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# AROID IMPROVEMENT IN THE EASTERN CARIBBEAN : AN UPDATE OF THE AROID/ARROWROOT PROJECT

*(Amélioration des Aroïdées dans la Caraïbe orientale : Une mise à jour du Projet Aroïdées/Arrow.root)*

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## SUMMARY

The work on aroid improvement from mid-1982 to the present in the English speaking islands of the Eastern Caribbean, was reported. The crops studied were dasheen (*Colocasia esculenta* (L.) Schott var. *esculenta*), eddoe (*Colocasia esculenta* (L.) Schott var. *antiquorum*) and tannia (*Xanthosoma* spp. Schott) Research and Development work based on constraints identified in CARDI farming systems root crop and aroid production surveys, yielded the following results : description of one hundred (100) aroid cultivars ; the identification of eleven (11) "elite" tannia cultivars ; the selection of three (3) tannia hybrids ; the development of systems for the multiplication of "clean" tannia plants ; the description of the "tannia root rot disease", its cause and methods for its management. An improved package of practices for tannia production was tested and the shelf-life of dasheen corms was prolonged to over four (4) weeks. Recommendations for further work in the major activities are made.

## RESUME

*Les travaux pour l'amélioration des aroïdées de la mi-1982 à aujourd'hui, dans les îles anglophones de la Caraïbe orientale, ont été présentés. Les cultures suivantes ont été étudiées : dachine ( Colocasia esculenta (L) Schoot var. esculenta), madère graine (C. esculenta (L.) Schott var. antiquorum) et Malanga (Xanthosoma spp. Schott). Les travaux de recherche et d'application basés sur des enquêtes de production du CARDI sur les systèmes d'exploitation des plantes à tubercules, ont conduit aux résultats suivants : description de cent cultivars d'aroïdées ; identification de onze cultivars "élite" de malanga ; sélection de trois hybrides de malanga ; le développement de systèmes de multiplication de plants "sains" de malanga ; la description de la "maladie*

*de la pourriture des racines du malanga", ses causes et les méthodes de lutte. Un ensemble de pratiques améliorées pour la production du malanga a été testé et la durée de conservation des récoltes de dachine a été portée à quatre semaines. Nous présentons des recommendations pour de futures recherches dans les principaux domaines.*

## INTRODUCTION

The edible aroids (*Colocasia* spp and *Xanthosoma* spp : Fam ARACEAE) are a traditional staple food for the people of the Eastern Caribbean Islands. Tannia (*Xanthosoma* spp), dasheen (*Colocasia esculenta* var. *esculenta*) and eddoes (*Colocasia esculenta* var. *antiquorum*) are the principal edible aroids grown. Banana or tree crop based production systems predominate on small subsistence farms. Pure stands are rare. Over the past decade there was a trend of increasing aroid exports both to the Caribbean Region and the U.K., from the Eastern Caribbean and particularly from Dominica (Table 1).

Table 1. Exports of Aroids and other root crops fromDominica, metric tons.

| Crop/Year | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|
| Dasheen | 217 | 214 | 101 | 107 | 192 | 174 | 331 | 413 |
| Tannia | 227 | 182 | 83 | 55 | 139 | 123 | 174 | 227 |
| Yam | 92 | 63 | 28 | 12 | 27 | 39 | 70 | 91 |
| Sweet potato | 18 | 10 | 6 | 3 | 3 | 3 | 8 | 10 |

Source : Annual Overseas Trade Reports. Central Statistics Office, Roseau.

The aroids covered an estimated area of 2,111 ha (Table 2) in the 1982/83 season with a production of approximately 16,900 metric tons. A low average yield of 8 metric tons/ha was estimated. Using a conservative mean market price of EC$1 per kg, the total annual value of production is EC$16,900,000.00 or US$6M (US$1 = EC$2.75).

Table 2. Area (ha) under Aroid cultivation in 4 Eastern Caribbean Countries, 1982/83

| Country | Dasheen | Eddoes | Tannia | Total |
|---|---|---|---|---|
| Dominica | 850 | - | 553 | 1 403 |
| Grenada | 85 | 4 | 40 | 129 |
| St. Vincent | 109 | 156 | 113 | 378 |
| St. Lucia | 159 | - | 42 | 201 |
| Total | 1 203 | 160 | 748 | 2 111 |

Source : Adams and Pattanjalidial (1983)

However, the yield of marketable dasheen corms, tannia cormels and eddoe cormels are not fully realized due to several factors identified in field surveys (FERGUSON, 1981 ; ADAMS et al., 1983 ; GEORGE et al., 1981). A brief listing of the constraints is a follows :

1. The decline of the tannia production due to the tannia root rot disease ;
2. The short shelf-life of the dasheen ;
3. The high cost of manual labour in weed control ;
4. Haphazard methods used in the selection and production of tannia planting material and the low level production practices ;
5. The low level of productivity of the mixture of genotypes commonly cultivated ;

6. The unfavourable post-harvest handling increased losses and reduced consumer acceptability particularly in the budding export trade ;

7. The neglect of the eddoe crop in most of the islands (except St. Vincent) ;

8. The absence of any clear and effective plant fertilization recommandations and practices except in the case of dasheen ; and

9. The absence of any information on varietal description and evaluation (except for the dasheen in Dominica).

The task of studying the edible Aroids, with the general objective of improving the industry, was undertaken by the CARDI/EDF sub-Project (within Project n° 5100.33.94.041) entitled "Increased Production of Aroids (Tannia, Dasheen, Eddoe) and Arrowroot in the Eastern Caribbean". The work, begun in September 1982, was funded by the European Development Fund (EDF) and implemented by the Caribbean Agricultural Research and Development Institute (CARDI). The sub-Project islands were Dominica, St. Lucia, St. vincent and Grenada.

The specific reference of the sub-Project was to increase tannia production by managing the tannia burning disease hereafter referred to as tannia root rot disease and increasing the shelf life of the aroids. Tannia root rot disease accounts for 65 and 80 per cent loss in production in Dominica and St. Lucia, respectively.

The sub-Project then adopted a four-way approach to the problem as follows (Figure 1) :

- Genetic Improvement
- Agronomic Improvement
- Pathological Studies and
- Post-harvest Studies

## METHODOLOGY

- Tannia, dasheen and eddoe cultivars were collected in each of the four countries (Table 2) and national germplasms evaluated over two years. A regional tannia collection was maintained and observed in Trinidad. The information recorded is being formulated to produce a reliable list of TANNIA DESCRIPTORS (Figure 1).

Hybrid plants, from seeds produced in the University of Florida, The University of the West Indies and the International Institute for Tropical Agriculture (IITA) in Nigeria,

Fig. 1 : The methodology of the aroid improvement project as described by an activity flow chart

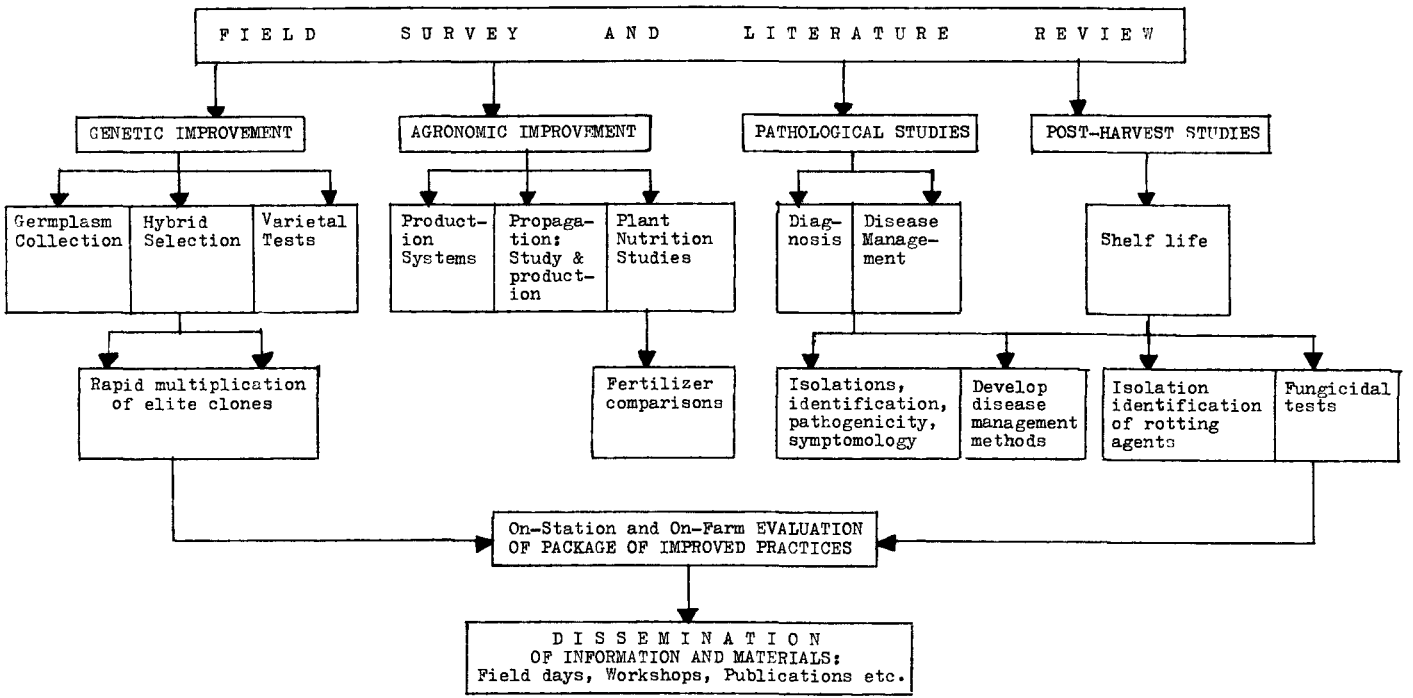

Table 3. Dasheen and eddoe (Colocasia) cultivars and their main characters in some Eastern Caribbean islands

| Island<br>Cultivar name | Maturity Range (months) | Petiole Colour | Raw corn flesh colour | Consumer Acceptability |
|---|---|---|---|---|
| Dominica | | | | |
| Dasheen Soufe | 9 | purple | yellow | very good |
| Dasheen Noir | 8 - 9 | striped (pink-purple -black) | pink | very good |
| Dasheen Common | 8 - 9 | dark green | white | very good |
| Dasheen Blanc | 7 - 9 | cream & purple | white | good |
| St-Lucia | | | | |
| Dasheen Purple | 8 - 9 | purple | purple | very good |
| Dasheen White | 8 - 9 | white | white | very good |
| Dasheen Green | 8 - 9 | green | white | good |
| St- Vincent | | | | |
| Common White Dasheen | 7 - 9 | white | white | fair |
| Common Black Dasheen | 8 - 9 | purple | bluish | fair |
| Pink Dasheen | 8 - 9 | pink | pink | fair |
| Common White Eddoe | 5 - 6 | white | white | fair |
| Common Black Eddoe | 6 - 7 | purple | bluish | fair |
| Nut Eddoe | 5 - 6 | green | white | fair |
| Grenada | | | | |
| Black Dasheen | 7 - 9 | black | bluish | fair |
| White Dasheen | 7 - 9 | green | white | very good |
| Blue Dasheen | 7 - 9 | bluish | white | fair |
| Chinee Nut Eddoe | 5 - 6 | green | white | very good |

Eleven 'elite' tannia cultivars of the region were identified (Table 4) and described

Table 4. Elite Tannia (Xanthosoma) Cultivars of the Eastern Caribbean and their Main Characters

| Island & Cultivar name | Cormel Skin Texture | Cormel Flesh Colour | Petiole Colour | Productivity | Suckering (+, 0) |
|---|---|---|---|---|---|
| Dominica | | | | | |
| Bruce | smooth | white | green | high | 0 |
| St. Lucia | smooth | pink | purple | high | 0 |
| St. Lucia | | | | | |
| Jamaica | smooth | pink | purple | high | 0 |
| Bruce | smooth | white | green | high | 0 |
| Grenada | | | | | |
| Marblay | smooth | pink | light purple | high | 0 |
| John Swift | mildly rough | purple | purple | high | 0 |
| St. Vincent | | | | | |
| Red Seed | smooth | pink | purple | high | 0 |
| Barbados White | smooth | white | green | high | 0 |
| Trinidad | | | | | |
| Viquiera | rough | white | light green | high | + |
| Bagatelle | mildly rough | white | light green | high | + |
| Deer Horn | smooth | pink | light purple | medium | 0 |

were subjected to selection pressure to identify clones resistant to the tannia disease under field conditions at two locations.

The most acceptable "elite" tannia cultivars were compared in each country trials with the aim of identifying the highest yielders with the highest general adaptability.

- Agronomic Improvement

Crop mixes including bananas, plantains, beans and vegetables were evaluated with the specific objective of measuring their influence on the tannia root rot disease.

Eight types of tannia planting material were compared to observe their effect on the rate of plant growth and its ability to resist or tolerate the disease.

An "improved package of practices" (TANNIA TEK PAK) was formulated from root crop and tannia production system surveys for testing at 7 field locations.

Leaf samples of tannia and dasheen from six aroid ecozones within the 4 countries were collected for DRIS analyses by the University of Florida, IFAS. The DRIS method determines optimum nutrient status of tannia and dasheen.

- Pathological Studies

The causal agent, symptoms, development, spread and management of the tannia root rot disease were investigated.

- Post-harvest Studies

In Dominica, the causal agents of the dasheen corm rots and appropriate fungicidal treatments to prevent rot at ambient conditions, were studied. Post-harvest methods in handling eddoes and tannia were initiated in St. Vincent with the aim of enhancing consumer acceptability, reducing losses and prolonging shelf life.

## RESULTS AND DISCUSSION

The results achieved in the areas of genetic improvement, agronomic improvement, pathological studies and post-harvest studies are summarised and presented below.

- Genetics

One hundred aroid accessions were collected and maintained in germplasm collections in five islands. The different clones were described and "Agronomist/Breeder's" tannia descriptor was developed (Figure 2). Some of the aroid cultivars are listed in Tables 3 & 4.

Three (3) hybrid tannia clones selected from one hundred and sixty seedlings survived harsh environmental field conditions and the selection pressure for root rot disease, yield and general adaptability (Table 5) over three generations.

Table 5. Hybrid Tannia Selected in Dominica

| Clone No. | Plant height (cm) | *Marketable cormels | | Total Number of cromels | Cormel skin texture | Cormel flesh colour | Consumer acceptability |
|---|---|---|---|---|---|---|---|
| | | No. | kg | | | | |
| H-31-15/2 | 75 | 11 | 3.18 | 18 | smooth | pink | good |
| H-31-25 | 80 | 11 | 2.8 | 12 | smooth | pink | good |
| H-31-27 | 52 | 13 | 1.0 | 13 | smooth | white | good |

* harvested at 8 months

- Agronomy

Intercropping of tannia with bananas and beans (Table 6a) or plantains (Table 6b) had no effect on the tannia root rot disease.

Fig. 2 : Tannia descriptors developed for Agronomists/Breeders

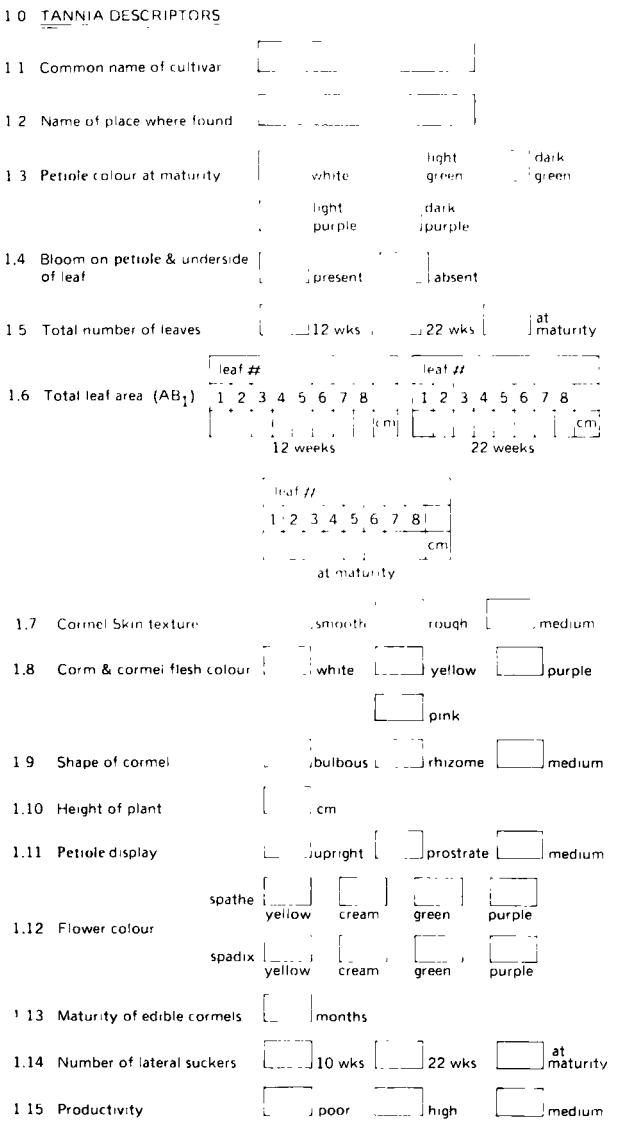

Table 6a Effect of banana intercropping on incidence of root rot disease on tannia cvs Rabess and St. Lucia

| Treatment | Tannia root rot score (0-4) | | |
|---|---|---|---|
| | Cv Rabess | Cv St. Lucia | Mean |
| Banana (2.5m x 2.5m) + tannia + beans | 3.45 | 2.85 | 3.15 |
| Tannia + beans | 3.70 | 3.35 | 3.52 |
| Tannia (control) | 3.40 | 3.30 | 3.35 |
| Banana (3.75m x 3.75m) + tannia + beans | 3.45 | 3.04 | 3.25 |
| Mean | 3.50** | 3.14** | |

$LSD_{0.01}$ = 0.33 treatment means

$LSD_{0.05}$ = 0.24 treatment means

Table 6b Effect of intercropping plantain on tannia root rot

| Treatment | Mean root rot score* |
|---|---|
| Tannia cv Rabess | 2.97 |
| Tannia + plantain | 2.72 |

* 0-4 = nil - severe

Comparative tests on types of tannia planting material showed that headsetts, lateral suckers and pre-sprouted bits of corm and cormels produced the best early crop growth (Table 7). There was no significant difference between the effects of planting material type on the tannia root rot disease.

*Table 7. Effects of planting material on early growth parameters and incidence of tannia root rot disease

| Kind of planting Material | Number of leaves per plant | | Plant height (cm) | | Leaf Area ($cm^2$) | | Root rot |
|---|---|---|---|---|---|---|---|
| | 5% | 1% | 5% | 1% | 5% | 1% | |
| Head setts | $1.84^{abc}$ | ab | $32.48^{a}$ | a | $392.63^{a}$ | a | 3.86 |
| Lateral suckers | $2.10^{ab}$ | ab | $25.00^{ab}$ | ab | $253.25^{ab}$ | ab | 3.89 |
| Sprouted bits (top corm) | $1.85^{abc}$ | ab | $24.20^{ab}$ | ab | $220.38^{abcde}$ | abcde | 3.99 |
| Sprouted bits (bottom corm) | $1.89^{abc}$ | ab | $27.06^{ab}$ | a | $239.88^{abcde}$ | abcde | 3.90 |
| Unsprouted bits (top corm) | $0.95^{cd}$ | bc | $17.26^{abc}$ | ab | $15.63^{f}$ | e | 3.91 |
| Unsprouted bits (bottom corm) | $1.05^{bcd}$ | abc | $15.28^{bc}$ | ab | $80.13^{e}$ | bcde | 3.78 |
| Cormels (sprouted) | $2.43^{a}$ | a | $26.46^{ab}$ | ab | $240.97^{abc}$ | abc | 3.94 |
| Cormels (unsprouted) | $0.38^{d}$ | d | $6.01^{c}$ | b | $1.16 \times 10^{-9}$ | | 3.75 |

* Duncan Multiple Range Test : Values followed by the same letters are not significantly different.

A technique for the rapid multiplication of elite tannia clones was successfully tested and made fully operational in Grenada. This planting material production system utilised a screenhouse equipped with bins for growth media and a mist irrigator. This seedlings are then moved to a hardening nursery from where they are distributed to farmers. The essential considerations of this technique are the selection of disease free parent plants, breaking the dormancy of the corm and cormel bits, sterilising planting material

and media and the maintenance of high humidity for rapid initial growth. Routine checks are made for signs of abnormal plants and diseases. Rigorous roguing and desinfection are also very important. The throughput of the system is 10,000 plants per 20 weeks.

Secondly, corm bits and cormels from healthy parent plants were sprouted in a mixture of 2 peat : 1 vermiculite (V/V) under high humidity and high temperature for 18 hours followed by ambient conditions for 72-96 hours. This method has an advantage of short term production by the farmers themselves.

The shoot-tip meristem culture technique was successful using the Murashige and Skoog basal media and growth hormones to provide healthy seedlings excised from elite genotypes. On the longterm, the tissue culture laboratory, in Dominica, with its screenhouse and nursery for hardening of plantlets, will supply clean stocks of tannia for multiplication by the propagation centres throughout the islands. The movement of the vegetatively propagated aroids between countries will be made secure against the spread of diseases and pests.

The field test of the package of production practices showed that the management of the tannia root rot disease was achieved in 3 out of 7 field locations with a satisfactory yield of 4.2 kg/plant from 8 months old cv Rabess. The main points of disease management were as follows :

1. Use of clean and vigorous planting material

2. Good drainage of soil

3. Treatment of planting material and rhizosphere with an anti-Pythium fungicide (metalaxyl) and

4. Adequate plant nutrition.

The time of planting, rainfall and water-table were among some other factors that apparently differed between the tannia plots that produced tannia and those with high disease.

An improved package of tannia production techniques, has been compiled. This information is, in effect, a synthesis of the results generated by the separate activities. the importance of the improved package of practices lies in its immediate applicability to farmer production, in those eco-zones where rainfall is enough but not too much and where vigorous plants are available.

The DRIS analysis with fertilizer trials will further enhance the total production process of tannia, dasheen and eddoe.

- Pathology

Extensive field observations and precise experiments helped in the description of the tannia root rot disease. Four associated pathogens were isolated. *Pythium myriotylum* Dreschsl was found to be capable of inciting tannia root rot and leaf yellowing when compared to *Phythium splendens* Brown, *Rhizoctonia solani* Kuhn, *Fusarium solani* Sacc. and *Ceratobasidium cornigerum* (Bourdot) Rogers. The pathogenicity of *Pythium myriotylum* was further substantiated by the efficacy of metalaxyl (an anti-*Pythium* fungicide) in preventing any root rot for up to 42 days in greenhouse studies and reduced root rot in field conditions. However, besides rotting of the roots due to *Pythium myriotylum*, the above ground symptoms on the leaves were only a rapid yellowing of successive leaves, as if it were a toxin induced process. Neither bacterial spots/marginal necrosis of leaves (BERNIAC, 1974 and LAGUNA et al., 1983) nor classical symptoms of mineral deficiencies of Tannia (SPENCE and AHMAD, 1967) were observed in plants inoculated with *Pythium myriotylum*. In the field, root rot affected plants may have mild incidence of bacterial spots and marginal necroses.

In both greenhouse and field studies, the tannia root rot was found to be initiated as early as the twelfth day after planting, the number of rotted roots coupled with yellowing of leaves, dramatically increased.

Infested planting material coupled with poor drainage were consistently observed to contribute to the spread and development of the tannia root rot disease. Severely diseased tannia fields were always associated with these two factors.

- Post harvest Studies

The main rotting agents of dasheen corms were indentified as *Pythium splendens*, Brown and *Botryodiplodia theobromae*. The fungicidal dip, consisting of a mixture of metalaxyl and benomyl, prevented the corm rot. The treatment of dasheen corms prolonged the shelf life to over 4 weeks (Table 8).

Indications are that permissible residue levels are obtained after 3 weeks and therefore this method allows for ease of harvest, transportation and storage until marketing day. Lower levels of metalaxyl may even reduce the duration of storage before market.

Table 8. Effect of fungicides on dasheen corm rot

| Treatment | ROTTING DISEASE INDICES | |
|---|---|---|
| | 4 weeks | 6 weeks |
| Control | 62.90 | 72.55 |
| 250 ppm metalaxyl[1] 550 ppm + benomyl[2] | 28.77[a] | 37.81[b] |
| 500 ppm metalaxyl 500 ppm+ benomyl | 27.87[a] | 37.92[b] |

[a] significantly different from cotrol LSD $_{0.01}$ = 6.35

[b] significantly different from control LSD $_{0.01}$ = 12.19

[1] metalaxyl from Ridomil M758 containing 10% a.i.

[2] benomyl from Benlate WP50 containing 50% a.I

## CONCLUSIONS

The 17 Colocasia (Dasheen and eddoe) cultivars needs to be further investigated for productivity and storage characters since they are naturally adapted to this region.

The eleven elite tannia cultivars and three hybrid clones identified should be further tested for resistance or tolerance to high disease pressure as is obtained in Dominica and St. Lucia. The cultivars or clones with smooth skin and pink/white flesh should be studied for general consumer acceptability in both overseas and regional markets before large scale multiplication of clones is planned.

Since the improved production practices : clean and vigorous planting material, good drainage, treatment of planting material and adequate plant nutrition has been successful in 3 out of 7 differing field situations, further work on refining the improved production practices applicable to the important ecozones in each island should be done.

The techniques for rapid multiplication of healthy parent material either under mist propagation, high temperature/high humidity and shoot tip meristem culture technique should be examined where relevant for replication and direct application to farmer or government nurseries in the region. In addition this method is applicable to some ornamentals or food crops for export.

The successful use of metalaxyl (Ridomil M7 58) with benomyl (Benlate WP 50), respectively, in preventing dasheen corm rot up to 4 weeks should be extended to the other countries in the region, subject to acceptable residue levels.

Since chemical and agronomic management of the disease is a short and medium term solution and further that the elite clones within this region have been identified, it is recognised that a programme of hybridization and selection for resistance would yield a lower cost and more lasting solution to the tannia root rot disease.

## FUTURE WORK

This will be firstly directed to the extension agents and farmers through demonstration plots, field days, radio programmes and farmer bulletins. Clean stock of tannia and eddoes will be supplied to farmers via state propagation centres.

It is hoped that a Phase II of the present Project will be approved by a donor agency to make the full impact of the results felt on farms.

Increased attention is being placed on marketing and processing of the Aroids in the region.

The breeding and selection of improved cultivars are required to provide resistance to diseases and increase productivity over the longterm.

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