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INVENTORY OF FUNGI GENERA RESPONSIBLE FOR AFRICAN EGGPLANTS DISEASES (*SOLANUM AETHIOPICUM* L. AND *SOLANUM MACROCARPON* L.) AND ASSESSMENT OF THE PREDOMINANT PATHOGEN IN BURKINA FASO

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ABSTRACT

Fungal diseases represent a major constraint for African eggplants producers. This study aims at contributing the improvement of the production of two species of *Solanum*, *Solanum aethiopicum* L. and *Solanum macrocarpon* L. in Burkina Faso through better management of these diseases. A high prevalence of the disease has been observed in the provinces of Houet and Bazèga. Laboratory analyses were conducted to diagnose fungal pathogens associated with samples from diseased plants. The findings revealed seven fungal genera associated with these two species, with a varying relative citation frequencies. These include *Fusarium* (FRC average = 96.5%), *Colletotrichum* (55.9%), *Alternaria* (21.5%), *Aspergillus* (10.2%), *Botrytis* (9.35%), *Curvularia* (6.3%), and *Exserohilum* (0.85%). Among these genera, *Fusarium* was frequently detected in symptoms such as leaf yellowing and necrosis by 95.8%, plant wilting by 96.9%, plant desiccation by 95.8%, and fruit rot by 94.3%, and was found in all plant organs of both species (leaf, stem, root, and fruit). The same applies to the *Colletotrichum* genus, which had a high frequency only in *S. macrocarpon* by 74.7%. At the end of the pathogenicity test, two *Fusarium* isolates, E38FUS named *Fusarium flagelliforme* and E41FUS named *Fusarium falciforme*, proved to be more pathogenic in terms of disease incidence and severity. The GenBank accession number of these two isolates are respectively PV363863 and PV363622. This study is a crucial step in choosing the right control strategies.

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INTRODUCTION

African eggplants (*Solanum aethiopicum* L. and *Solanum macrocarpon* L.) are leafy vegetables and fruits which are widely grown due to their nutritional and therapeutic virtues. Indeed, they are increasingly recognized for their contributions to food supply and income generation among horticultural producers (Adeyeye and Adanlawo, 2011; Daunay *et al*., 1998; NRC, 2006; Rubaihayo, 2002). They are rich in mineral salts, dietary fiber, proteins, iron, Vitamin C, and also contain appreciable levels of calcium, carotene, and saponins (Agoreyo *et al*., 2012; Bationo-Kando *et al*., 2016; Horna *et al*., 2007; Nyadanu and Lowor, 2015; Okon *et al*., 2010). Their consumption is associated with reduced blood cholesterol levels and contributes to the prevention of cardiovascular diseases and obesity as well (Muanya, 2009). Additionaly, African eggplants are also used in the treatment of various ailments such as gastroesophageal conditions, cholera, asthma, skin

infections, constipation, vomiting, diarrhea, diabetes, and hypertension (Adeniji and Aloyce, 2012; Daunay *et al*., 1998; Nwodo *et al*., 2011).

In recent years, however, the production of African eggplants in Burkina Faso has been constrained by numerous factors, similar to those affecting the growing of tomato and purple eggplant *S. melongena* (AVRDC, 2005; Daunay *et al*., 1997). These include insects pests, nematodes, viruses, bacteria, and fungi (Tiendrebeogo *et al*., 2023). Fungal diseases, frequently identified are responsible for significant yield losses and that discourage gardeners from continuing the growing of African eggplants. The symptoms include leaf yellowing followed by necrosis, plant wilting, plant drying, and fruit rot (Djidji and Fondio, 2013; Kaboré, 2019; Messiaen *et al*., 1991; Sikirou *et al*., 2011). In response to the intensification of these diseases, the development of effective and sustainable control methods requires accurate identification of the fungal pathogens involved. This study aligns with this objective, aiming at promoting healthy production and revitalizing African eggplants cultivation (*S. aethiopicum* and *S. macrocarpon*) in Burkina Faso.

MATERIALS AND METHODS

Study Area

Symptomatic fragments of African eggplants including leaves, stems, roots, and fruits, were collected from eleven provinces across Burkina Faso between October and December 2022. These provinces included Bazèga, Zoundwéogo, Sanguié, Boulkiemdé, Kadiogo, Ziro, Oubritenga (located in the Sudano-Sahelian zone) as well as Nahouri, Sissili, Houet, and Comoé (within the Sudanian zone). Each symptomatic fragment, as well as the entire plant itself, constituted the sample, which was collected randomly from 10 plants using the diagonal method (or X method). The samples were transported to the mycology laboratory of the Regional Center of Excellence in Fruits and Vegetables (CRE-FL) at INERA/Farako-Bâ.

Disease Incidence and Severity Assessment

The disease incidence and severity were assessed by taking into account all the plants on each of the 60 plots, ranging in size from 15 to 2,500 m^2. Visual identification of fungal symptoms was carried out on each plot, followed by manual counting of all plants showing these symptoms. A pre-prepared form was used to record the data, namely the number of plants affected and the total number of plants in the plots concerned. Cooke's formula (2006) was adapted to calculate the incidence rate per site.

$$Im\ \% = \frac{n}{N} \times 100$$

Im： incidence rate by site ;

n： number of diseased plants per site ;

N： total number of plants observed in a site.

Severity was assessed on ten symptomatic samples for each plot. The four-class scale developed by Lebeda and Urban (2004) was adapted for this assessment (Table 1). The disease severity index for a site was determined using the following equation (Kranz, 1988):

$$Is = \sum \left(\frac{Xixni}{NxZ}\right) x100$$

with : *Is* : Disease severity index on site, *Xi* : Severity *i* of the disease on the plant, *ni* : Plant number of severity *i*, *N* : Total number of plants observed (*N* = 10) et *Z* : Highest severity scale, rating 4.

Table 1. Lebeda and Urban (2004) scale adapted for assessing the severity of fungal diseases in African eggplants.

Scales	Symptom characteristics
0	Plants that appear healthy
1	Yellowed and necrotic plants
2	Wilted plants
3	Dried plants
4	Plant bearing rotten fruit

Fungal Inventory

The collected samples were incubated based on four types of fungal symptoms, with the number of samples ranging from 5 to 14 (Table 2). They were cut into small pieces. The fragments of each organ were subjected to sterilization using 70% alcohol, followed by 1% bleach, and then rinsed with sterile distilled water in order to eliminate surface saprophytic flora. They were then placed in Petri dishes lined with previously sterelized, moistened blotting paper using sterile distilled water. Each dish contained four fragments of each type of organ (Dianda *et al*., 2018). The prepared treatments were incubated at 28°C under alternating light conditions : 12 hours of UV light followed by12 hours of darkness for a period of 7 days with the aim of stimulating fungi sporulation. This light comes from a near-UV lamp. The observation of pycnidia and acervuli through a stereomicroscope, followed by conidia under light microscope (40X) were compared with the data provided in the identification manuel of Mathur and Kongsdal (2003). Benzene was used to sterilize the medium during the isolation of fungi. A pre-designed data sheet was used to record the different fungi genera

associated. Based on fungi frequency assessment, the fungi genera were classified according not only by eggplant species, but also by symptoms and organs.

Pathogenicity of Predominant Fungus

Given the diversity of fungi obtained and the high frequency of the *Fusarium* genus, 28 isolates of this genus were selected based on the characteristic symptoms of fusarium wilt (Table 3). These isolates were used to inoculate eight African eggplant genotypes, four *S. aethiopicum* and four *S. macrocarpon* (Table 4).

Table 2. Number of incubated samples.

Species	Symptoms			
	Leaf yellowing and necrosis	Plant wilting	Plant Drying	Fruit rot
Solanum aethiopicum	10	11	7	5
Solanum macrocarpon	6	14	14	5

Table 3. Various *Fusarium* isolates used.

Provinces	Symptoms			
	LYN	PW	PD	FR
Nahouri	E7 FUS	E4 FUS	E2 FUS	E3 FUS
Zoundwéogo	E11 FUS	E15 FUS	E9 FUS	E7' FUS
Sanguié	E34 FUS S.m	E41 FUS S.m	E18 FUS	E11' FUS
Sissili	E47 FUS S.m	E65 FUS S. m	E36 FUS	E21 FUS
Oubritenga	E57 FUS	E76 FUS	E58 FUS	E34 FUS
Houet	E64 FUS	E85 FUS	E70 FUS	E38 FUS
Comoé	E81 FUS	E95 FUS	E71 FUS	E41 FUS

Legend : LYN : Leaf yellowing and necrosis ; PW : Plant wilting ; PD : Plant drying ; FR : Fruit rot ; EFUS : Code for the Fusarium isolate (obtained from Solanum aethiopicum) ; EFUS S.m : Code for the Fusarium isolate (obtained from Solanum macrocarpon).

Table 4. Different genotypes of African eggplants used

Species	Genotype codes							
	G1	Origins	G2	Origins	G3	Origins	G4	Origins
Solanum aethiopicum	4AL4	Bazèga	12AL4	Houet	13AL5	Ioba	16AL2	Koulpélogo
Solanum macrocarpon	LS13	Sissili	RT7	Sanguié	TG1	Nahouri	BD4	Sissili

Legend : G1 : genotype 1 ; G2 : genotype 2 ; G3 : genotype 3 ; G4 : genotype 4.

Plant Inoculation

The experiment involved inoculating two-week-old seedlings with isolates that had been cultured for 10 days, using an eight-replication split-plot design, with genotypes as the main plot and isolates as the subplot. Conidial suspensions were prepared by diluting Tween 80 (0.05%) with sterile distilled water. The mycelia of each isolate were scraped off and vortexed with 10 ml of this solution (Tween 80 diluted to 0.05%), which was also used to adjust the concentration of the suspensions until a concentration of 10^6 conidia/ml was obtained for each isolate (Abawi and Pastor-Corrales, 1990). A drop of the suspension was injected at the seedling's collar, on the leaf, and onto the potting soil (Figure 1), with the exception of the control seedlings.

The data collected included the percentage of seedlings that had emerged 21 days after sowing (EM21), the incidence of the disease (INC), which is the percentage of infected seedlings (the number of infected plants out of the total number of plants examined, expressed as a percentage), and the severity (SEV) of the disease, which was assessed using a 5-class scale described by Abawi and Pastor-Corrales (1990). The incidence scores from the sixth week were used for the analysis. The same applies to the average severity indices, whose scores were calculated using the formula employed by Williams and

Singh (1981) and expressed as a percentage. That is:

$$SEV = \sum (\frac{Xixni}{NxZ}) x100$$

with : *SEV* : Disease severity index, *Xi* : Severity *i* of the disease on the plant, *ni* : Number of plants of severity *i*, *N* : Total number of plants observed (*N* = 8) et *Z* : The highest severity level, a score of 9.

Adapted scale: according to Abawi and Pastor-Corrales (1990):

1- No visible symptoms

3- One to three leaves, accounting for only 10% of the foliage, are wilted and chlorotic

5- Approximately 25% of the leaves and branches are wilted and chlorotic

7- Approssximately 50% of the leaves and branches are wilted and chlorotic

9- Approximately 75% of the leaves and branches show signs of wilting, chlorosis, and defoliation, which may eventually lead to the death of the plant.



Figure 1. Inoculation of African eggplant seedlings.

Confirmation of Koch's Postulate

Koch's postulate involved collecting four symptomatic samples per genotype and per isolate. The plant parts were disinfected in 70% alcohol, 1% bleach, and then in sterile distilled water, and incubated at 28°C under alternating 12-hour cycles of UV light and 12 hours of darkness (Dianda *et al*., 2018). One week after incubation of the fragments, the fungi were re-isolated, and their morphological characteristics were compared to those used for plant inoculation using a binocular magnifying glass, an optical microscope, and the identification key by Mathur and Kongsdal (2003).

Statistical Analysis

Microsoft Excel 2016 was used for data entry and organization. The software RStudio 2024.04.1, with the ethnobotanyR package version 0.1.9 was employed to work out the relative citation frequencies, i.e., the number of symptomatic fragments from which the fungus was isolated, divided by the total number of incubated fragments. Diversity indice (Simpson's index= 1-D, Shannon's index= H') and eveness (E), were computed using PAST software version 3.22.

Simpson's index fundamentally measures the probability that two randomly selected fungus belong to the same genus. High values indicate greater diversity.

$$D = \sum Pi^2 \; and \; Pi = \frac{Ni}{N}$$

where *Ni* represents the number of fungus *i* and *N* the total number of fungi.

Shannon's index combines the number and the evenness of each fungus.

$$H' = -\sum (\frac{Ni}{N}) * \ln(\frac{Ni}{N})$$

Pielou's equity index measures the ratio of observed diversity to the maximum possible diversity, meaning the uniformity measuring the distribution of fungus species.

$$E = \frac{H'}{\ln S}$$

where H' represents Shannon index and S the total number of fungi recorded in a given area.

RESULTS

Field Infestations Status

The incidence and severity rates of fungal diseases by province show that Houet Province has the highest incidence rate (89%) and Boulkiemdé Province has the lowest incidence rate (16.5%). The highest severity rate was recorded in Bazèga Province and the lowest in Oubritenga Province, with respective frequencies of 73% and 41.5% (Table 5).

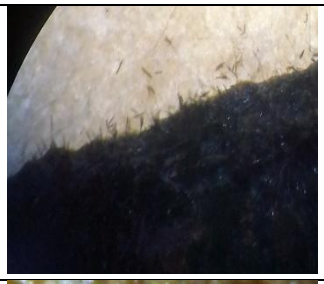
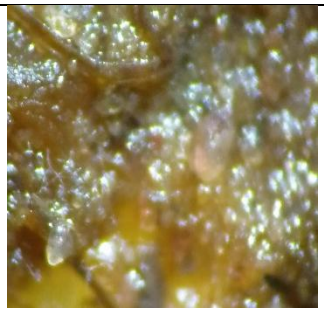
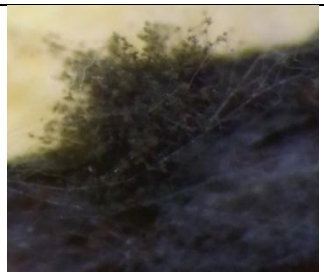
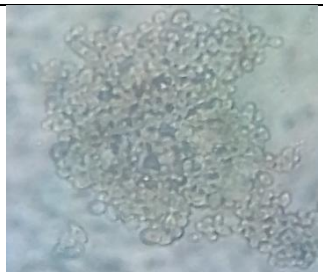
Table 5. Disease assessment in the surveyed fields.

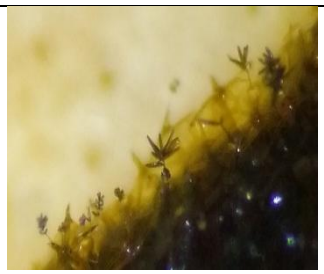
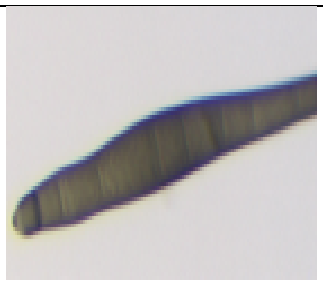
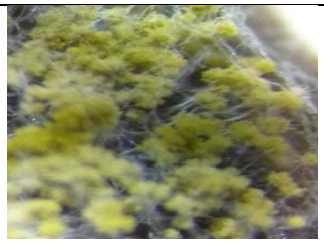
Provinces	Incidence (%)	Severity (%)
Nahouri	62,5	62,5
Bazèga	72	73
Zoundwéogo	77,5	64
Sanguié	70	69
Boulkiemdé	16,5	59
Kadiogo	52	51,5
Sissili	66,5	56,5
Ziro	34,5	42,5
Oubritenga	78,5	41,5
Houet	89	53
Comoé	71	47,5

Description of Fungal Inventories

Miscroscopic and stereoscopic observations revealed a collection of seven genera of fungi (Table 6). Three genera, namely *Fusarium*, *Colletotrichum*, and *Alternaria* are the most frequently observed. *Aspergillus*, *Botrytis*, *Curvularia*, and *Exserohillum* were occasionally encountered. These fungi were present in all analyzed organ.

Table 6. Inventoried fungi genera.

Fungi genera	Observation under binocular magnifier 7 days after incubation	Observation under the optical microscope (40X)
Fusarium		
Alternaria		
Colletotrichum		
Botrytis		

Exserohillum		
Curvularia		
Aspergillus		

Fungi Diversity Across Provinces

The values of the calculated diversity indices (Table 7) reveal that the most diverse provinces in terms of fungus are Sissili (0.68), Zoundwéogo (0.67), Oubritenga (0.66), Sanguié (0.65), Comoé (0.62), Ziro (0.59), Kadiogo (0.58), and Houet. (0,53). Regarding the equity index value (E), it ranges from 0.62 to 0.90 respectively for the provinces of Houet and Ziro. Besides Ziro, a greater evenness values of fungi is observed in the Boulkiemdé province (E= 0.84) and in Comoé (E= 0.81).

Table 7. Diversity and equity of fungi inventoried in the eleven provinces

Provinces	1-D	H'	E	Fungi inventoried
Nahouri	s	0.87	0.63	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Aspergillus*
Bazèga	0.39	0.7	0.63	*Fusarium* ; *Alternaria* ; *Colletotrichum*
Zoundwéogo	0.67	1.44	0.74	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis* ; *Curvularia* ; *Exserohilum* ; *Aspergillus*
Sanguié	0.65	1.28	0.65	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis* ; *Curvularia* ; *Exserohilum* ; *Aspergillus*
Boulkiemdé	0.39	0.58	0.84	*Fusarium* ; *Colletotrichum*
Kadiogo	0.58	1.09	0.78	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Aspergillus*
Sissili	0.68	1.36	0.76	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis* ; *Curvularia* ; *Aspergillus*
Ziro	0.59	0.99	0.9	*Fusarium* ; *Alternaria* ; *Colletotrichum*
Oubritenga	0.66	1.37	0.76	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis* ; *Curvularia* ; *Aspergillus*
Houet	0.53	1.12	0.62	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis* ; *Curvularia* ; *Aspergillus*
Comoé	0.62	1.13	0.81	*Fusarium* ; *Alternaria* ; *Colletotrichum* ; *Botrytis*

Fungal Distribution across African Eggplants Species

All seven genera of fungi were observed in both African eggplants species, with a frequency variation ranging from 0.004 to 0.974 depending on the specie and the fugal genus identified (Table 8). *Fusarium* recorded the highest relative citation frequency for both species (FRC = 95.7% for *S. aethiopicum* and 97.4% for *S. macrocarpon*). In addition to *Fusarium*, *Colletotrichum* (84.4%) also had a

very high citation frequency in *S. macrocarpon*. The least observed genus in both species was *Exserohilum* with a relative citation frequency below 2%.

Type of Fungi Associated with Organs

Among the various fungi identified, *Fusarium* is the most frequently recorded on all vegetative *organs* of both plants (Figure 2). In *S. aethiopicum* specie, the *Fusarium* genus is the dominant fungus responsible for symptoms across different plant organs. It is followed by the *Colletotrichum* genus with proportions ranging from 15.6% (in the roots) to 29.10% (in the leaves). The fruits are infected by three genera: *Fusarium* (88.60%), *Colletotrichum* (17.10%), and *Aspergillus* (11.40%).

In the *S. macrocarpon* specie, along with *Fusarium*, the *Colletotrichum* genus is also mentioned with a very high frequencies on the leaves (95.5%), stems (96.2%), and roots (95.8%). The fruits are attacked by two genera: *Fusarium* (100%) and *Colletotrichum* (10%). *Aspergillus* and *Alternaria* are more prevalent on the stems (with a proportion of 38.5% each) and on the roots (with a proportion of 37.5% each) compared to other plant organs. Overall, *Exserohilum* is the fungus infecting *S. macrocarpon* and *S. aethiopicum* the least. It is mainly found on the leaves with a proportion of less than 2%.

Table 8. Distribution of fungi associated with each species.

Species	Relative citation frequency (FRC %)						
	Fusarium	*Alternaria*	*Colletotrichum*	*Botrytis*	*Curvularia*	*Exserohilum*	*Aspergillus*
Solanum aethiopicum	95,7	20,9	27,4	12,2	3,5	0,4	6,1
Solanum macrocarpon	97,4	22,1	84,4	6,5	9,1	1,3	14,3

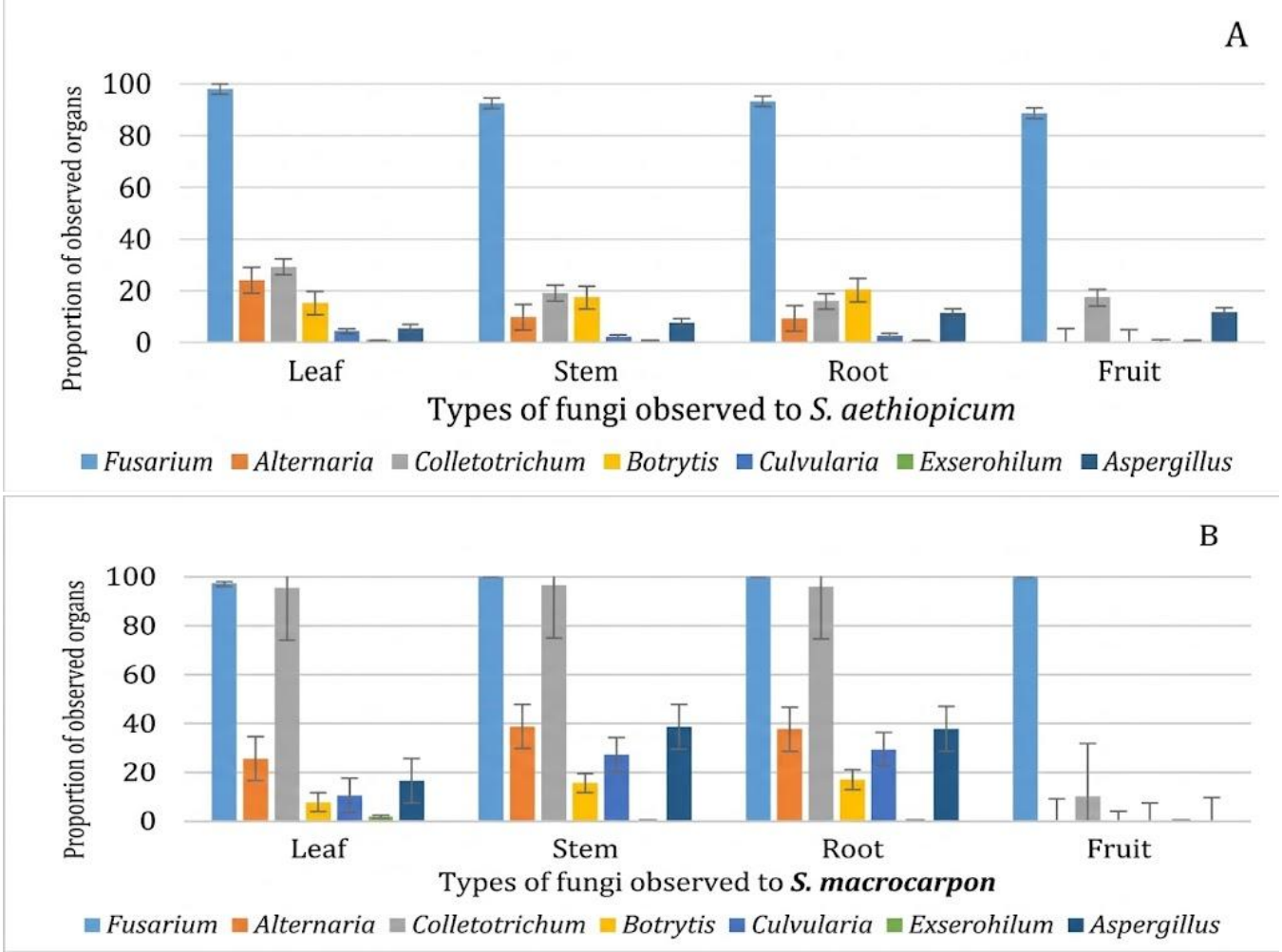


Figure 2. Distribution of fungi by type of plant organ : (A) *S. aethiopicum* ; (B) *S. macrocarpon*.

Type of Fungi Associated with Symptoms

This is a list of fungi isolated from symptomatic fragments. The results revealed a variation in the seven fungi genera from one symptom to another in the two African eggplants species (Figure 3). Thus, for the yellowing and necrosis of the leaves, six genera are associated with *S. aethiopicum* (*Fusarium*, *Alternaria*, *Colletotrichum*, *Botrytis*, *Curvularia*, *Exserohilum*) and four genera with *S. macrocarpon* (*Fusarium*, *Alternaria*, *Colletotrichum*, *Exserohilum*). For plant wilting, all fungi are observed in both eggplants, except for *Exserohilum*. A similar pattern is seen in plant desiccation, where two genera are absent in *S. aethiopicum* (*Curvularia*, *Exserohilum*) and one genus is in *S. macrocarpon*. (*Exserohilum*). Regarding fruit rot, *Fusarium*, *Colletotrichum*, and *Aspergillus* are identified in *S. aethiopicum*, whereas only *Fusarium* is found in *S. macrocarpon*.

Pathogenicity of *Fusarium* sp. on Emergence Parameters

The E41FUS isolate significantly inhibited seedling emergence in *S. aethiopicum* and *S. macrocarpon*, with emergence rates of 78.5% and 75.25%, respectively, compared to the E0FUS controls (100%) (Table 9).

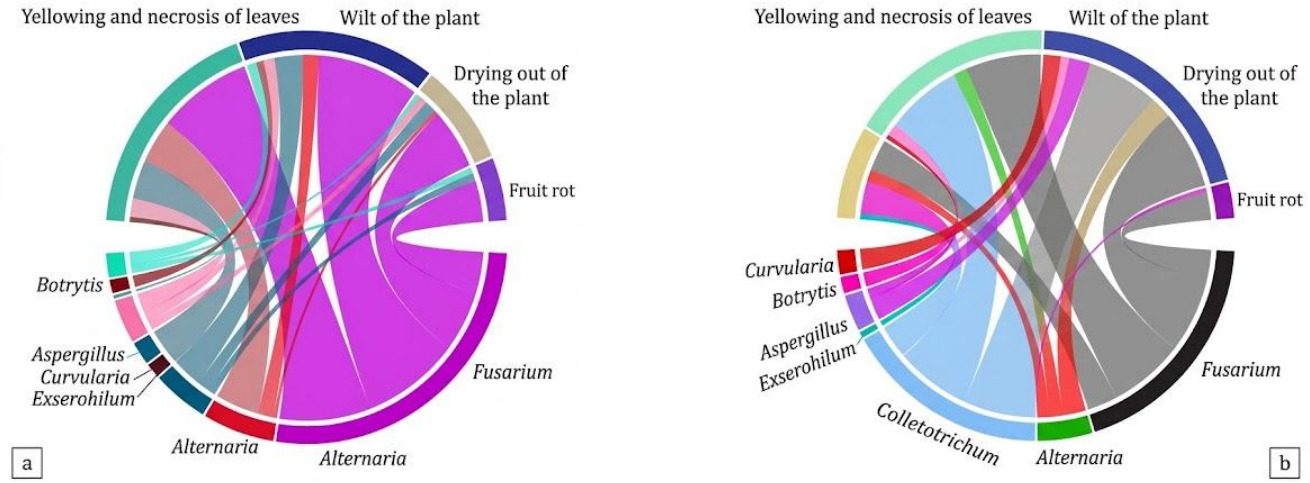


Figure 3. Circular diagram illustrating associations between fungi genera and the various fungal symptoms in the plants: (a) *S. aethiopicum* ; (b) *S. macrocarpon*.

Table 9: Effect of fungi on seedling emergence 21 days after inoculation

Isolate	*S. aethiopicum*	*S. macrocarpon*	Isolate	*S. aethiopicum*	*S. macrocarpon*
	EM21	EM21		EM21	EM21
E0 FUS	100a	100a	E2 FUS	100a	100a
E7 FUS	97a	97a	E9 FUS	100a	100a
E11 FUS	100a	100a	E18 FUS	100a	100a
E34 FUS S.m	100a	100a	E36 FUS	100a	100a
E47 FUS S.m	100a	97a	E58 FUS	100a	100a
E57 FUS	100a	97a	E70 FUS	100a	97a
E64 FUS	100a	97a	E71 FUS	100a	97a
E81 FUS	100a	100a	E3 FUS	94a	97a
E4 FUS	100a	97a	E7' FUS	100a	100a
E15 FUS	100a	97a	E11' FUS	100a	97a
E41 FUS S.m	100a	100a	E21 FUS	100a	100a
E65 FUS S.m	100a	100a	E34 FUS	100a	97a
E76 FUS	100a	100a	E38 FUS	97a	84,5a
E85 FUS	100a	93,75a	E41 FUS	78,5b	75,25b
E95 FUS	100a	100a	F value	7,48	3,14
Pr (>F)	1,82e-13 ***	2,41e-05 ***			

Legend: Means followed by different letters are significantly different according to the Newman-Keuls test at the 5% significance level. EM21: percentage of seedlings that had emerged 21 days after inoculation

Incidence of *Fusarium* sp. in African Eggplants

In *S. aethiopicum*, the highest incidence rates (INC) were observed for isolates E38FUS and E41FUS, respectively, compared to the control E0FUS (0%), for the symptoms of leaf yellowing and necrosis (47.25% and 44.25%), wilting of plants (34.5% and 34.5%) and drying out of plants (3.25% and 22.25%). For this symptom wilting of plants, isolates E7FUS and E3FUS also recorded incidence rates of 3.25% and 6.5%, respectively. As for *S. macrocarpon*, E38FUS and E41FUS were the isolates that caused high incidence rates compared to the control E0FUS (0%), specifically 37.75% and 47% for leaf yellowing and necrosis, 31.5% and 25.25% for plant wilting, and 15.75% and 25.25% for plant desiccation. The various results are recorded in the Table 10.

Table 10. Incidence of *Fusarium* sp. isolates based on symptoms.

Isolates	*S. aethiopicum* (INC %)			*S. macrocarpon* (INC %)		
	LYN	PW	PD	LYN	PW	PD
E0 FUS	0c	0b	0c	0d	0c	0c
E7 FUS	25,5b	6,5b	3,25bc	6,5cd	13bc	3,25c
E11 FUS	6,5bc	6,5b	0c	16cd	0c	0c
E34 FUS S.m	0c	0b	0c	16cd	9,75bc	0c
E47 FUS S.m	6,5bc	0b	0c	25,25bcd	0c	3,25c
E57 FUS	3,25bc	3,25b	0c	12,75cd	3,25bc	3,25c
E64 FUS	6,5bc	0b	0c	12,75cd	3,25bc	3,25c
E81 FUS	6,25bc	6,5b	0c	3,25d	0c	0c
E4 FUS	12,75bc	3,25b	0c	0d	0c	3,25c
E15 FUS	3,25bc	3,25b	0c	6,5cd	6,5bc	3,25c
E41 FUS S.m	6,25bc	3,25b	0c	16cd	3,25bc	0c
E65 FUS S.m	3,25bc	0b	0c	9,75cd	6,5bc	3,25c
E76 FUS	0c	0b	0c	0d	0c	0c
E85 FUS	3,25bc	0b	0c	9,75cd	3,25bc	6,25c
E95 FUS	6,5bc	3,25b	0c	9,5cd	0c	0c
E2 FUS	16bc	0b	0c	3,25d	3,25bc	0c
E9 FUS	9,5bc	9,5b	0c	0d	0c	0c
E18 FUS	9,75bc	0b	0c	3,25cd	0c	0c
E36 FUS	6,5bc	0b	0c	6,5cd	0c	0c
E58 FUS	19bc	3,35b	0c	3,25d	6,5bc	0c
E70 FUS	6,5bc	3,25b	0c	3,25d	6,5bc	3,25c
E71 FUS	3,25bc	0b	0c	12,75cd	3,25bc	3,25c
E3 FUS	9,75bc	9,75b	6,5b	3,25d	3,25bc	3,25c
E7' FUS	13bc	6,5b	0c	3,25d	0c	0c
E11' FUS	3,25bc	3,25b	0c	6,25cd	3,25bc	3,25c
E21 FUS	6,5bc	0b	0c	9,75cd	3,25bc	3,25c
E34 FUS	19bc	15,75b	0c	28,5bc	16b	3,25c
E38 FUS	47,25a	34,50a	3,25bc	37,75ab	31,5a	15,75b
E41 FUS	44,25a	34,50a	22,25a	47a	25,25a	25,25a
F value	6.47	7.81	7.54	5.38	6.46	2.82
Pr (>F)	8.12e-12 ***	5.54e-14 ***	1.46e-13 ***	7.01e-10 ***	8.37e-12 ***	0.000122 ***

Legend: Means followed by different letters are significantly different according to the Newman-Keuls test at the 5% significance level. LYN: leaf yellowing and necrosis; PW: plant wilting; PD: plant drying; INC: incidence.

Severity of *Fusarium* sp. isolates in African eggplants

In *S. aethiopicum*, isolates E38FUS and E41FUS caused the highest severity levels for yellowing and leaf necrosis (21.25% and 20.5%), plant wilting (18.75% and 18.75%), and plant desiccation (13.75% and 30.25%), compared to the control E0FUS (11%). The same is true for *S. macrocarpon*, where the control E0FUS had a rate of 11% compared to isolates E38FUS and E41FUS, which caused high severity for leaf yellowing and necrosis (19.25% and 21.5%), plant wilting (18% and 16.75%), and plant desiccation (24.75% and 33.25%). The various results are presented in the Table 11. The identity of the two virulent isolates was confirmed via molecular sequencing.

Frequency of Re-Isolated Fungi following Koch's Postulate

In *S. aethiopicum*, the results of Koch's postulate showed 100% *Fusarium* in symptomatic fragments from all isolates, except for isolates E0FUS, E34FUS S.m, and E76FUS (Figure 4). As for *S. macrocarpon* (Figure 5), no fungal growth was observed in isolates E0FUS, E76FUS, and E9FUS, in contrast to the other isolates (100% *Fusarium*).

Table 11. Severity of *Fusarium* sp. isolates based on symptoms

Isolates	*S. aethiopicum* (SEV %)			*S. macrocarpon* (SEV %)		
	LYN	PW	PD	LYN	PW	PD
E0 FUS	11b	11c	11c	11e	11c	11c
E7 FUS	16,5b	12,5bc	13,75bc	12,5cde	14bc	13,75c
E11 FUS	12,5b	12,5bc	11c	14,75cde	11c	11c
E34 FUS S.m	11b	11c	11c	14,75cde	13,25bc	13,75c
E47 FUS S.m	12,5b	11c	11c	16,75bcd	11c	13,75c
E57 FUS	11,75b	11,75bc	11c	14cde	11,75c	13,75c
E64 FUS	12,5b	11c	11c	13,75cde	11,75c	13,75c
E81 FUS	12,5b	12,5bc	11c	11,75de	11c	11c
E4 FUS	14b	11,75bc	11c	11e	11c	13,75c
E15 FUS	11,75b	11,75bc	11c	12,5cde	12,5bc	13,75c
E41 FUS S.m	12,5b	11,75bc	11c	14,5cde	11,75c	11c
E65 FUS S.m	11,75b	11c	11c	13,25cde	12,5bc	13,75c
E76 FUS	11b	11c	11c	11e	11c	11c
E85 FUS	11,75b	11c	11c	13,25cde	11,75c	16,5c
E95 FUS	12,5b	11,75bc	11c	13,25cde	11c	11c
E2 FUS	14,75b	11c	11c	11,75de	11,75c	11c
E9 FUS	13,25b	13,25bc	11c	11e	11c	11c
E18 FUS	13,25b	11c	11c	11,75de	11c	11c
E36 FUS	12,5b	11c	11c	12,5cde	11c	11c
E58 FUS	15,25b	11,75bc	11c	11,75de	12,5bc	11c
E70 FUS	12,5b	11,75bc	11c	11,75de	12,5bc	13,75c
E71 FUS	11,75b	11c	11c	13,75cde	11,75c	13,75c
E3 FUS	13,25b	13,25bc	16,5b	11,75de	11,75c	13,75c
E7' FUS	14b	12,5bc	11c	11,75de	11c	11c
E11' FUS	11,75b	11,75bc	11c	12,5cde	11,75c	13,75c
E21 FUS	12,5b	11c	11c	13,25cde	11,75c	13,75c
E34 FUS	15,25b	14,75b	11c	17,25bc	14,75b	11c
E38 FUS	21,25a	18,75a	13,75bc	19,25ab	18a	24,75b
E41 FUS	20,5a	18,75a	30,25a	21,5a	16,75a	33,25a
F value	5.76	7.86	7.52	5.47	6.58	2.85
Pr (>F)	1.42e-10 ***	4.69e-14 ***	1.6e-13 ***	4.85e-10 ***	5.24e-12 ***	0.000108 ***

Legend: Means followed by different letters are significantly different according to the Newman-Keuls test at the 5% significance level. LYN: leaf yellowing and necrosis; PW: plant wilting; PD: plant drying; SEV: severity.

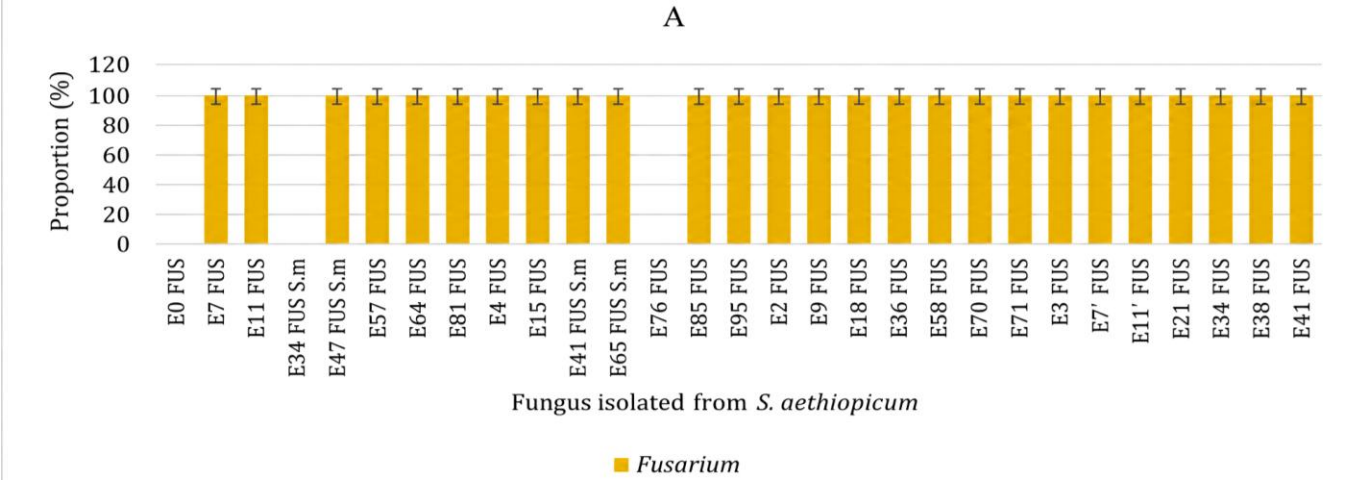


Figure 4. Testing Koch's Postulate on Infected Fragments of *S. aethiopicum.*

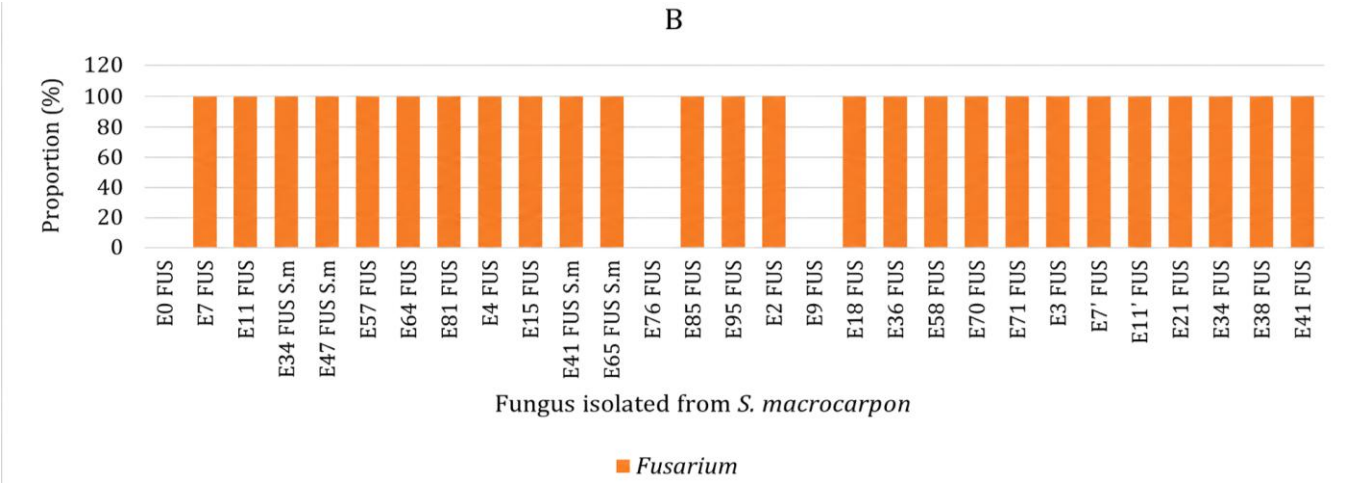


Figure 5. Testing Koch's postulate on the attacked fragments of *S. macrocarpon.*

DISCUSSION

Nowadays, fungal attacks are very common in most *Solanaceae* crops. In Burkina Faso, the assessment of the infestation's level in African eggplant fields focused on incidence and severity. The high incidence and severity rates observed both in Houet and Bazèga provinces, can be explained by a high proliferation of fungal inoculum in these areas. These provinces are known as areas of large production of African eggplant in humid conditions permanently. The proliferation of fungal diseases is linked to these soil and climate conditions and to agricultural practices as well. According to Tremblay *et al*. (2012), the three factors that induce the manifestation of certain fungal diseases are climate, the amount of inoculum present, and the susceptibility of the plants in the environment. This is consistent with the findings of Dossa *et al.* (2019), who demonstrated that climatic variables such as precipitation, soil and air humidity, sunlight, and temperature are all factors that impact fungal development.

The different fungi genera inventoried may explain the wide range of pathogens involved in fungal diseases affecting African eggplants (*S. aethiopicum*, *S. macrocarpon*). These findings are consistent with the work of Kaboré (2019) who identified the same fungi genera in the *Solanum macrocarpon* specie, including *Fusarium*, *Colletotrichum*, *Alternaria*, *Aspergillus*, *Curvularia* and *Exserohilum*. A similar diversity of pathogens is also reported in other solanaceous crops such as tomato (Tiendrebeogo *et al*., 2023). Among these fungi, the high frequencies of *Fusarium* observed in both African eggplants species could be attributed to its telluric nature. It survives in soil and on plant debris for more or less extended periods (Tiendrebeogo *et al*., 2023). This type of fungus frequently could affect most vegetable crops. The same holds true for *Colletotrichum,*

frequently detected in *S. macrocarpon*. High frequencies of these fungi had also been reported in tomatoes by Tiendrebeogo *et al*. (2023), especially the *Fusarium* genus accounted around 60% to 80% of the losses in some vegetable gardens in Burkina Faso. Rakotoarimanga *et al*. (2014) further confirm that *Fusarium* seems to be dangerous due to its ubiquitous nature, and can be source of serious challenges in agriculture and horticulture. The devastating impact of this pathogen on Solanaceae was also confirmed by Zombré *et al*. (2025) and Sana *et al*. (2026). This fungus is involved in all identified symptoms in African eggplants, including leaf yellowing and necrosis, plant wilting, plant desiccation, and fruit rot. It is widely present accros all plant organs. According to Tiendrebeogo *et al*. (2023), *Fusarium* is one of the most frequently isolated fungal pathogens on the aerial parts of tomato (affected fruits and leaves). Similarly, *Colletotrichum* specially prevalent in *S. macrocarpon*, has been isolated from rotten fruits, stems, and leaves of tomato as reported by Saini *et al*. (2017).

All of these information could be alligned with the work of Rakotoarimanga *et al*. (2014) on tomato who noted that *Fusarium*-induced diseases are challenging to be diagnosed and controlled. It easily spreads by persisting in soil. In Madagascar, it causes substancial losses for farmers. The same is true when considering the Sana *et al*. (2026) work, which reveals that this fungus attacks more than a hundred plant species, confirming its economic significance. Rabah *et al*. (2006) and Zombré *et al*. (2025) identified *Fusarium* as one of the most widespread and serious fungal diseases in tomato, pepper, chili and eggplant. Other researchers have also highlighted the impact of this type of fungus on cereal and fruit crops. This is in line with the findings of Bani (2011) who showed that bayoud disease, a vascular wilt caused by *Fusarium oxysporum* f.sp. *albedinis* (*Foa*), is considered a destructive fungal disease, threatening Algerian palm groves. Likewise, Stover (1962), as cited by Saravanan *et al*. (2007) reported that fusariosis is a major constraint in banana production worldwide due to the soil-borne and genetically stable fungus.

The pathogenicity test carried out revealed a decrease in the emergence rate caused by isolate E41FUS. This reduction is linked with the high virulence of the isolate mentioned, which further highlights the pathogenicity of the *Fusarium* genus. Cases of decreased emergence of *Solanum aethiopicum* plants by *Fusarium oxysporum* were observed by Kaboré (2019), with the pathogen severely affecting plant emergence in two morphotypes of *S. macrocarpon*. In addition to E41FUS, the E38FUS isolate was also prevalent, with remarkable incidence and severity rates assessed on the basis of numerous symptoms related to the pathogenicity of these two fungal strains. These symptoms include seedling blight, leaf spots, leaf wilting, and seedling death. Similar symptoms, particularly the first three, had previously been observed on plants of the genus *Solanum*, especially *S. macrocarpon* (James *et al*., 2010, Sikirou *et al*., 2011). The findings of Rotino *et al*. (2004) explain that leaf wilting caused by the fungus *Fusarium oxysporum* is one of the most serious diseases in eggplant growing because it induces vascular wilting of the fruit and causes heavy yield losses (Altinok 2005). To sum up, the *Fusarium* isolates E38FUS and E41FUS have demonstrated their pathogenicity on both species of African eggplant and are believed to be responsible for numerous attacks.

CONCLUSION

This study aimed to diagnose the spectrum of fungal pathogens associated with African eggplant cultivation in Burkina Faso. The findings revealed that Houet and Bazèga are the provinces that are mostly affected by this disease. It also showed that this crop is severely attacked by a variety of fungi. The most prevalent and harmful pathogens are *Fusarium* found in both plant species, and *Colletotrichum*, which was frequent only in *S. macrocarpon*. The pathogenicity test carried out revealed the *Fusarium* isolates E38FUS and E41FUS to be the most damaging. Regarding the proliferation potential of the *Fusarium* genus, identification of these two most virulent isolates is unavoidable in order to begin variety screening.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest

AUTHOR CONTRIBUTIONS

SAS, KB, B-KP designed the study. KB, B-KP, DZO provided the materials for the laboratory experiments. SAS, KB, B-KP, DZO, TWV, OJ participated in supervising the work,

analyzing the data, and reading the document. SAS conducted the experiment and wrote the manuscript. All the authors have read and approved the final version of the manuscript.

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