An overview of *Phytophthora colocasiae* of cocoyams: A potential economic disease of food security in Cameroon

Mbong GA¹, *Fokuang CN², Lum A. Fontem³, Bambot MB⁴, Tembe EA²

¹Faculty of Science, Department of Plant Biology, University of Dschang, B.P. 67, Dschang, Cameroon  
²Faculty of Medicine and Biomedical Sciences, University of Yaoundé 1, Cameroon  
³Faculty of Agriculture and Veterinary Medicine, University of Buea, Cameroon  
⁴Faculty of Agronomic Sciences (FASA), University of Dschang, Cameroon

* Email for Correspondence: gracembong@yahoo.com

Abstract

Cameroon is one of the food bread baskets for the Central African region and a big producer of cocoyams (*Colocasia esculenta*) locally known as taro. This crop is facing a significant production decline due to the increased incidence of taro leaf blight caused by the fungus *Phytophthora colocasiae* Raciborski. The blight disease has caused low yield, poor quality corms and reduced commercialization of the market product. There is also the problem of post harvest rapid biodeterioration of corms. The objective of this survey was to carry out a field assessment of the disease incidence, etiology, and damage, determine the mode of disease transmission and do post harvest evaluation of food quality. This pilot survey was aimed at generating field information to launch an expanded field survey in different ecological regions.

Key word: Taro, *Colocasia esculenta*, *Phytophthora colocasiae*, Post harvest, Biodeterioration, Cameroon.

INTRODUCTION

Cameroon is one of the countries in the dense humid tropical forest of Africa where the subsistent farmers in the South–West, North–West and West Regions were alarmed by complete destruction of their taro crops by Taro Leaf Blight (TLB) during the 2010 cropping season. The disease was first reported in Nigeria in November 2009. Taro Leaf Blight, caused by *Phytophthora colocasiae* Raciborski, is the most destructive fungal disease of taro (*Colocasia esculenta* L (Schott)). It is believed to have originated in South East Asia and is widely distributed throughout the tropical regions of the world (CMI, 1997). Symptoms typical of TLB begin as small, brown, water-soaked lesions that rapidly become enlarged to form large, dark brown lesions, zonate spots on the leaves, often coalescing to destroy large parts of the leaf, sometimes with numerous droplets of orange or reddish exudates. The pathogen can cause rapid and complete defoliation and crop destruction. Under certain circumstances the disease can attack harvested corms and cause heavy losses during storage. The epidemic was widespread in Cameroon during the 2010 rainy season between April to November in all the taro-growing areas. The three Regions mentioned above still suffer losses up till date, during the taro cropping season as a result of re-occurrence of the disease. A comprehensive history of the pathogen or the disease is not yet available. However, there were previous reports of taro blight-like disease attributed to *P. colocasiae* in Nigeria, Ethiopia, Equatorial Guinea and this has occurred more recently in Cameroon. From our knowledge, much has not been done on *P. colocasiae* in Cameroon and this seems to be the first observed record of the disease. The disease has posed a serious threat to the production and biodiversity of this important food crop. There is urgent need to
halt this emerging epidemic in both West and Central Africa. In this paper, some of the key features of the biology of the organism are outlined and the implication of some control measures is also discussed.

The Crop

Most farmers in the North-West, South-West and Western Regions of Cameroon depend on taro (*C. esculentum*) as their primary source of food. The crop provides the indigenous population with food in periods of food scarcity. The species *C. esculentum* has peltate leaves and the varieties cultivated in Cameroon are mainly identified by the colour of the leaves and the petiole. There are three common varieties in Cameroon which are commonly identified in the communities where they are grown and consumed as “ebo coco, atangana and country”. The crop is mostly grown as an intercrop with maize, cassava and plantain and is cultivated on a wide range of soils. The crop is grown throughout the seasons. During the dry season it is grown in waterlogged areas and in the forest under canopy cover. The three varieties commonly grown in Cameroon had symptoms of the disease, but the severity rate was not the same. Among the three varieties, “ebo coco” was the most susceptible with 100% destruction of the entire plant (Figures 1, 2, 3 respectively) and therefore no corm yield (Figure 4).

Uses

The leaf, petiole and corm of Taro are edible. The corms are boiled and eaten with vegetable or the tender leaves and petioles of the same crop. The leaves are also mixed with smashed cowpea to prepare a common meal called “Koki” or dried and preserved to be eaten during periods of scarcity as in the dry season. In some parts of the country, the petioles are harvested, dried and used as a soup thickener when groundnuts are expensive. The corms can be prepared as porridge, or boiled and pounded to prepare a traditional dish “achu” that is eaten with yellow or black soup. This is a delicacy for most traditional rites.

LIFE CYCLE AND EPIDEMIOLOGY

The key factors controlling the life cycle of the disease and its epidemiology are rainfall, humidity and temperature. The sporangia are the primary reproductive unit of *P. colocasiae*. Potter (1976) and Trujillo (1965) reported that the sporangia require free water to germinate and germination can be reported in two ways viz. indirect and direct germination depending on the temperature. During indirect germination, the cytoplasm within each sporangium differentiates into 20 zoospores during ‘cool’ conditions (20-22°C). The terminal pore of these sporangia dissolves and
the zoospores ooze out and swim off into the film of water which is a rapid process. The formation of zoospores usually starts within 15-20 minutes of being cooled at 20°C and then settles on the surface of the leaf, lose their flagella and form a round cyst. The cysts germinate to form a fine germ tube within 5-10 minutes. This mode of germination provides a strong ecological advantage to the fungus. It provides up to 15-fold increase in inoculums, allows dispersal in dew or rainwater, and because new infections can be initiated within an hour of a sporangium being formed, the fungus can continue to sporulate and infect during short periods of leaf wetness.

In direct germination, when conditions are warmer (28-30°C), the sporangia germinate directly by a germ tube and infect the leaf. This process is relatively slower than the production of zoospores which can take 5-6 hours for the sporangia to germinate. The production of sporangia during direct germination is generally lower than during the formation of zoospores.
Dispersal and spread

The sporangia and zoospores are spread by rain plash and wind blown moisture within and between plants. Putter (1976) reported that rivulets of dew and exudates droplets carrying sporangia and zoospores are important mechanisms of spread on and between leaves of the same plant. Long distance dispersal of the organism occurs only by movement of infected plant materials like the leaves, petioles and infected corms.

Survival

Survival of the pathogen can be by continuous recycling, often as a single plant within the crop. Sitansu and Pan (1994) reported that the fungus does not survive as hyphae in soil. They reported that the sporangia on leaves dehydrate rapidly during the day. Those in vegetative materials seldom survive more than a few days though reports have confirmed that they can survive for up to two weeks (Gollifer et al., 1980). However, under normal circumstances large numbers of sporangia are washed into the soil. Most of the discharged zoospores are lysed within the first five days but a small proportion develops a thick wall to form chlamydospores that are able to survive in the soil for up to three months. The importance of this in epidemiology of the disease has not been established but it could allow survival of the pathogen between crops (Quitugua and Trujillo, 1998). Butler and Kulkarni (1913) reported that in situations where the vegetative material dies off as a result of drought or cold conditions, the fungus can survive between seasons as vegetative mycelium in infected corms.

Consequences of plant disease epidemic outbreak

There is widespread famine in Cameroon in all the taro eating areas because this special crop served the teeming population in different ways as it was always available throughout the seasons. Due to the outbreak of *P. colocasiae* on taro, farmers in Cameroon encountered heavy corms and leaf losses of up to 100%. Farmers were also skeptical of the etiology and health consequences and they abandoned the crop in the field which led to widespread poverty. There was scarcity of ‘achu’ which is a staple food to most people in the North West Region and also a threat to food security and change in eating habits. As a result of this disease epidemic, huge financial losses have been incurred by many farmers since taro was the main crop grown and also their main source of income both locally and for exportation to nearby...
countries. In some regions where farmers manage to have some corms, storage is a major problem because the corms cannot last for up to three days without everything getting rotten. The result of all this has led to increase in prices.

**Farmers' initial perception of disease etiology**

Field visits were carried out in some of the major growing areas of taro in the North West and South West Regions of Cameroon. In each of these major taro growing Regions, six farms were visited each from Buea, Lysoka, and Ekona for the South West and Widikum, Ngie and Mankon for the North West Regions. Most of the farmers in these areas were frightened and confused with the alarming outbreak of *P. clocasiae*. There were many perceptions of the sudden outbreak of the disease as people thought it may be due to desert dust/acid rain, others thought of climate change and microbes. Some were even afraid to touch the infected plants or eat the corms because they had this conception that if you touch or eat the corms you will have cancer. Some farmers quickly removed the infected leaves with the hope that the re-emerging ones will not be attacked but all these efforts proved abortive. The future to farmers is uncertain and they find themselves unable to provide food for their families. They believe that there shall be hunger because the disease still keeps re-occurring and the taro is almost becoming extinct. This has cause a serious dilemma to the farmers.

**Infection rate**

Infection can be observed on both sides of the leaves. When infection is severe, the entire leaves plus the petioles get rotten leading to complete defoliation and rottenning of the entire crop. In some fields one could observe 100% destruction of the entire field with all the plants completely destroyed and no corm formed. Germ tubes can either penetrate the epidemic directly or enter via stomata and spread inter- and intra-cellularly through the leaf tissues. Putter (1976) reported that most infections occur between midnight and dawn with the majority over the period 2400-0200hr. The conditions of cooler temperatures and free moisture from rain or dew over that period are also those that promote zoospores production by sporangia. Infections occur when there is a continuous wet season during the day.

**The need for fast action**

Before the outbreak of the disease, the taro plant was grown with relative ease by most farmers. The crop was cultivated on a wide range of soils, and this was repeated every year. It can be intercropped with other crops. It is a short duration crop. It was the main crop cultivated around homes. Under good storage conditions, the corms can be preserved for a long period.

**Management options for taro blight**

- Breeding for resistance- Resistant cultivars offer the best long-term control to taro blight in most production systems. Breeding for horizontal resistance utilizing recurrent mass selection techniques has been proposed (Anon., 1998)
- Chemical control using Fungicide sprays with co-formulation: Ridomil plus, Ridomil Gold will manage the disease. Note. Routine chemical sprays are neither economically practical nor environmentally suitable. Fullerton and Tyson (2004) reported that successful control of taro leaf blight is technically possible with fungicides like mancozeb (e.g. Dithane M45), copper (e.g. copper oxychloride), metalaxy (e.g. Ridomil MZ-containing Mancozeb) and phosphorus acid (e.g. Phoschek). Mancozeb and copper have protectant activity only. Metalaxyl and phosphorus acid are specific for *Phytophthora* (and Pythium) diseases; metalaxyl is prone to the development of resistance. However, results with chemical control can be variable. Jackson *et al*. (1980) found that mancozeb did not control the disease in Solomon Islands. This was also the case of Trujillo (1996) who also reported that copper gave little control in Hawaii. The efficacy of fungicidal control of any foliar disease is strongly governed by the severity of the disease at the time, and the prevailing weather conditions. In principle, fungicides are most effective when the target disease is present at low incidence, thereby limiting inoculum levels in the crop. But when diseases enter an exponential phase, the efficacy of control is reduced. On this basis, fungicides might be expected to be most effective against taro leaf blight when applied regularly during its endemic phase. Because of the rate at which taro leaf blight can progress from an endemic to an epidemic state, and the frequency of epidemic promoting conditions in many localities, fungicidal control can be both
• difficult and expensive. For example, in Samoa fungicides were frequently applied at higher rates and with greater frequency than label recommendations in an attempt to maintain control (Adams, 1999; Semisi, Mauga and Chan, 1998).
• Cultural control measures- Cultural methods such as exclusion are important. Where the organism is likely to be dispersed over long distances by fungi propagules, or infected plant materials, constant vigilance is required to ensure that the disease is not imported. Suppression of diseased leaves (Sanitation) which is an effective control measure in subsistence gardens particularly when plots are relatively separated from one another seems not to be effective for taro disease. This strategy would be most effective when the disease is in an endemic phase with a relatively low and restricted disease incidence. When the disease is in an epidemic phase, the removal of all the leaves with lesions would quickly lead to almost complete defoliation of the crop with consequent effects on yield. Plant spacing was also ineffective.

**Research Highlights**

Urgent and collaborative effort is needed to halt this novel epidemic in order to prevent taro from going into extinction so that the farmers' needs can be achieved

**References**