



Incidence and Severity of Taro Leaf Blight (*Phytophthora colocasiae* Raciborski) in the Sudanian Climatic Zone of Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijpss/2025/v37i45402>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/134423>

Original Research Article

Received: 09/02/2025

Accepted: 11/04/2025

Published: 14/04/2025

ABSTRACT

Taro leaf blight is considered the most destructive disease affecting taro worldwide. In the Sudanian climatic zone of Burkina Faso, the disease has led to a consistent decline in taro production over recent years.

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Cite as: Claire, CECE Marie, SOGOBA Kouka Hamidou, KOÏTA Kadidia, KABORE Bowende Zodo Appolinaire, OUEDRAOGO Nicolas, and TRAORE Renan Ernest. 2025. "Incidence and Severity of Taro Leaf Blight (*Phytophthora Colocasiae* Raciborski) in the Sudanian Climatic Zone of Burkina Faso". *International Journal of Plant & Soil Science* 37 (4):206-17. <https://doi.org/10.9734/ijpss/2025/v37i45402>.

Aims: The current research study was aimed to determine the incidence and the severity of taro leaf blight in various taro fields in three provinces of the sudanian climate zone.

Methodology: Plant growing conditions were assessed in 27 fields. Data on healthy and diseased plants, and leaves per plant, were collected within 64 m² quadrats. Disease incidence was the percentage of infected plants per field. Severity was rated on a 12-point scale (0–11) and converted to percentage of affected leaf area, averaged over 10 plants per field. Infestation intensity was calculated as the ratio of infected to total leaves per plant.

Place and Duration of Study: Surveys were conducted in fields across the provinces of Houet, Kéné Dougou, and Comoé between June and July 2021.

Results: *Phytophthora colocasiae* was morphologically identified from diseased taro samples based on the shape of sporangia, mycelial structure, colony characteristics, and the presence of chlamydospores, revealing morphological variability. The results showed that the disease was widespread across all three surveyed provinces, with notable differences in severity. The local variety *Tabouchi*, which is highly susceptible to leaf blight, was found in 88.88% of the surveyed fields. In contrast, the exotic variety *BL/SM/120*, known for its higher tolerance to the disease, was grown by only a minority of farmers. Disease incidence and intensity exceeded 50% in all provinces, with Kéné Dougou recording the highest severity (31.85%), followed by Houet (20.21%), and Comoé with the lowest (13.80%).

Conclusion: These results indicate that leaf blight constrains taro cultivation in these provinces. They also lay the groundwork for developing effective control strategies to safeguard taro production in the Sudanian climate zone of Burkina Faso.

Keywords: Food security; taro leaf blight; incidence; severity; mycelial structure.

1. INTRODUCTION

Taro (*Colocasia esculenta* (L.) Schott) is a major staple food in many parts of the world. It is one of the few plants where all parts are consumed (Matthews, 2010). Taro corms are essential food in the African diet, consumed in a variety of ways and used as food additives (Ubalua et al., 2016). The leaves are used as vegetables and are a good source of vitamins. They contain 23% protein by dry weight and are a rich source of calcium, phosphorus, iron, vitamin C, thiamine, riboflavin and niacin (Rashmi et al., 2018). In some Asian and Pacific food cultures, the flowers are also eaten. The corms and leaves are also used for medicinal purposes. They are used to treat high blood pressure, liver infections, rheumatism and snake bites (Safo-Kantanka, 2021). In addition, taro is a good source of calcium for children who cannot take milk due to lactose intolerance (Kreike et al., 2004) and is gluten-free, making it suitable for people with gluten intolerance. In Burkina Faso, taro contributes to food security and provides income to rural people (Traoré, 2014). It is produced in two climatic zones, the Sudanian and the Sudano-Sahelian. Four local varieties are cultivated (Cécé, 2019).

However, taro production is increasingly confronted with numerous biotic constraints including fungal diseases as Taro Leaf Blight

(TLB) caused by the oomycete fungus *Phytophthora colocasiae* Raciborski. This pathogen is the major constraint to taro production worldwide and is the main cause of severe yield losses ranging up to 100% of corms and leaves (Hong et al., 2021). The first symptoms are small brown spots on the leaf lamina that enlarge to dark brown lesions, often with a yellow margin (Manju et al., 2017). Petioles infection is infrequent, but occurs in susceptible varieties. Taro corms quality is affected by the disease. Rapidly development of rots is observed after harvest (Hong et al., 2021). TLB epidemics have potential to reduce food availability, indeed a serious threat to rural residents and regional food security.

Since 2009 in West Africa, TLB epidemics has been the main constraints to taro production (Onyeka, 2021). In Burkina Faso, the disease is a major constraint to the production of taro in the Sudanian climatic zone area with consequences on the plant and farmer's livelihoods (Cécé et al., 2024). The incidence and severity of disease studies are of fundamental importance to any effective disease management process. These studies have already been conducted on several crops such as yam (Ntawuruhunga et al., 2007), potato (Naher et al., 2013) and cassava (Kabemba et al., 2017) and taro (Lum et Takor, 2021). However, these data are still insufficient in Burkina Faso. This study aimed to

describe the symptoms of the disease and to estimate its incidence and severity in farmers' fields in the sudanian area of Burkina Faso.

2. METHODS

2.1 Study Area

The study was carried out in July 2021 during the rainy season across the three taro-producing provinces located in the Sudanian climatic zone of Burkina Faso: Houet, Comoé, and Kéné Dougou. This region is the most humid in the south, with average annual rainfall ranging from 900 to 1200 mm, distributed over a six-month period (World Bank, 2021). Additionally, it is characterized by minimal temperature fluctuations. These climatic conditions promote the growth of *Phytophthora colocasiae*, the pathogen that causes TLB (Benzohra et al., 2018).

2.2 Sample Collection and Isolation of Pathogen

During the survey, some samples of infected leaves showing notable symptoms such as brown spots with yellow margins, water-soaked necrotic areas that coalesced into large lesions, blighted leaf blades were collected randomly, placed in collection bags and sent to the Phytopathology Laboratory at Joseph KI-ZERBO University for isolation and purification of the pathogen according to the fungus isolation protocols of Abdulai et al., (2020). The isolation was carried out under a laminar flow hood. Portions of taro leaves, including both symptomatic and healthy parts, were cut. They were surface-sterilized in 70% ethanol for 1 minute, then carefully washed in three exchanges of distilled water and dried on filter paper for 2 minutes, after which they were placed on potato dextrose agar at 28 °C for three days and examined daily for mycelial growth development. The isolation was replicated three times. The identification involved first examining the necrotic parts of each sample under a magnifying glass. Then, these necrotic parts were scraped using a metal loop, and the obtained residues were mounted between a slide and cover slip, followed by observation under a microscope (magnifications of 10x10 and 40x10). The images of the sporangia obtained were compared to the description provided by Barry (1989) for microscopic identification of the pathogen.

2.3 Disease Incidence Determination

The study involved sampling for disease incidence in 10 randomly selected taro fields, each aged 6 to 7 months, across the provinces of Kéné Dougou and Comoé. In contrast, only 7 fields were chosen in the province of Houet due to the gradual decline of taro cultivation in that area. Initially, the study documented field characteristics, including the varieties cultivated and the type of fertilizers used. Subsequently, quadrats measuring 64 m² were established within each field. The density of plants was determined by dividing the total number of plants by the area of the quadrat. Disease incidence was then calculated using the formula provided by Chaube and Pundhir (2005):

$$\text{Incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants in the quadrat}} \times 100$$

2.4 Disease Severity Determination

Ten plants were then randomly selected and observed individually to describe the disease symptoms. Disease severity was assessed by observation using a scale (Fig. 1) on the 10 plants. New partially rolled leaves and old leaves touching the ground were not assessed. Leaves showing symptoms of TLB were scored on a 12-point scale ranging from 0 to 11 per plant (Miyasaka et al., 2012). Scores for each leaf blade were converted to the average percentage of leaf blade area affected by disease (0%, 0.5%, 3%, 7%, 13.5%, 28%, 50%, 72%, 86.5%, 94%, 97.5% and 100%) according to the scale and averaged over 10 plants.

2.5 Determination of Disease Intensity

Ten diseased taro plants were randomly selected from each quadrat. For each plant, the number of diseased and healthy leaves was counted. Infestation intensity was calculated according to the formula of Brunner et al. (2017):

$$\text{Infestation intensity (\%)} = \frac{\text{Number of infected leaves}}{\text{Total number of leaves per plant}} \times 100$$

2.6 Data Analysis

The calculation of frequencies, incidence, mean infestation intensity and the construction of diagrams were performed using Excel version 2016. The test of Pearson's correlation was carried out with the data on density, incidence,

severity and average intensity of infestation to highlight the relationships between these different parameters using XLstat (2016).

3. RESULTS

3.1 Symptoms Description of the Disease

Of the 27 fields surveyed in the three provinces, 22 showed similar symptoms, in particular more or less large, zoned necrotic spots that coalesce to destroy the leaf blade (Fig. 1a). The margin of the lesion is marked by a white powdery band of sporangia and numerous droplets of orange exudate (Fig. 1b). Lesions may become dry during the day, disintegrating and giving the appearance of holes in the leaf blade (Fig. 1c, e). Rotting petioles (Fig. 2a, b, c), sheaths (Fig. 3a) and flowers (figure 3b) have also been observed. However, in the province of Houet, fields in the locality of “Karangasso-Sambla” showed different symptoms compared with fields elsewhere. In this locality, yellowing and non-zonal necrosis of the leaf blades were observed (Fig. 4).

3.2 Morphological Identification of the Pathogen

Pathogens isolated from diseased taro samples in localities in the Houet, Kéné Dougou and Comoé provinces were morphologically identified as *Phytophthora colocasiae* on the basis of sporangia shape, mycelium, colony color and shape, and observation of chlamydospores. The results showed three types of sporangia. Sporangium A has a cylindrical shape containing spores in aggregate and forming a nucleus. Its membrane is less visible, with a transparent outgrowth. It ends with a less distinct mycelial branching (Fig. 5_A). Sporangium B has a slightly elongated ovoid shape, lacking mycelial branching and formed of two well-visible membranes with a less developed outgrowth. The spores are formed in aggregates (Fig. 5_B). As for sporangium C, it is elongated and rounded with a thick membrane containing spores grouped in aggregates and/or free in the cytoplasm of the sporangium. These elements are visible under an optical microscope,

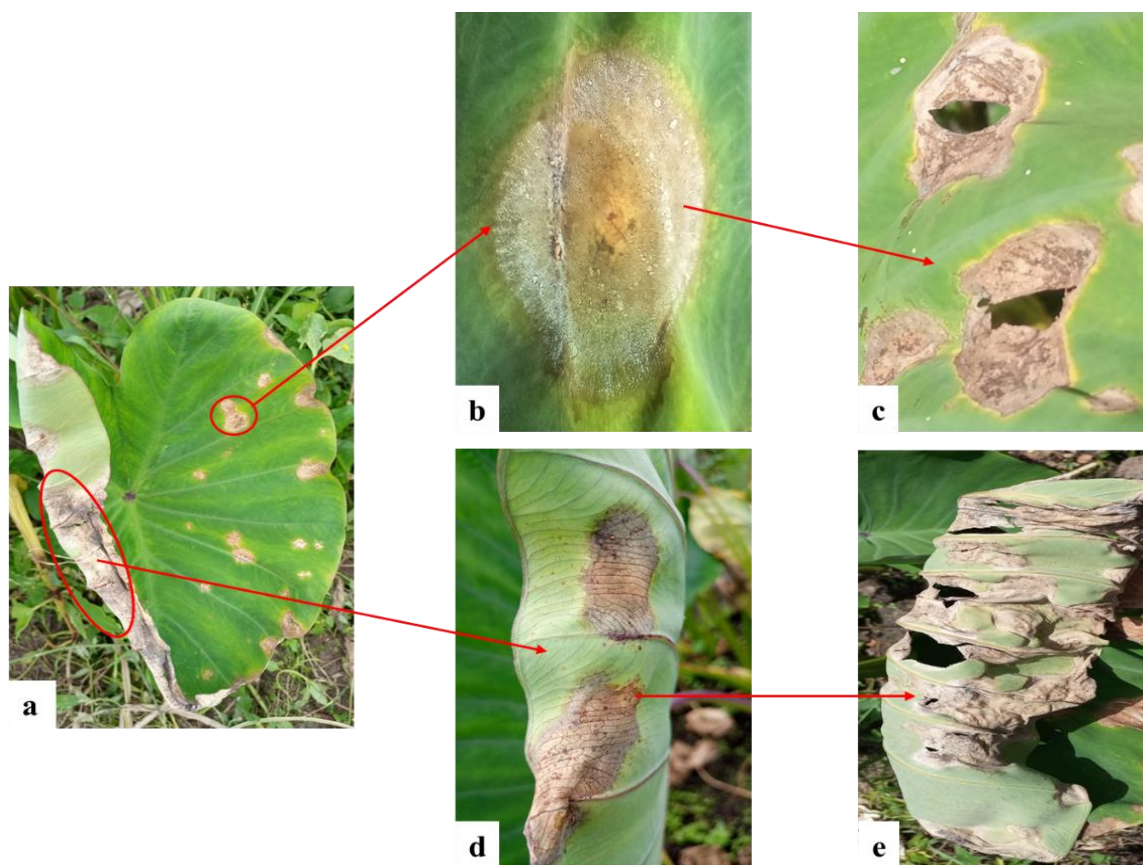


Fig. 1. TLB symptoms in the field

Legend: a: symptomatic leaf; b: zoom of the symptom on the upper side of the leaf blade; c: evolution of the symptom forming holes; d, e: view of the symptom on the lower side of the leaf blade

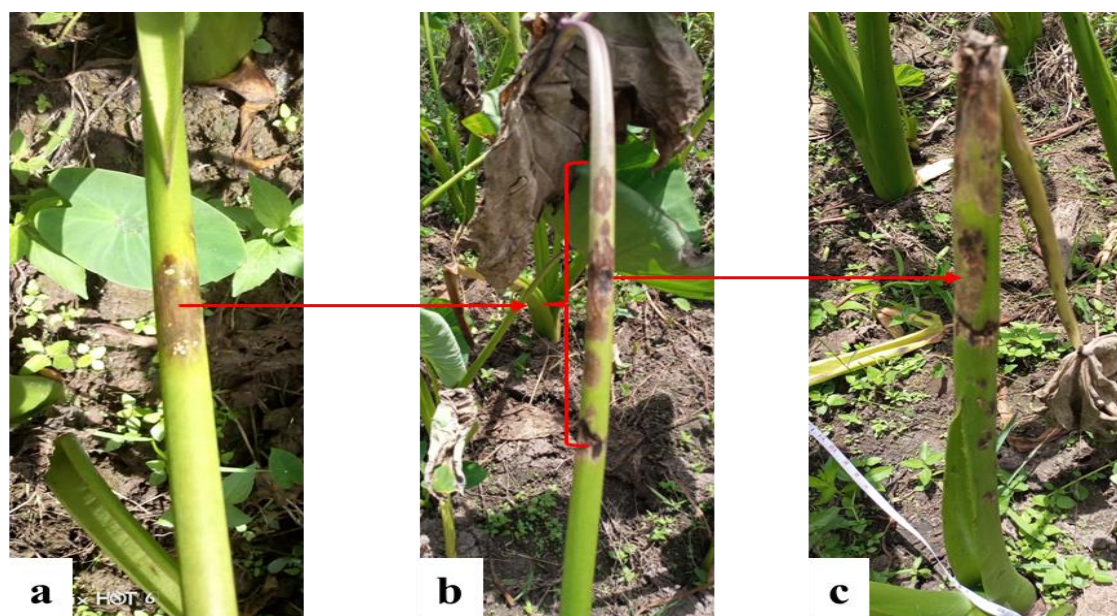


Fig. 2. Petiole rot

Legend: a: initial necrotic spot; b: development of necrotic spots; c: destruction of the petiole

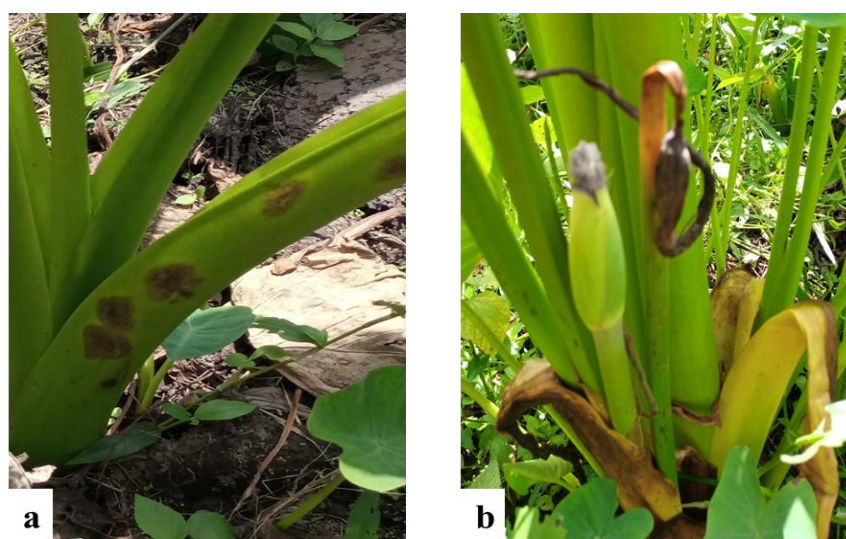


Fig. 3. Sheath (a) and flower (b)

particularly at a magnification of 40x10 (Fig. 5_C). The colors of the colonies varied from white to light pink, with textures ranging from cottony (Fig. 6_A) to star-shaped (Fig. 6_B). The chlamydo spores are cylindrical in shape, with a thick membrane and visible contents under an optical microscope, particularly at a magnification of 40x10 (Fig. 7).

3.3 Profile Description of Field

The studied fields showed various characteristics. In terms of topography, 55.56%

of fields were located on plains, while 44.44% were in lowlands, mainly in the province of Kéné Dougou. In the provinces of Houet and Comoé, all fields were surrounded by mango, banana and avocado plantations. The cropping system predominantly involved monoculture, with two varieties being grown either alone or together. The local variety *Tabouchi* was the most widely grown in the provinces of Houet and Kéné Dougou, while the exotic variety *BL/SM/120* was more common in the province of Comoé. All producers utilized organic manure and mineral fertilizer.

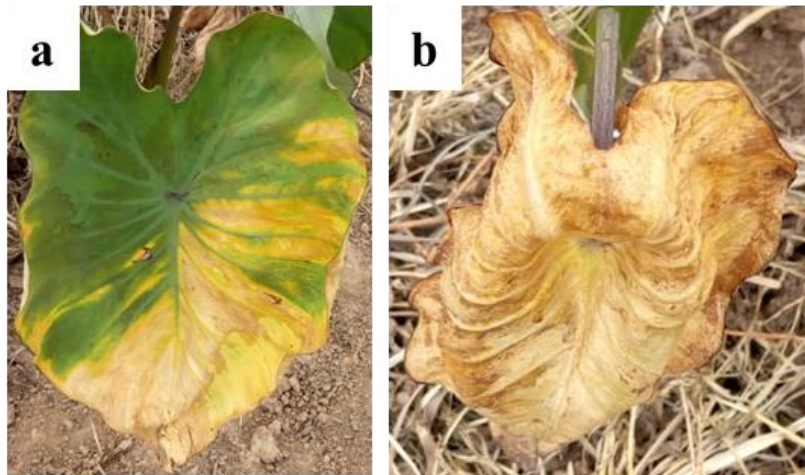


Fig. 4. Symptoms observed at Karangasso-Sambla (Houet)
Legend: a: beginning of yellowing of the leaf blade; b: complete necrosis of the leaf blade

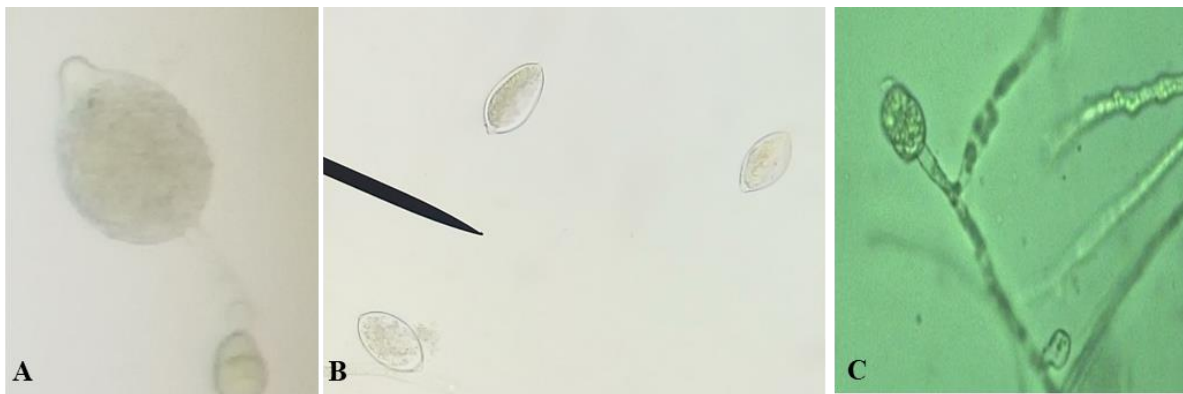


Fig. 5. Different types of sporangia of *Phytophthora colocasiae*

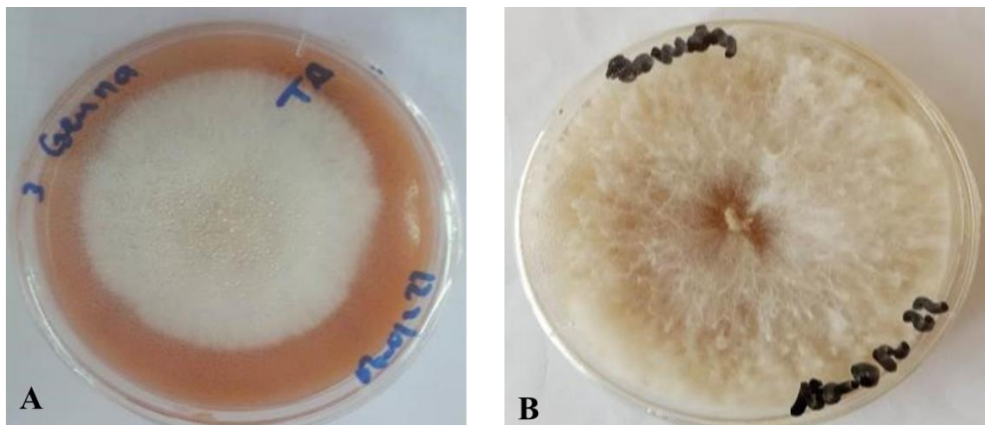


Fig. 6. Mycelial colonies of *Phytophthora colocasiae*

3.4 Effect of the Disease on Varieties Produced in the Sudanian Climatic Zone

Both varieties *Tabouchi* and *BL/SM/120* produced in the area are affected by TLB.

However, they differ in their expression of disease symptoms. In the fields where the exotic variety *BL/SM/120* was grown, the minimum incidence was 26% and the maximum 42%. Disease severity was also low in these fields (minimum: 3%; maximum: 7%). In addition, the

spots were only visible on the leaf blade, without completely destroying the entire blade (Fig. 8). The petioles of this variety are not attacked by the disease. This variety seems to be tolerant to leaf blight. Most of the fields surveyed were planted with the local *Tabouchi* variety (88.88%).

Growers produce it despite its high susceptibility to the disease. The disease affects all parts of the plant (leaf blade, petiole, corm) (Fig. 9). The minimum incidence was 34.54% and the maximum 100%. The estimated severity had a minimum value of 3% and a maximum of 97.5%.

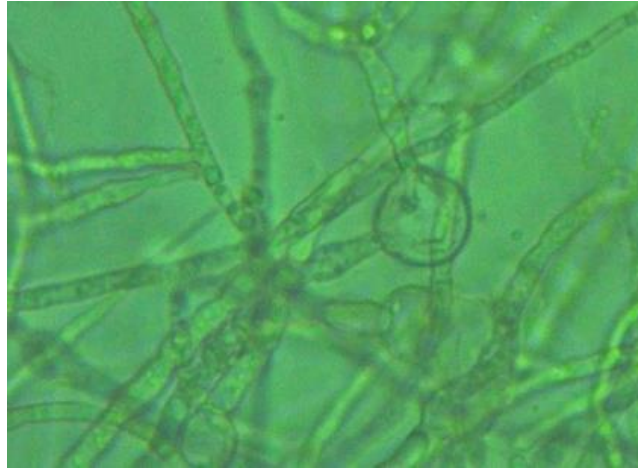


Fig. 7. Microscopic view of a chlamydospore of *Phytophthora colocasiae*



Fig. 8. Symptoms of TLB on the exotic variety *BL/SM/120*

Legend: a: infested fields of the exotic taro variety *BL/SM/120*; b: necrotic spots on the leaf blade



Fig. 9. Symptoms of TLB on the local variety *Tabouchi*

Legend: a: field of the local variety *Tabouchi* infested by leaf blight; b: leaf blade destroyed by the disease; c: petiole rot; d: collet and root rot

3.5 Incidence, Severity and Intensity of TLB in the Three Provinces

The incidence of TLB is very high in the Sudanian climatic zone of Burkina Faso. The province of Kénédougou recorded the highest average incidence (96%), followed by the province of Comoé (80.4%) and the province of Houet (73.90%) (Fig. 10). As for the severity of the disease, the mean values were 31.85%, 31.88% and 13.80% respectively for Kénédougou, Houet and Comoé provinces (Fig. 10). The province of Kénédougou recorded the higher mean intensity of disease infestation (76.63%) (Fig. 11).

The Pearson correlation test (Table 1) shows non-significant correlations between taro planting density and the incidence, severity and average

intensity of disease infestation. A strong positive correlation (0.748) was observed between incidence and infestation intensity of TLB.

4. DISCUSSION

Taro is affected by at least ten major pests and diseases worldwide (Kohler et al., 1997), among which *Phytophthora colocasiae*, the causal agent of taro leaf blight (TLB), is considered the most destructive. This pathogen has been reported to cause up to 95% reduction in leaf yield, post-harvest rot affecting up to 50% of the yield, and deterioration of corm quality (Jackson, 1999; Singh et al., 2006; Nelson et al., 2011).

In the Sudanian climatic zone of Burkina Faso, field observations revealed that TLB has spread throughout most taro-growing areas,

Table 1. Pearson correlation test

Variables	Density	Incidence	Severity
Incidence	-0,018		
Severity	0,024	0,371	
Intensity	-0,067	0,748	0,322

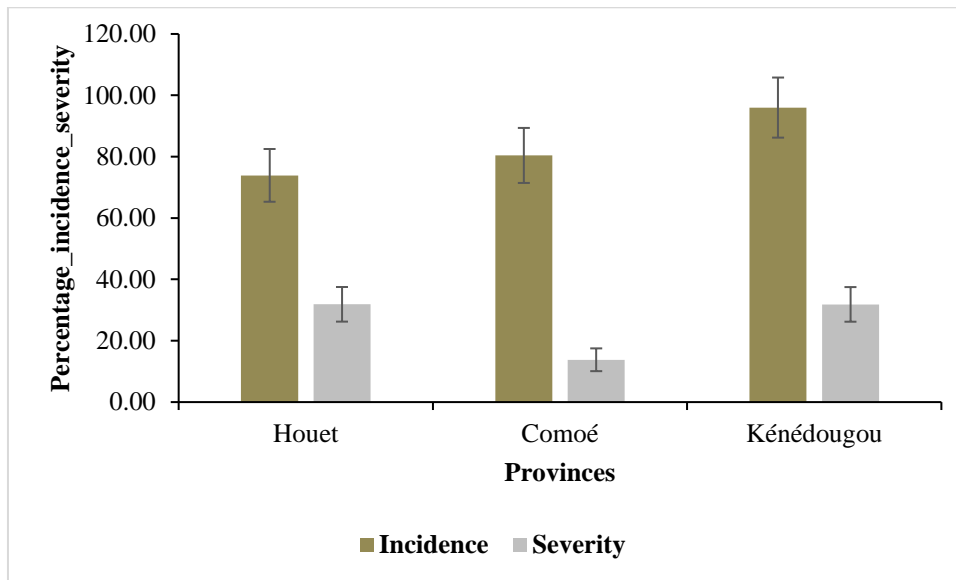


Fig. 10. Average incidence and severity of TLB in the three provinces

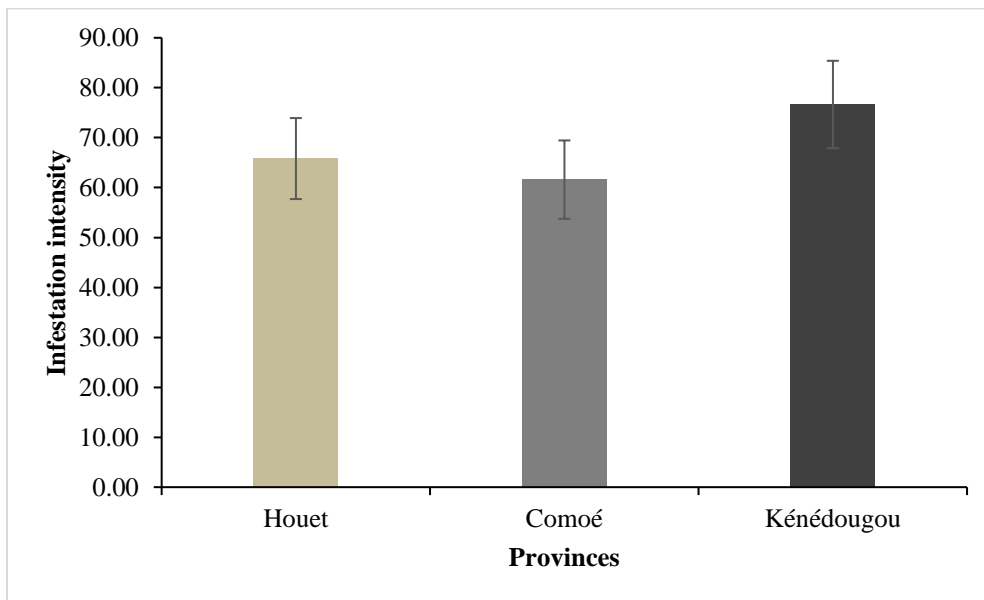


Fig. 11. Average infestation intensity

with the notable exception of Karangasso Sambla (Houet province). In all other surveyed fields, symptoms typical of TLB were observed, consistent with those reported in Samoa (Hunter et al., 1998), Nigeria (Bandyopadhyay and Sharma, 2011), and Cameroon (Manju et al., 2017). The spread of the disease in this region may be associated with informal seed exchange practices, as reported in Ghana (Abdulai et al., 2020). According to Traoré (2014), farmers often obtain planting materials either from local markets or from other farmers within or near their communities. Previous studies have shown that

once the disease is introduced into a country, it can quickly spread across production zones (Bandyopadhyay and Sharma, 2011; Fontem and Mbong, 2011; Omane et al., 2012). The apparent absence of the disease in Karangasso Sambla may be attributed to the farmers' reliance on self-saved planting material, which may have contributed to delaying the introduction of the pathogen in that locality.

Monoculture is the dominant cropping system (95%) in the study area. A small fraction of fields (0.07%) uses a mixed cropping system involving

the exotic variety BL/SM/120, known by farmers for its tolerance to TLB, cultivated alongside the local variety Tabouchi. This strategy, observed in Comoé province, serves as a cultural control method to reduce disease damage to the local cultivar. As reported by Akanda and Mundt (1996), disease spreads more slowly in mixed cropping systems, likely due to the presence of non-host plants or resistant varieties that interrupt the transmission cycle. In this case, the inclusion of a less susceptible variety helps lower disease severity in the field.

TBL disease incidence is high across the three provinces surveyed. However, disease severity is relatively lower in Comoé province, likely due to the cultural control measures adopted by farmers. The high incidence and severity observed in the region can be attributed to two main factors: the favorable climatic conditions for the pathogen's development and the high susceptibility of the widely cultivated local variety. Similar results were also reported for bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae*, with an incidence rate of 72.34% recorded (Yagnasree et al., 2024). In Kenya, Otieno et al. (2018) highlighted the role of environmental factors in the occurrence of TLB, with an average incidence of 27.9%, which is lower than the rates observed in Burkina Faso likely due to varietal differences. Likewise, field surveys in Ghana reported high disease incidence (30% to 92.5%) and severity (6.5% to 86.5%) (Adomako et al., 2016).

Since severity is measured as the percentage of the leaf area affected by blight, high severity levels can be used as an indirect indicator of potential yield loss. Leaf characteristics such as blade length and width, plant height, and the number of leaves per plant are positively correlated with yield-related traits such as corm weight and diameter (Traoré, 2014; Cécé, 2019; Boampong et al., 2018). Thus, severe leaf damage is likely to negatively impact taro productivity. According to farmers, TLB has caused a noticeable decline in taro production in the Sudanian zone of Burkina Faso (Cécé et al., 2024).

These findings confirm that TLB is the main constraint to taro cultivation in the region. The results presented here provide a scientific basis for the development of effective and locally adapted strategies to manage the disease in the Sudanian climatic zone of Burkina Faso.

5. CONCLUSION

Characterization of farmers' taro fields in the three provinces of the Sudanian climate zone shows that the plant is produced on a varied topographical type. Taro production in the area is limited by the high incidence and severity of the disease. Despite its susceptibility to the disease, the local variety *Tabouchi* is predominant in the area, demonstrating the attachment of producers to this variety.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

DATA AVAILABILITY

Data presented in this study will be available on a fair request to the corresponding author

ACKNOWLEDGEMENTS

Thanks to LEBOT Vincent for proofreading the manuscript and providing relevant literature.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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