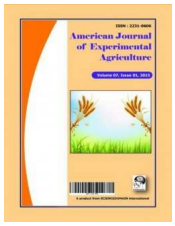

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Prevalence of *Phytophthora* Leaf Blight of Taro (*Colocasia esculenta* (L.) Schott) in the Semi Deciduous Forest Zone of Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author JA designed the study, undertook survey, data collection and analysis, developed the protocol, wrote and reviewed draft of the manuscript and submission for publication. Author CKK supervised the project and reviewed all drafts of the manuscript. Author ME conceived the project and provided technical laboratory supervision. Author LKS was involved in survey and data collection, review of draft manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim was to assess the incidence, severity and symptoms of the leaf blight of taro.
Methodology: A survey of 50 taro fields was conducted during the major cropping season of 2015 in 11 districts of the semi deciduous forest zone of Ghana. Disease incidence and severity were calculated and samples collected. Isolation, morphological identification and Koch's postulate of the associated pathogen was carried out at the Plant Pathology Laboratory of the CSIR-Crops Research Institute, Kumasi, Ghana.
Results: *Phytophthora colocasiae* Raciborski, was identified as the causal pathogen of the leaf

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blight disease attacking taro. The study revealed a high incidence and severity of the disease across all locations surveyed. Incidence ranged from 30% in the East Akim District to 92.5% in the Tano South district whilst severity ranged from 6.5% to 86.5% in the East Akim and Tano North districts respectively. Disease incidence and severity was significantly different ($P < 0.05$) across the districts surveyed. Symptoms of the disease included multiple circular spots on the leave surface, white mycelia on lesion surface; shot holes on affected parts and water soak beneath the developed spots.

Conclusion: The current study revealed a high incidence and severity of the disease in the surveyed districts and has laid the foundation for extensive studies on the epidemiology of the disease in Ghana and the need to develop management strategies to reduce its impact.

Keywords: Epidemiology; incidence; Phytophthora colocasiae; severity; survey.

1. INTRODUCTION

According to [1] 9.0 billion kilograms of taro (*Colocasia esculenta*) was produced worldwide in 2010 making it the fifth most harvested root crop globally. It is widely grown in both the lowland and upland areas of Africa, Asia, the Caribbean, and South America. The crop has high nutritional and medicinal values and as such all parts of the plant including corm, cormels, rhizome, stalk, leaves and flowers are utilized [2]. It is a rich source of proteins, carbohydrates, minerals and vitamins [3]. Medically, it is known to reduce tuberculosis, ulcers, pulmonary congestion and fungal infection [4].

The production of taro in Ghana, in recent times, has been affected by the taro leaf blight caused by *Phytophthora colocasiae* which has also been reported to have threatened the sustainability of taro production globally [5-7]. In Ghana [8] reported the presence of the disease after similar reports in Nigeria [9] and Cameroon [10]. The disease affects all parts of the crop including the leaves, corms, petioles and cormels, resulting in extensive damage of the foliage and reduced yield [11]. It has become a limiting factor to taro production in all taro growing countries.

Notwithstanding the widespread of the disease with its corresponding damage to the crop, there is lack of information with respect to the incidence and severity of the disease across the growing districts of Ghana. However, to effectively develop a sustainable management tool for the disease, there is the need to assess the extent of the epidemic.

The present study therefore seeks to assess the incidence and severity of the disease in selected taro growing areas in the semi deciduous forest zone of the country. The current study will be useful to unravel the impact of the disease on taro production and also provide reliable basis for the development of management strategies.

2. MATERIALS AND METHODS

2.1 Site Description and Field Sampling

Epidemiological surveys were conducted in taro fields across 11 districts of the semi deciduous forest zone of Ghana during the major cropping seasons of 2015. Foliage showing symptoms of the disease were selected from fields comprising of home gardens, wild and research fields. The selected areas experience a bimodal rainfall pattern which allows for two cropping. Growth of the crop is observed very much during the major rainy season between April and August although it can be found growing along water bodies and the inland valleys throughout the year. A total of 50 fields in 11 districts were surveyed. With the exception of the research fields, taro fields had established as volunteer crops and hence no proper agronomic practices were observed. Locations of district, soil and geo-environmental characteristics are presented in Table 1.

2.2 Incidence and Severity of *Phytophthora* Leaf Blight

In each field, 10 taro plants were selected and observed individually to assess the incidence and severity of the disease. Disease incidence was calculated as the percentage of plants showing symptoms of the *Phytophthora* leaf blight. Disease severity was defined as a percentage of plant leaf surface affected by leaf blight, either lesions or lesions plus lesion-related chlorosis and yellowing. Disease severity was estimated on 10 randomly selected plants. Five matured leaves showing symptoms of *Phytophthora* leaf blight of each selected plant was assessed and scored on a 12 rating scale of 0-11 [9] based on visual examination of the proportion of leaf area affected by the taro

Table 1. Geo-ecological and soil characteristics of study districts

District	Location	Soil type	Mean rainfall (mm)	Mean temp (℃)
Tano South	Lat. 7°00'N and 7°25' Long. 1°45'W and 2°15'W	Forest ochrosols	1269.0	25.7
Sunyani West	Lat. 7°19'N and 7°35' Long. 2°08'W and 2°31'W	Ochrosols	1500.0	26.5
Tano North	Lat 7°00'N and 7°25' Long 2°3'W and 2°15'W	Forest ochrosols	1300.0	25.3
Bekwai Municipal	Lat. 6°00N and 6°30'N Long. 1°00W and 1°35'W	Bekwai –Oda Compound association	1500.0	26.0
Sekyere South	Lat. 6°50'N and 7°10'N Long.	Forest ochrosols	1455.0	24.6
Atwima-Mponua	Lat. 6°32'N and 6°75'N Long. 2°00W and 2°32'W	Forest ochrosols	1500.0	28.0
Kumasi Metropolis	Lat. 6°35'N and 6°40'N Long. 1°30'W and 1°35W	Forest ochrosols	1448.0	26.3
Ahafo Ano South	Lat. 6°04'N and 7°02'N Long. 2°26'W and 2°04'W	Forest ochrosols	1353.0	26.3
East Akim	Lat. 6°03'N and 6°35'N Long. 0°56W and 0°15W	Asikuma-Atiwa-Ansum/Oda Compound Association	1500.0	27.0
Kwahu West	Lat. 6°30'N and 7°N Long. 0°30°W and 1°W	Forest Ochrosol	1600.0	27.0
Ejisu-Juabeng	Lat. 1°15'N and 1°45'N Long. 6°15'W and 7°00W	Forest ochrosol	1500.0	26.0

Source: www.ghanadistricts.com

leaf blight disease. Severity ratings for each leaf assessed was converted into the midpoint percentage [12]. Severity score and corresponding percentages are shown in Table 2.

Table 2. Leaf blight of taro rating scale and corresponding % severity score

Rating scale (0-11)	Range of leaf blade damaged	% Mean leaf blade damage
0	Healthy leaves	0.0
1	0.01-1	0.5
2	1.01-5	3.0
3	5.01-9	7.0
4	9.01-18	13.5
5	18.01-38	28.0
6	38.01-62	50.0
7	62.01-82	72.0
8	82.01-91	86.5
9	91.01-97	94.0
10	97.01-98	97.5
11	98.01-100	100

2.3 Isolation and Identification of *Phytophthora colocasiae*

Diseased samples collected from the survey sites were kept in brown paper bags and transported to the Plant Pathology Laboratory of the CSIR-Crops Research Institute, Kumasi, Ghana. Sporulated lesions on taro leaves were agitated in 10 mls of sterilized distilled water in a 9 cm petri dish. The resultant sporangial suspensions obtained were filtered through a cheesecloth to remove leaf debris. Aliqout of the sporangial suspension was mounted on a slide and observed microscopically (SWIFT microscope mounted with camera, Swift Optical Instruments, USA) at magnification of 100X. For pathogenicity test, leave discs (5 x 5 cm) of taro were placed on sterilised Whatman filter paper soaked with distilled water and placed in petri dishes. The leaves were inoculated with 2 mls of the sporangial suspension containing 10 sporangia of *P. colocasiae*.

2.4 Data Analysis

The experiment was unbalanced design with unequal replicates per site. The data for the leaf blight incidence and severity were analyzed using the Genstat statistical package version 12.0 (VSN International). All the collected data were subjected to ANOVA, followed by Duncan multiple comparison analysis, to determine significant differences ($P < 0.05$) among the treatments. The means were separated by the standard error differences at probability level of 5%.

3. RESULTS AND DISCUSSION

Leaf blight of taro is a major constraint to taro production worldwide [13]. In the current study, symptoms of the disease were identified in all the fields surveyed across the districts. The diseased symptoms were identified on the leaves, cormels and petioles of the plants (Figs. 1-7), resulting in extensive damage of the foliage and collapse of the petiole (Fig. 7). Symptoms of the disease appeared as small, dark brown flecks or light brown spots on the upper side of the leaf (Figs. 1,3) and water-soaked spots on the underside of the leaf (Fig. 3) as described by (14). The spots were found to appear on several parts of the leaf surface (Fig. 1) and enlarges rapidly, becoming circular and zonate until the whole leave is damaged. According to [14] the center of the lesions under dry weather conditions becomes papery and falls out producing a shot-hole appearance (Fig. 2). Dead leaves were found to hang on their petioles (Fig. 5) whilst white rings of mycelia (Fig. 2) were observed around the edges of the lesions which is a prominent sign of *P. colocasiae* [15].

Disease incidence and severity ranged between 30% and 92.5%, 6.5% and 86.5%, respectively (Table 3). The lowest incidence rate was recorded from East Akim (65%) whilst Tano South recorded the highest incidence (92.5%). Consequently East Akim recorded the least severity rate compared to Tano North which recorded the highest severity. There were significant differences in both disease incidence and severity across the various district (Table 3). The low incidence and severity rates recorded for East Akim could be due to the planting materials used and the good agricultural practices observed. It was observed that 67% of the fields surveyed were research fields planted with accessions from Samoa and Vanuatu whilst local varieties were used in all the other districts surveyed. *P. colocasiae* (Fig. 8) was isolated from infected tissues and was able to cause similar symptoms as observed on the field after inoculating them on taro leaves.

The transportation and use of diseased planting materials represents a major means of transmitting the disease. Due to the lack of certified and resistant varieties, farmers picked planting materials from any source and most especially from volunteer crops for propagation. It was also observed from the survey that taro which used to be a main crop grown around several low land areas and farmers' home has now been replaced by other crops such as rice and sugar cane since the outbreak of the disease. It has become a highly neglected and underutilized crop. Although the impact of the disease on taro production has not fully been documented in Ghana, reports from other countries such as Samoa shows the detrimental effect of the disease.

Table 3. Mean disease incidence and severity rates of *Phytophthora* leaf blight of taro from selected districts

Districts surveyed	Number of fields	Incidence (%)	Severity (%)
Ejisu-Juaben	6	84.2b	62.2bc
Kumasi Metropolis	6	90.0bc	55.2b
Ahafo-Ano South	5	82.5bc	37.8e
Bekwai Municipal	5	65.0e	32.8e
Sekyere South	4	83.8bd	40.9d
Atwima Mponua	4	80.0d	50.0cd
Kwahu-West Municipal	3	80.0d	50.0cd
East Akim Municipal	5	30.0f	6.5f
Tano South	4	92.5ab	68.3b
Tano North	4	90.0ab	86.5a
Sunyani West	4	71.7e	62.2bc
S.E		7.0	13.5

Values in the same column followed by the different letters were significantly different at P < 0.05

Fig. 1. Multiple spots/lesions on taro leaf

Fig. 2. Leaf blight showing shot hole and white mycelia around lesions

Fig. 3. Water soaks beneath spots

Fig. 4. Lesion inside and on surface of cormel

Fig. 5. Damaged leaf

Fig. 6. Affected petiole

Fig. 7. Broken petiole due to disease

Figs. 1-7. Symptoms of *Phytophthora* leaf and petiole blight of taro plants from surveyed fields

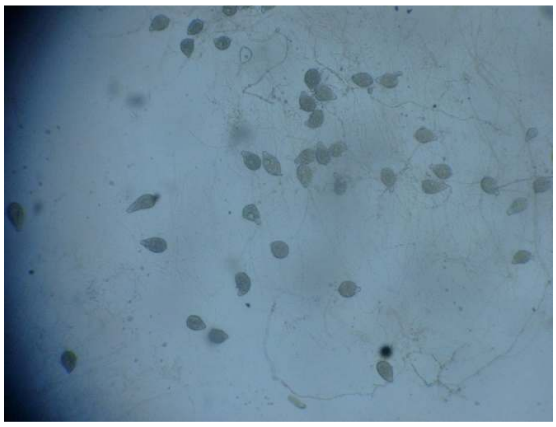

Fig. 8. Sporangia of *Phytophthora colocasaie* on Swift microscope (x100)

4. CONCLUSION

Results from this current survey suggest that leaf blight of taro has become an epidemic in the study areas, hence the urgent need to develop strategies to manage the menace. Management strategies should however be aimed at developing resistant varieties and low cost integrated management packages which can easily be adopted by farmers interested in taro production in Ghana. Finally, an impact study should be conducted to determine the effect of the disease on taro production in Ghana.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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