 kg N/ha, 50 kg P/ha and 40 kg K_2O/ha. A split plot design with accessions as the main plots and with four single plant replications was used.

Plants were treated with foliar applications of aqueous solutions of the potassium salt of Gibberellic Acid (GA_3) at the concentrations of 0, 500, 1000, and 1500 ppm. These were applied with surfactant (0.01% by volume) using a hand sprayer. Water with surfactant was used as control. The chemicals were applied one time at the 3-5 leaf stage. About 20 ml was applied to each plant so that most of the liquid accumulated in the cup formed by the petiole bases. Observations on flowering were recorded weekly and continued for 120 days after the appearance of the first inflorescence when the onset of the dry season terminated the experiment.

Using the large number of inflorescences which resulted from the GA treatments, hand pollinations were made within clones and between clones. The pollination procedure was similar to that described by Volin and Zettler (1976). The unpollinated controls were not bagged to exclude insects. Mature fruits were harvested 50-60 days after pollinating and seeds were extracted by washing. Seeds were surface sterilized for 5 minutes in 20% chlorox and germinated at 25-28°C with 12-hour light on either water agar, nutrient agar or dilute soil agar in small screw top bottles or in Petri dishes. Nutrient agar was made with Murashige and Skoog medium (Murashige and Skoog, 1962) containing vitamins as in B5 medium (Gamborg, *et al* 1968), supplemented with 0.5 ppm benzyl amino purine, 0.1 ppm naphthaleneacetic acid and 200 ppm casein hydrolysate and solidified with 7 g agar/l. Dilute soil agar was made with 50 g soil/l water, decanted, and 7 g agar/l. Seedlings were transplanted first into "jiffy-7" pellets in the screenhouse and later into the field.

Results and Discussion

Promotion of flowering. For the purpose of data analysis, the results for *Colocasia* have been pooled according to morphological groups with 9 accessions making up *Colocasia* 1, seven accessions in *Colocasia* 2, and a single accession in *Colocasia* 3. All of the accessions in any one group appeared to belong to one clone. Data are given for only one accession of *Xanthosoma* since the growth of the second accession was limited by a disorder which severely reduced the production of normal leaves and flowers.

The percent flowering plants was significantly increased by GA (Fig. 1). Generally, increasing concentrations resulted in increasing numbers of plants flowering, with 1500

ppm giving the highest percentage flowering.

GA-treated plants produced significantly more inflorescences (spadices) than untreated plants (Fig. 2). Except for *Colocasia* 3, increasing concentrations of GA resulted in increasing numbers of inflorescences/plant. Note that the 1500 ppm GA treatment increased the mean number of inflorescences/plant by 1, 3.5, 5 and 12 fold over the control for *Colocasia* 1, 2, 3 and *Xanthosoma*, respectively.

Mean number of days from treatment to first spadix are given in Table 1. Generally, GA-treated plants flowered earlier than the controls, but there were no significant differences between GA concentrations. In *Colocasia* 1 GA-treated plants flowered about 30 days earlier than the control. Untreated plants of *Colocasia* 2 did not flower, whereas treated plants flowered in less than 77 days. In *Colocasia* 3 no difference was observed in time of flowering between treated and untreated plants. This clone flowers naturally much more frequently than other clones and does not respond consistently to GA. In *Xanthosoma* GA reduced time to flowering by more than 100 days.

Various GA-induced deformities were observed. In *Colocasia*, these included flower-like traits in floral bracts and on leaves similar to those described by Alamu and McDavid (1978a) and in *Xanthosoma* doubled or branched spadices were observed. The frequencies of these deformities varied between accessions and generally was increased as GA concentrations increased, the 1500 ppm treatment being the highest.

For the clones used in this study 1500 ppm GA was significantly more effective in promoting flowers than lower concentrations. However, 1500 ppm result in frequent floral deformities and subsequent experiments with additional clones and with seedlings suggest that this concentration may be too high in many cases, and that 1000 ppm may be more appropriate for a larger range of genotypes.

Hand pollinations. In *Colocasia*, only 2% of the pollinations produced viable seeds. Additional work is required to improve the probability of success. In *Xanthosoma*, 37% of the pollinations within a clone and 50% of the pollinations between clones were successful (Table 2) and more than 8,000 seeds were harvested. No seeds developed on the unpollinated controls. In *Colocasia*, successful pollinations were made the same way as pollen shed and pollination within a spadix was possible. In contrast, *Xanthosoma* displayed protogeny with the female flowers of a spadix generally receptive 2-4 days before pollen shed.

Seed germination and seedling establishment. In terms of percent germination and convenience of handling large numbers of seed, the dilute soil agar in Petri dishes gave the best results. Germination began 7 days after sowing and seedlings were ready for transplanting into "jiffy-7" pellets 14-21 days after sowing. They were large enough to be transplanted into the field after growing in the screenhouse for 50-60 days. Germination was more than 50% and there was no apparent seed dormancy. Albino seedlings were frequently observed, making up 3-30% of the seedlings, with the higher frequencies in the progenies from pollinations within clones. Establishment of normal seedlings in the screenhouse and field was nearly 100% although development was slow and seedlings showed variability for vigor at an early age.

The results of this study indicate that under field conditions GA can successfully induce numerous inflorescences in predictable time in both *Xanthosoma* and *Colocasia*. In *Xanthosoma*, the inflorescences produced can be successfully pollinated to produce large quantities of viable seeds from which seedling populations can be established.

Thus, the availability of techniques for controlling all steps of sexual propagation permit the establishment of a breeding program for the genetic improvement of cocoyam.

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Table 1. The effects of GA treatments on the mean number of days from treatment to first spadix in cocoyam

GA Conc. (ppm)	Colocasia 1	Colocasia 2	Colocasia 3	Xanthosoma
0	148	NF[1]	71	193
500	116	77	66	81
1000	119	73	71	90
1500	106	73	72	88

[1]No flowers produced.

Table 2. Percent seed set resulting from artificial pollinations in cocoyam, *Colocasia* and *Xanthosoma*

	Spadices Pollinated	Spadices Seed Set	% Spadices Seed Set
Colocasia			
Pollinations within clones	82	2	2.4
Pollinations between clones	16	0	0.0
Total pollinations	98	2	2.0
Unpollinated controls	20	0	0.0
Xanthosoma			
Pollinations within clones	62	23	37.1
Pollinations between clones	6	3	50.0
Total pollinations	68	26	38.2
Unpollinated controls	15	0	0.0