JOINT PROCEEDINGS

TROPICAL REGION

21st Annual Meeting of the Caribbean Food Crops Society and 32nd Annual Meeting of the American Society for Horticultural Science — Tropical Region

technology for agricultural development

Hilton Hotel, Port of Spain, Trinidad
8 - 13 September 1985

Host Institutions

— Caribbean Agricultural Research and Development Institute

— Ministry of Agriculture, Lands and Food Production, Trinidad & Tobago

— Faculty of Agriculture, University of the West Indies

Published by the Caribbean Food Crops Society, Box 506, Isabela, Puerto Rico 00662

AN APPROACH TO THE INTEGRATED MANAGEMENT OF THE TANNIA RAPID YELLOWING DISEASE

Pattanjalidial, H. Adams and A. Clarke
Caribbean Agricultural Research Institute
Botanical Gardens, Roseau, Dominica.

ABSTRACT

Tannia, *Xanthosoma* spp. (L.) Schott, is a staple root crop in the humid tropics. In the East Caribbean, the crop is also of great survival and economic value to the largely subsistence farming population, amidst the constant threat of hurricanes. The crop is susceptible to Tannia Rapid Yellowing Disease (TRYD), especially in Dominica and St. Lucia. The disease is caused by the fungus, *Pythium myriotylum* Drechsl. It is prevalent in poorly drained locations and particularly affects the desirable, smooth-skinned, white or purple-fleshed cultivars. It is spread through the use of infested planting material and perpetuated in fields with volunteer, diseased host plants. A rough-skinned, white-fleshed tannia cv of limited marketability is tolerant to TRYD. The eddoe, *Colocasia esculenta,* is resistant. The use of fungicides, including metalaxyl, cultural practices, combined with host plant resistance, are suggested for the integrated management of the disease. In the long term, joint efforts with existing breeding programmes for resistance to the disease are recommended.

RESUMEN

El ocumo, *Xanthosoma* spp (L.) Schott, es un tubérculo alimenticio de importancia en el trópico humedo. En el Caribe Oriental, este cultivo es tambien de gran valor económico y de sobrevivencia para la población agrícola marginal, la cual se encuentra en constante amenaza de incidencia de huracanes. El cultivo es susceptible a la enfermedad del Amarillamiento Rapido del *Xanthosoma* spp. (TRYD) especialmente en la isla de Dominica y en la de St. Lucia. La enfermedad es causada por el hongo *Pythium myriotylum* Drechsl. Este es predominante en lugares con pobre drenaje y afecta particularmente a los cultivares de cáscara lisa y de color blanco o morado, los cuales tienen mayor demanda. La enfermedad se disemina mediante el uso de material de plantío infectado y perpetuado en campos con plantas voluntarias-huespedes. La *Xanthosoma* spp cv, blanca y con cascara rugosa y de mercadeo limitado, es tolerante a la enfermedad TRYD. La *colocasia esculenta,* es resistente a dicha enfermedad. El uso de fungicidas, incluyendo el metalaxyl, y las formas de cultivo combinadas con plantas huespedes, son las practicas sugeridas para el manejo integrado de la enfermedad. A largo plazo se recomienda, la practica de esfuerzos mutuos con programas exsistentes de mejoramiento genético.

Tannia *(Xanthosoma* spp. (L.) Schott)*)* originated in tropical America, but is now widely grown as a subsistence food crop in Africa, Asia and Polynesia (Kay, 1973).

Whilst it is rarely grown as a sole crop in subsistence farming systems, it is no longer a "poor man's crop", but rather a crop with economic value (Adams et al., 1985; I.I.T.A., 1981). Under high level management, cormel yields of 25 – 37.5 t/ha have been reported, whereas, with peasant agriculture, yields as low as 5 – 7.5 t/ha (Kay, 1973) are common. However, the lower peasant yield is generally related to intensive, mixed cropping and poor management practices.

In the 1960's there was an upward trend in exports of tannia from the Carihbean to the UK (Kay, 1973), but by the 1970's the trend had begun to drop, due to a 'burning' disease. An apparently similar disease is known to be severe in the Americas, especially in the Caribbean and West Africa (Ghana and Cameroon). It is currently the subject of investigations in Nigeria and Cameroon (I.I.T.A., 1981; Nzietcheung, 1983), Costa Rica (Salazar, 1985), Florida (O'Hair, 1984) and in the Eastern Caribbean (Adams and Pattanjalidial, 1983).

In the Eastern Caribbean, this tannia disease was originally described as tannia leaf burning disease (CARDI-Windward Islands, 1982) and tannia burning disease (Clarendon, 1982; Demarque and Auguste, 1982). Hereafter, in this presentation, the disease will be referred to as tannia rapid yellowing disease (TRYD). This name conveys the most obvious symptom of the disease as we have observed it in the field. It is distinct from bacterial leaf spots (Berniac, 1974) and mineral deficiences or nutrient disorders that cause yellowing and root rots (Spence and Ahmad, 1967), but it is similar to the *Pythium*-induced root rot of cocoyam in Cameroon (Nzietcheung, 1983); Martinique and Guadeloupe (Messiaen and Hotoundji, 1984). The symptoms of cocoyam root rot blight or 'mal seco' of *Xanthosoma* spp. in Costa Rica (Laguna *et al.,* 1983; Salazar, 1985) appears to be similar to TRYD. Earlier reports suggested that 'mal seco' of *Xanthosoma* spp. in Puerto Rico is similar, but Rodriguez (1984) indicated a different array of symptoms and the causal organism was described as *Rhizoctonia solani* Kuhn.

Economic importance of the T R Y Disease in the Eastern Caribbean

Subsistence farmers depend on tannia both as a staple food and cash crop. In addition, the tannia represents food security in times of hurricane and high winds.

The gross annual value of the cormel yield from an estimated area of 2111 ha (Adams and Pattanjalidial, 1983) in the Eastern English-speaking) Caribbean has been estimated to be US$ 6M (Adams *et. al.,* 1985).

However, it was estimated that approximately 65 and 80 per cent of the crop is lost due to the disease in Dominica (Clarendon, 1982) and in St. Lucia (Demarque and Auguste, 1982), respectively. Estimates of losses in St. Vincent and Grenada are not available, but observations by the authors indicate that tannia crops in these two islands are similarly plagued by the disease. Plants observed with bacterial leaf spots, viruses and nutrient disorders produced marketable cormels, whereas the TRY-diseased plants often produce no edible cormels.

Characteristics of the Tannia Rapid Yellowing Disease (TRYD)

TRYD is characterized by a successive. rapid yellowing and early senescence of the outer leaves from as early as 3 weeks after planting, and it may affect plants as old as 24 weeks (CARDI/EDF: Aroids & Arrowroot, 1984). The yellowed leaves are without necrotic spots and successive leaves are smaller than those in the normal, healthy plants. The net result is a severe dwarfing of the plant in the case of early infection. With late infection at 20–24 weeks, a sudden yellowing of the leaves preceded by root rotting, results in an abrupt termination of growth of cormels. Several roots may appear watersoaked and/or semi-decorticated at any point or all along the longitudinal axis of the root to the stele. The fungus, *Pythium myriotylum* Drechsl, an Oomycete, has been isolated from the infested roots and its pathogenicity was proven (CARDI/EDF: Aroids & Arrowroot, 1984).

The disease tends to be associated with poor drainage or water-logged conditions and residual inoculum from volunteer host plants. The susceptible cultivars are the commercially acceptable cultivars, having smooth-skins, with either white or pink-fleshed cormels. Planting material with infested roots provides a source of inoculum (CARDI/EDF: Aroids & Arrowroot, 1985).

Factors Affecting Integrated Management Strategies

Tannia is a preferred staple, and is naturally adapted to the wetter regions of the Windward Islands (Domica, St. Lucia, St. Vincent and Grenada). It requires high rainfall, but cannot tolerate poor drainage or waterlogged conditions. Drainage is generally poor on new plantings, usually after a fallow or newly cleared forest holding, particularly in the seasons of heavy torrential rains experienced in these countries.

The predominant farming systems in these countries, especially where the incidence of the disease is high, is characterised by small farm sizes, multiple farm parcels, mixed cropping and limited crop rotation (Adams *et al.*, 1985). The practice of shifting cultivation is common, but the tannia plants in the intercrop are left and harvested for food. Ultimately, a farmer ends up with volunteer tannia crops on several parcels of land. In this process, "volunteer", diseased plants are often used as the source of planting material for the next crop. Alternatively, diseased tannia planting material from nearby, infected farm parcels is used.

Since the price of tannia is fairly attractive and some storage may be obtained in or out of the ground, the farmer tends to grow the crop as a second cash crop to banana, the latter being the principal export and cash crop of three East Caribbean countries except Grenada.

In general, it is evident that the total tannia production and interest in tannia production are on the increase (Sorhaindo, 1985; Thomas, 1985) and thus underlines the importance of disease management. The principal factors affecting disease management are farm size, farm location and farming system.

Integrated Management Options

Use of fungicides

Calculations by the authors suggest that the income status of the majority of farmers does not presently permit an economic level of control of *Pythium* to be achieved using the fungicide, metalaxyl. Any appropriate fungicide for the management of *Pythium* and, hence, of the disease will have to be effective over a minimum of 24 weeks. The period of planting and early infection coincides with the rainy season which is also favourable for the rapid development of *Pythium* spp., and, therefore, the fungicidal application(s) must be effective under heavy rains.

Use of the fungicide, metalaxyl, has been demonstrated to induce fungal resistance in other crops and, therefore, any sustained fungicidal application for management of TRYD must be such that the induction of fungal resistance is nil or low. Besides, fungicide formulations other than granular are of little practical value for tannias grown at altitudes of 1000–1500 m and on slopes of 10–20°, because of limited access to water and increased labour input. Metalaxyl is systemic, both up and down, and therefore may be used as a dip treatment of planting material in the predominant small farms. Additional dosages of metalaxyl may be applied as granules, especially for its slow releasing property.

Genetic

A few tolerant, tannia cultivars have been identified in the East Caribbean (CARDI/EDF: Aroids & Arrowroot, 1984 and 1985) and will provide an interim option at least for food on farm and limited local and regional markets. Eddoe *(Colocasia antiquorum),* which bears tannia-like, smooth-skinned, white-fleshed cormels is also known to be resistant to the disease (CARDI/EDF: Aroids & Arrowroot, 1984).

It is imperative, therefore, that any integrated management of TRYD be based on the interactions between cultural measures and host plant resistance.

Cultural Practices

Cultural practices relevant to the management of the tannia disease revolve around measures to exclude the pathogen, avoid build up of inoculum, maintain field sanitation and ensure adequate plant nurtients in the soil.

Exclusion of the pathogen

Measures for the exclusion of the pathogen include the legislative regulatory functions to restrict or ban the importation of any planting material, unless it is produced in tissue culture, between islands where the disease is present. Though the actual implementation of an embargo is not guaranteed, due to the ease of movement of farm produce, it certainly guarantees an awareness of the severe dangers of the problem and should restrict any movement to a low level. This is currently in operation in all the tannia producing islands in the Eastern Caribbean. However, a practical option may be to permit the movement of plants that are free of soil, de-rooted and with

corms that are surface sterilized. The principal incitant, *P. myriotylum,* a soil 'liver; has been isolated only on infested roots. No evidence of the fungus has been found either in or on the tannia corm EDF: Aroids & Arrowroot, 1985). A further step in the exclusion of the pathogen may be to cut or trim the corm after roots have been severed. Should this latter method be the preferred means, material from Grenada and Trinidad would have to be prohibited, due to the possibility of transferring the banana 'moko' disease bacterium, *Pseudomonas solanacearum.*

Avoiding build up of the inoculum

P. myriotylum is a soil-borne fungus, apart from being carried on the tannia roots. Therefore, a manipulation of factors in the soil avoiding the build-up of inoculum is desirable. Observations in diseased fields of both farmers and the CARDI field station (CARDI/EDF: Aroids and Arrowroot, 1984) indicate that poor drainage results in more rapid and certain disease build-up.

Hence, good drainage is a necessary first step to enhance better management of the disease. This is substantiated by the successful tannia cultivations in naturally free-draining soils and by those with artificial drainage. Particular evidence of the latter has been achieved in 3 experimental tannia plots in Dominica, where adeqate drainage coupled with disinfested planting material kept the disease to a low level. When compared to adjacent plots planted with similar quality of planting material but having poor drainage, 100% plants were diseased within 12 weeks of planting (CARDI/EDF: Aroids & Arrowroot, 1984).

Secondly, crop rotations may reduce build-up of inoculum, but since *Pythium* spp. are a typical group of organisms whose inoculum can increase markedly in the presence of susceptible tannia and host roots, this is a risk. *Pythium* spp. also have the ability to function as saprophytes in the presence of readily available, decaying tannia and other host roots and organic matter, and to efficiently maintain an inoculum potential indefinitely without dependence on the presence of a host plant, by forming metabolically inactive sporangia, chlamydospores or oospores (Mitchell, 1979).

Crop rotation however, tends to be incompatible with farmers' production needs and the limited availability of arable land. Therefore, it appears that emphasis should be placed on adequate drainage to avoid a build-up of active inoculum.

Finally, diseased plants may be rouged at about 3–4 weeks after planting and continually thereafter to avoid a build-up of inoculum.

Sanitation

The presence of the fungus, *P. myriotylum,* on the roots of tannia planting material and other known host plants, eg., turmeric and ginger rhizomes and rotting dasheen corms suggests the following sanitary measures at harvest, post-harvest and pre-planting.

At Harvest

Cutting, gathering and burying, in one or more locations, of all tannia corms (including roots) that are below-ground.

Post-harvest

- Removal and destruction of all volunteer tannia plants, especially corms with roots, in early growth.
- Removal of all potential hosts which are not important crops.
- Production of, or ensuring the availability of disease-free plants, using the methods in practice in Grenada byT.W. Beddoe, UNDP/FAO–Minag and this project (Benjamin, 1985). Simpler field methods develop by the authors for use by the small farmers include the improved sprouting of corms, headsetts and cormels.

Fertilizer application

In an apparently similarly diseased situation in the Cameroon, soil fertility studies indicated that up to a 40% increase in cormels may be obtained with the application of fertilizers. Phosphorus at 60–120 kg P_2O_5 per hectare increased the cormel yield in a diseased field (IRA – Cameroon, 1982). In Puerto Rico, in fields where the disease was not present, best yields were obtained following the application of 125 kg N/ha, 15 kg P/ha and 156 kg K/ha, 48 kg Mg/ha and 25 kg Ca/ha (Vincente-Chandler *et al.,* 1982). In Ghana, 1000 kg /ha of 10–5–15–3 proved optimal (Karikari, 1974). Farmers in the Windward Islands (East Caribbean) tend to use the easily available 16–8–24–4 banana fertilizer for their tannia crops at 625–1250 kg/ha.

However, these recommendations are merely expressing a fertilizer need and should be taken against the background of induced root rotting by Ca, Mg and K-deficient plants in pot studies conducted by Spence and Ahmad (1967).

Host Plant Resistance

Observations in the field indicated about two types of resistance to TRYD. Firstly, there is the hypersensitive response of the host, complete with rapid yellowing and root rotting, eg., the susceptible cv. Rabess Dominica (smooth skinned-white fleshed) (CARDI/EDF: Aroids & Arrowroot, 1984).

Secondly, rotting of roots due to *P. myriotylum* was found associated with rough-skinned, white-fleshed cormels, describbed by Adams *et al.*(1985), and on a wild type with yellow flesh cv Jabba (Dominica) (CARDI/EDF: Aroids & Arrowroot, 1984). No rapid yellowing of leaves, as in the first type, occurs.

Whatever the type or nature of resistance, the following may be considered for management of the tannia disease: since eddoe, *Colocasia antiquorum,* is not susceptible to the disease even under the most severely diseased conditions, this crop should be encouraged in severely diseased fields. In moderately diseased

locations, the rough-skinned, white-fleshed types and the eddoe are the best alternative, both for food and market. In mildly infected fields, the rough-skinned, white-fleshed cultivars should be judiciously mixed with the smooth-skinned, white or pink-fleshed types, taking care to put these susceptible types on the best drained sites.

Present trends in regional marketing indicate that the rough-skinned, white-fleshed types are marketable to a moderate extent. Eddoes are established in regional trade.

Acknowledgements

For their active interest and advice, the following:

- Staff of the Ministries of Agriculture and farmers in the participating countries.
- Dr. S.Q. Haque, Virologist and Honorary Leader, Root Crops Programme.
- Dr. R. Phelps, Principal Pathologist and Head of CARDI–Trinidad.
- Dr. C. Messiaen, Pathologist and Director of INRA, Guadeloupe.
- Dr. J. Hammerton, Weed Biologist and Head of CARDI–Windward Islands Units.
- Mr. C. George, Deputy Executive Director.
- Agricultural Advisors, European Development Fund.
- Project Co-ordinators.

Bibliography

Adams, H. and Pattanjalidial, (1983). An overview of the Aroid Industry in the Eastern Caribbean Is. of Dominica, St. Lucia, St. Vincent and Grenada. Proc. of Conference on "Taro and other Aroids for Food, Feed and Fuel". CATIE, Costa Rica. 35 pp.

Adams, H., Pattanjalidial, Browne, G., Cooper, B., and Clarke, A. (1985). Aroid Improvement in the Eastern Caribbean: An update of the Aroid/Arrowroot Project. Paper presented at the VIIth Symposium of the Int'l Soc. for Trop. Root Crops (ISTRC) 1-6 July, 1985, INRA, G'loupe, F.W.I. *in press* . 24 pp. cyclostyled.

Berniac, M. (1974). Une maldie bacterienne de *Xanthosoma sagittifolium* (L). Schott. *Annale Phytopathologie* 6 (2), 197–202.

CARDI/EDF: Ariods & Arrowroot. (1984). Annual Report for the sub-project "Increased Production of Aroids and Arrowroot" - Project Year II. CARDI–Dominica, Botanic Gardens, Roseau, 77 pp.cyclostyled.

CARDI/EDF: Aroids & Arrowroot. (1985). Annual Report for the sub-project "Increased Production of Aroids and Arrowroot" Project Year III. CARDI–Dominica, Botanic Gardens, Roseau *in press.*

CARDI - Windward Islands (1982). Annual Report for 1980 of the Windward Is. Unit. CARDI - St. Lucia, Castries, St. Lucia 16–17.

Clarendon, H. (1982). Situation of plant health in member countries. *Biannual Bull. of the Carib. Plant Prot. Comm.* Vol. XI No. 1 Jan - June, 1982,30.

Demarque and Auguste (1982). Situation of plant health in member countries. *Biannual Bull. of the Carib. Plant Prot. Comm.* Vol. XI No. 1 Jan - June, 1982,36–37.

IRA–Cameroon (1982). Annual Report - 200: for the year 1981-82. Doula, Cameroon.

IITA. (1981). Annual Report for 1980. IITA, Ibadan, Nigeria. 185 pp.

Karikari, S.K. (1974) The effect of nitrogen and potassium on yield and leaf area in cocoyam *(Xanthosoma sagittifolium). Ghana J. of Agri. Sci.* 7, 3–6 Accra, Ghana Univ. Press.

Kay, D.E. (1973). TPI Crop and Product Digest - No. 2 Root Crops. TPI, London, 245 pp.

Laguna, I.G., Salazar, L.G. and Lopez, J.F. (1983). Fungal and bacterial diseases of Aroids: *Xanthosoma* spp and *Colocasia esculenta* (L.) Schott, in Costa Rica. *Tech. Bull* 10 Trop. Agri. Res. and Training Center, CATIE, Turrialba, Costa Rica. 30 pp.

Messiaen, C.M. and Houtoundji, A. (1984). Tannia diseases in Matinique and Guadeloupe *Proc. of a Workshop "Aroid Improvement with Particular Reference to the Tannia Disease".* CARDI, St. Augustine, Trinidad. 65 pp.

Nzietcheung, S. (1983). La pourriture racinaire du macabo *(Xanthosoma sagittifolium)* au Cameroun: 1 - symptomatologie et etiologie de la maladie. *L'Agronomie Tropicale* 38 (4), 321–325.

O'Hair, S. (1984). Tannia breeding, *Proc. of a Workshop on "Aroid Improvement with Particular Reference to the tannia Disease".* CARDI, St. Augustine, Trinidad. 65 pp.

Sorhaindo, T.C. (1985). Root crops research in Dominica. Country Paper presented to Regional Network on Tropical Root Crops, INRA 9–10 July, 1985.

Spence, J., and Ahmad, N. (1967). Plant nutrient deficiencies and related tissue composition of tannia *Int. Symp. on Trop. Root Crops* Vol I: Section II, 61–69.

Thomas, M. (1985). Review Meeting August 1985 on Root Crops Marketing, MINAG, Botanic Gdns., Roseau, Dominica.

Vincente - Chandler, J. *et al.,* (1982). Nutrient uptake by taniers as related to stage of growth and effect of age on yields of the morada variety. *Jnl of the Univ. of P. Rico,* **LXVI** (1).