Preliminary Evaluation of 14 Puerto Rican and Six Ghanaian Varieties of Cocoyam (*Colocasia* and *Xanthosoma* Spp) Under Ghanaian Conditions

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Abstract

Fourteen Puerto Rican and six Ghanaian varieties of cocoyam (*Colocasia* and *Xanthosoma* spp) were evaluated. One Puerto Rican variety, *Xanthosoma brasiliensis* was extremely susceptible to cocoyam root rot, and so not suitable to be introduced in Ghana. The best varieties in terms of yield were *Mankani antwibo,* Chorbutton, *Mankani pa, Mankani fufuo,* Bisley and *Mankani fitaa,* yielding over 10 t/ha. Under mulching, all varieties tended to exceed the vigor and subsequently the yield of their unmulched counterpart. Mulching also activated a soil environment favorable for suppression of cocoyam root rot, a disease suspected to be caused by a bacteria.

Introduction

In Ghana and many parts of West Africa, starchy staples form the basic carbohydrate foods. These staples include plantains, cereals, and root crops. When cereals and plantains are in short supply as they often are, root crops provide the main sources of starch. These root crops include cocoyams, cassava and yams. Of the three, cocoyam is by far the most important root crop, as it stores better, and is available in reasonable quantities throughout the year. In terms of production, cocoyam comes first among the root crops, and in total acreage it is second to cassava (Tables 1 and 2). It forms an integral part of the cropping system (Table 3).

A large quantity of cocoyam produce goes into the export market. Almost the entire production comes from the forest zones of Ashanti and Southern Ghana. None is produced in the Northern Savannas. Acreage of production of various crops have increased tremendously recently (Doku 1966) and cocoyams are not likely to be an exception. Though the figures referred to in Tables 1, 2 and 3 may not be correct now, there is reason to believe that as with other crops, the same percentages in terms of acreage and yield have been maintained.

Six varieties of cocoyams have been identified in Ghana. These are made up of two varieties of the "old" cocoyam *Colocasia* (Twi = Kooko West Indies Eddo or Dasheen) and four varieties of the "new" cocoyam, *Xanthosoma* (Twi = Mankani, West Indies = Tania). There is evidence that the "old" cocoyam is indigenous to West Africa while the "new" cocoyam was introduced from the West Indies in 1843 (Wright 1930 a, Doku 1966, Karikari 1971). The varieties of the "old" cocoyam are namely *Mankani brobe* and *Mankani antwibo* while the "new" cocoyams are namely *Mankani pa Mankani fufuo, Mankani fitaa* and *Mankani serwaah.* Between the "old" and "new" varieties of cocoyam, there is not much distinction except that the *Colocasia* cocoyam have peltate

leaves while the leaves of *Xanthosoma* are sagitate.

Cocoyams are planted on newly cleared farm lands, and for good growth particularly during the dry season it is necessary that the plants be mulched. The Ghanaian cocoyams do not have much variability. For general agronomic studies on a crop, it is necessary to have variable materials, so that characters which are desirable could be selected and used in a breeding programme.

It was the object of this study therefore to evaluate local Ghanaian and introduced Puerto Rican cocoyams planted under mulching and non-mulching conditions.

Materials and Methods

Fourteen varieties of cocoyams representing the range of cocoyam types in Puerto Rico were obtained through the agency of the FAO in December 1974. These varieties were multiplied for one year, to obtain more corms for the experiment.

The experiment was carried out at the University of Ghana, Agricultural Research Station, Kade in 1976. The experimental plot which covered an area of 23.9 ha was cultivated to a crop of maize in the previous year. The area was divided into four replications of 97.5 m x 242 m. Each replicate was subdivided into two subplots of 120 m x 97.5 m and each subplot divided into 20 equal plot sizes of 24.5 m thus allowing for 1 m between replications and subplots, and 0.5 m between each subplot. There were 24 experimental plants/variety/subplot spaced 1 m x 1 m but records were kept on the inner 20 plants leaving the four corner plants as guard plants.

The experimental design was a split plot with mulching vs no mulching assigned to the main plots and varieties assigned to the subplots. Planting was done on 21st April 1977. All the varieties germinated 2 weeks after planting and by the third week each variety had obtained two leaves. The plants in the subplots for mulching were each mulched with 120 kilograms of fresh materials of *Pueraria.*

Six local Ghanaian and 14 Puerto Rican varieties of cocoyam were used as planting materials. Planting setts with at least two germinal buds each weighed between 90-100 gms. Before planting, the setts were dipped into 1,000 ppm "Benlate" (Benomyl) fungicide solution.

The names of the varieties of cocoyams and their accession numbers are shown in Table 4.

During growth, weeding was done by hand when necessary. Three months after planting, N (from urea 46% N) was broadcast to all the plots as a basal dressing at the rate of 100 kg/ha.

Records of percentage germination, vigor of the plants at 10 months of growth as expressed by number of leaves, plant height, and leaf areas (determined by the method of Chapman (1964) were kept. The plants were harvested after 13 months on 21st May 1978. The cormels/corms were dug out; thoroughly washed and the total cormels/corms produced per variety per treatment for each replication was weighed. The cormels/corms for each variety per treatment were examined and scored for infestation by cocoyam root rot. All data were analyzed statistically.

Results

Over 90% germination was observed in all varieties except *Xanthosoma brasiliensis* in which only 60% germination was obtained. In one replication out of 24 stands only 4 germinated. By the third month, an unidentified fungal disease had attacked and killed all stands of *Xanthosoma brasiliensis* in both the muclhed and unmuclhed plots. This vareity was therefore discarded from then on.

Tables 5, 6 and 7 show the vigor of the plants at 10 months expressed by number of leaves, plant height, and leaf areas respectively. Table 8 shows the estimated yield of cormels/corms and Table 9 shows the degree of infestation of cormels/corms at harvest.

Mulching appeared not to have any significant effect on number of leaves produced at 10 months, although the number was higher in mulched plants (12.7) than non-mulched plants (11.3). In all mulched varieties, plants produced more leaves than non-mulched plants (Table 5).

The heights of the plants were also not affected by mulching. Mulched plants reached an average height of 110.4 cm as compared with non-mulched plants of 106.0, but the difference was not significant at 5% level. As was the case with number of leaves, plants height in all varieties was greater in mulched plots than in non-mulched ones. (Table 6).

Mean leaf area per plant was significant ($p = 0.05$) for mulched plants as compared with the non-mulched ones. Among varietal means, significant differences were observed in the treatments except *Mankani brobe* in which the difference was not significant. In the case of this variety non-mulched plants had a higher leaf area than mulched ones. Varieties responded differently to mulching showing significant differences between varieties x mulching treatments (Table 7).

There was a significant influence of mulching on the yield of cormels/corms. Mean differences among cultivars were also significant. While significant responses were observed in the means of varieties at the same mulching treatment, no response was observed among means in varieties of different mulching treatments (Table 8).

Table 9 shows the percentage susceptibility of the cocoyam varieties to root rot. The statistical analysis shows that stands without mulching were significantly more susceptible to the disease than those planted under mulching. This trend was observed in all the varieties except the Puerto Rican varieties which appeared more susceptible to the disease than the Ghanaian ones. *Mankani pa* and *Mankani fufuo* were slightly more resistant to the disease.

Discussion and Conclusion

The number of leaves borne by any cocoyam plant at any one time is the result of two processes: production and loss. Healthy cocoyams normally produce their maximum number of leaves at 10 months of growth, the number falling towards maturity, a time when leaf loss is no longer balanced by leaf production. In the case of the varieties studied, mulching did not have any significant effect on number of leaves. It appeared that the leaves underwent much of its development before emergence. In most of the varieties which flowered, the time of appearance of the last maximum leaf indicated the transformation of the growing point into an inflorescence.

The Puerto Rican varieties produced more leaves than the Ghanaian varieties. Although *Mankani pa* produced the highest number of leaves, the other Ghanaian varieties produced comparatively few leaves with *Mankani brobe* producing the least number of leaves. The varieties from Puerto Rico could thus be more suited for production of *nkontomire* (spinach).

The height attained by the varieties was not significantly affected by mulching. The plants would grow to a maximum height after which time the petioles could no longer support the leaves, and mulching did not appear to improve the strength of the petioles. The Ghanaian varieties were generally much taller than the Puerto Rican ones, and this gave them the advantage of greater exposure to sunlight.

The leaf areas of the Ghanaian varieties were greater than the Puerto Rican ones, and correspondingly the Ghanaian varieties yielded more cormels/corms. The higher exposure to sunlight and the higher leaf areas contributed to the higher yield of the Ghanaian varieties (Table 8). Karikari (1974) has observed a very high linear correlation between leaf area and cormel production in the variety *Mankani pa.* The very high yield obtained in two Ghanaian cocoyams *Mankani brobe* and *Mankani antwibo* was due to the fact that being *Colocasia,* the produce was harvested from corms and not cormels.

The observation of the incidence of root rot disease was very interesting. All the cocoyams were attacked by the disease but the attack was less severe in mulched plants than non-mulched plants. Also the Puerti Rican varieties suffered more severe attack than the Ghanaian ones. In fact one of the Puerto Rican varieties *Xanthosoma brasiliensis* was wiped out completely by the disease when the plants were only 3 months old.

Cocoyam root rot has been observed in Ghana since 1925 (Wright 1930b). The disease takes the form of a wet root rot, wilting of leaves and the inability to form tubers. In severe cases this is followed by death and putrefaction of the entire plants. It may appear at anytime after planting. The causal organism is still not known. However, the author suspects that the primary pathogen might be a bacteria which caused lesions on the roots and rendered the plants susceptible to all sorts of fungal parasites present in the soil. Thus, under conditions of mulching, the microbial environment under the plants reduced the activities of the bacteria and subsequently caused a reduction in infestation by the cocoyam root rot.

References

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Table 1. Estimates of acreages of main staples (thousand acres)

Crops	Northern Territories (now Northern and Upper Regions)	Ashanti (now including Brong-Ahafo)	Colony (now Southern Ghana)		Togoland Ho District (now Volta Region)	Total
			Forest	Non-Forest		
Maize	79.5	66.7	87.0	100.1	21.0	354.3
Millet	432.0	–	–	–	–	432.0
Sorghum	332.5	–	–	–	–	332.5
Rice	20.5	6.5	5.5	–	16.5	49.0
Plantain	–	67.9	231.3	8.6	6.2	314.0
Cassava	1.5	45.7	56.8	92.5	8.2	204.7
Cocoyam	–	45.4	144.9	5.5	4.0	199.8
Yam	59.5	58.4	15.3	6.4	9.4	149.4
Groundnut (seed)	111.5	21.9	–	–	3.5	136.9
Pulses	39.0	–	–	–	–	39.0
	1,076.0	312.5	540.8	213.1	69.2	2,111.6

From Annual Report, Department of Agriculture, Ghana, 1950-51 (1952), p. 23.

Table 2. Estimates of crop production of main staple (thousand tons)

Crops	Northern Territories (now Northern and Upper Regions)	Ashanti (now including Brong-Ahafo)	Colony (now Southern Ghana)		Togoland Ho District (now Volta Region)	Total
			Forest	Non-Forest		
Maize	29.0	33.3	43.6	50.0	10.5	166.4
Millet	97.0	–	–	–	–	97.0
Sorghum	78.0	–	–	–	–	78.0
Rice	9.5	3.0	2.5	–	7.5	22.5
Plantain	–	271.6	925.2	34.6	24.8	1,256.2
Cassava	4.5	119.9	149.1	209.1	21.6	504.2
Cocoyam	–	115.8	369.6	14.1	10.1	509.6
Yam	204.0	175.2	45.7	19.2	29.5	473.6
Groundnut (seed)	22.5	6.0	–	–	–	29.5
Pulses	31.5	–	–	–	–	31.5
	476.0	724.8	1,535.7	327.0	105.0	3,168.5

From Annual Report, Department of Agriculture, Ghana, 1950-51 (1952), p. 23.

Table 3. The location, place in the subsistence economy and relative importance in exports of the principal root crops of Ghana

Crops	Principal growing areas in Ghana	Place in the subsistence economy	Estimates production 1968 (1000 tons)
Cassava	In the forest and coastal thicket and savanna zones. Very occasionally planted elsewhere	Grown principally as staple subsistence crops, but was also increasingly planted for sale	500
Cocoyam	In the forest zone. Also occasionally grown in the coastal thicket subzone		500
Sweet potato	Throughout Ghana, but more commonly cultivated in the interior savanna zone.	A subsistence crop of minor importance	No data
Yam	The principal crop of the interior savanna zone, but grown throughout the country.	A staple subsistence crop, the cultivation of which is becoming commercialized in and near the forest zone	475

Source: Wills, J. B. (1962), 'Agriculture and Land Use in Ghana', p. 392.

Table 4. Varieties of cocoyams used in the experiment

ACC No.	NAME	SOURCE
14795	Barbodes	Puerto Rico
14797	Blanca del Pais	Puerto Rico
14798	Bisley	Puerto Rico
14799	Charanelle	Puerto Rico
14800	Choubutton	Puerto Rico
14902	Drearies	Puerto Rico
14804	Kelly	Puerto Rico
14807	Viquera	Puerto Rico
14808	Vinola	Puerto Rico
14810	Aquadillana	Puerto Rico
14812	Arsenio	Puerto Rico
14813	Los Mesas	Puerto Rico
14814	Rayado Las Mesas	Puerto Rico
14815	Xanthosoma brasiliensis	Puerto Rico
K001	Mankani pa	Kade
K002	Mankani Fufuo	Kade
K003	Mankani fitaa	Kade
K004	Mankani serwaah	Kade
K005	Mankani brobe	Kade
K006	Mankani antwibo	Kade

Table 5. The effect of mulching on the number of leaves at 10 months of growth

Mulching Treatments	VARIETIES																			Mulching Mean
	14795	14797	14798	14799	14800	14902	14804	14807	14808	14810	14812	14813	14814	K001	K002	K003	K004	K005	K006	
									Mulching X Variety											
Non-mulching	8.1	15.9	8.6	13.5	13.9	14.4	12.7	10.2	8.0	7.6	11.5	11.3	9.0	17.7	11.8	12.6	10.9	7.7	9.0	11.3
Mulching	8.4	16.7	10.3	14.1	14.4	16.2	17.9	13.9	8.6	9.2	12.4	16.8	9.6	18.2	12.1	12.9	11.3	8.0	9.4	12.7
Variety Means	8.3	16.3	9.5	13.8	14.2	15.3	15.3	12.1	8.3	8.4	12.0	14.1	9.3	18.0	12.0	12.8	11.1	7.9	9.2	

Between mulching means = 1.6
Among varietal means = 3.2
Among mulching x varietal means: 1) Among means for varieties at the same mulching treatment = 4.1
2) Between means for mulching for the same variety or among means for varieties for different mulching treatment = 4.8

Table 6. The effect of mulching on plant height at 10 months of growth

Mulching Treatment	VARIETIES																		Mulching Mean
	14795	14797	14798	14799	14800	14902	14804	14807	14808	14810	14812	14813	14814	K001	K002	K003	K004	K005	K006	
									Mulching X Variety											
Non-mulching	91.7	126.4	112.3	102.6	121.9	116.5	140.0	109.2	86.4	72.1	88.8	133.0	81.0	140.4	126.6	116.3	84.2	85.1	77.9	105.96
Mulching	100.5	128.9	102.3	112.4	122.2	126.7	135.7	112.6	90.6	80.9	96.8	131.4	92.1	144.6	128.9	120.0	106.3	85.9	78.5	110.4
Variety Means	96.1	127.7	107.3	107.5	122.1	121.6	137.9	110.9	88.5	76.5	92.8	132.2	87.0	142.5	127.8	118.2	95.3	85.5	78.2	

Table 7. Mean leaf areas (dm^2) per plant at 10 months of growth

Mulching Treatment	VARIETIES																			Mulching Mean
	14795	14797	14798	14799	14800	14902	14804	14807	14808	14810	14812	14813	14814	K001	K002	K003	K004	K005	K006	
	Mulching X Variety																			
Non-mulching	1449	2261	1200	2128	2215	2411	1631	2201	1520	1466	1722	1637	1600	1472	1828	1914	1277	1202	1524	1709
Mulching	1626	2674	1241	2400	2477	2526	1727	2009	1764	1683	1946	1844	1662	1624	1890	2020	1331	1214	1726	1872
Variety Means	1538	2468	1221	2264	2346	2469	1679	2105	1642	1575	1834	1741	1631	1546	1859	1967	1304	1206	1624	

LSD(%): Between mulching means = 120.4 Among means = 55.8
Among mulching x varietal means:
1) Among means for varieties ar the same mulching treatment = 62.9
2) Between means for mulching for the same variety or among means for varieties for different mulching treatment = 126.6

Table 8. The effect of mulching on the yield of cocoyams (metric tons per hectare)

Mulching Treatment	VARIETIES																			Mulching Mean
	14795	14797	14798	14799	14800	14902	14804	14807	14808	14810	14812	14813	14814	K001	K002	K003	K004	K005	K006	
	Mulching X Variety																			
Non-mulching	14.1	12.9	12.6	3.1	14.1	3.7	3.0	2.9	2.2	3.5	2.9	2.2	2.0	12.7	11.2	12.7	7.3	16.4	21.9	8.5
Mulching	15.4	14.1	13.0	3.7	15.3	4.2	3.6	4.1	3.2	3.9	4.2	4.8	2.0	14.4	11.9	13.2	9.9	21.7	26.3	9.9
Variety Means	14.8	13.5	12.8	3.4	14.7	4.0	3.3	3.5	2.7	3.7	3.6	3.5	2.0	13.6	11.6	13.0	8.6	19.1	24.1	

LSD(%): Between mulching means = 1.2 Among varietal means = 0
Among mulching x varietal means: 1) Among means for varieties at the same mulching treatment = 2.4
2) Between means for mulching for the same variety for among means for varieties for different mulching treatment = 3.0

Table 9. Percentage infestation of cormels/corms by cocoyam root rot 13 months after planting (transformed angels)

Mulching Treatment	VARIETIES																		Mulching Mean
	14795	14797	14798	14799	14800	14902	14804	14807	14808	14810	14812	14813	14814	K001	K002	K003	K004	K005	K006	
									Mulching X Variety										
Non-mulching	26.6	30.0	28.0	23.0	18.4	18.4	18.4	30.0	32.0	33.2	23.6	30.0	35.1	18.4	20.3	23.6	20.3	23.0	11.5	24.4
Mulching	12.9	18.4	18.4	14.2	11.5	11.5	11.5	26.6	28.0	33.2	11.5	23.6	25.1	11.5	11.5	14.2	14.2	17.5	8.1	17.0
Variety Means	19.8	24.2	23.2	18.6	15.0	15.0	15.0	28.3	30.0	33.0	17.6	26.8	30.1	15.0	15.9	18.0	17.3	20.3	9.8	

LSD(%): Between mulching means = 6.0 Among varietal means = 5.2
Among mulching x varietal means: 1) Among means for varieties at the same mulching treatment = 11.8
2) Between means for mulching for the same variety or among means for varieties for different mulching treatment = 15.5