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Original Research Article

Diagnosis and mapping of African plum (*Dacryodes edulis* [(G Don) H.J.Lam] diseases in three agro-ecological zones of Cameroon

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ABSTRACT

African plum is an important fruit tree native to the Gulf of Guinea. Its fruits are consumed and sold in urban markets in African and European markets, generating substantial income for producers and traders. Diseases are the main biotic production constraint in Cameroon. However, diseases of the African plum in the orchards and during harvest are not yet studied in the country. This study aimed to identify African plum diseases in Cameroon agro ecological zones to reduce yield losses. Disease diagnosis was carried out in the field by visual observations of signs and symptoms and description of the general environmental conditions that could favour disease appearance and in the laboratory for pathogen isolation and pathogenicity confirmation. For each disease, its distribution was carried out using an analytical geographical approach. In the orchards, African plum is associated with trees and fruit diseases such as: Anthracnosis, Cercospora leaf spot, die-back, red rust, peri-peduncular fruit rot and leaf chlorosis. Cercospora leaf spot was significantly ($p<0.005$) the most severe disease (64.03%) in the Western highland and Bimodal rainfall forest agro-ecological zones, while anthracnosis was the most severe (50.46%) in the Monomodal rainfall forest zone. However, diseases diagnosis show that anthracnosis, Cercospora leaf spot and leaf chlorosis were more widespread in the Western highland agro-ecological zone (disease density = 49 to 61, 135 to 169 and 79 to 122, respectively) while red rust was mostly spread in the Bimodal and Monomodal rainfall forest zones (disease density = 71 to 89 and 53 to 71, respectively). Knowledge of diseases affecting African plum trees in different agro-ecological zones in Cameroon is essential for improving management and increasing yields. The diagnosis highlighted the presence of several diseases in the African plum orchards. The map representation confirms and visualizes the spatial distribution, showing the disease densities across the agro-ecological zones.

Keywords: Diagnosis, mapping, severity, African plum, Agro-ecological zones.

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INTRODUCTION

Dacryodes edulis (G.Don) H.J. Lam, is one of the most important fruit tree species in West and Central Africa. This oleaginous species belongs to the Burseraceae family and is ranked as the second most important species for domestication (Mboujda et al., 2024). It is also known by different vernacular names specific to each country: "*Atangatier*" in Gabon, "*prunier*" in Cameroon, "*NSafou*" in the Democratic Republic of Congo, "*Safu*" in *Sao Tomé*. The terms "*safoutier*" (tree) and "*safou*" (fruit) are Frenchized names conventionally used in all these countries (Lemoine et al., 2023). English names are much more numerous: African pear tree, African black pear, African plum tree, Butter fruit tree, bush butter tree. African plum fruit is sold on almost all markets in the Central African sub-region. A food and cosmetic oil can be extracted from the fruit (Swana *et al*., 2023). This species grows both in orchards and in wild ecosystems and contains 59% water (Rimlinger et al., 2021). African plum oil yields realised from Soxhlet, traditional and screw press methods are 34.09%, 10.26% and 7.10%, respectively. Chemical composition ranged from 26.00 to 63.90 g I2/100 g, 1.47 to 13.26% and 128.00 to 227.50 mg KOH/g for iodine value, unsaponifiable matter and saponification value, respectively. Quality properties ranged from 2.12 to 7.08% for free fatty acid, 0.94 to 2.55 meq O2/kg for peroxide value, 0.02 to 1.11 mg/g for thiobarbituric acid and 4.23 to 14.15 mg KOH/g for acid value. Physicochemical properties ranged from 0.90 to 0.93 g/cm^3 for specific gravity, 1.42 to 1.46 for refractive index, 0.00 to 37.00°C for melting point, 174.00 to 236.50°C for smoke point, 186.60 to 309.50°C for flash point and 0.08 to 12.23% for moisture content (Tsado et al., 2025).

Most of the scientific research carried out on *D. edulis* has focused on characterising the food value of its pulp and oil, oil extraction processes and techniques for propagating the species. However, based on the field observations, diseases are a major production constraint in Cameroon. Despite the efforts made by plant pathologists on the management of post-harvest diseases, which are still poorly understood, no study has yet been carried out on the knowledge of diseases in orchards. The research question was: What diseases are found in Cameroon orchards? This led to the hypothesis that Cameroon orchards are always subject to high pressure from fungal diseases. This study was carried out with the aim to identify African plum diseases in Cameroon agro ecological zones to reduce yield losses.

MATERIAL AND METHOD

Study site

The study was carried out in three major agro-ecological zones of Cameroon: the western Highlands zone (14 villages), the bimodal rainfall forest zone (18 villages) and the monomodal rainfall forest zone (06 villages). Disease diagnosis in the orchards was carried out in three main stages: a preliminary field study to describe the signs and symptoms observed in relation to the environment, the severity and incidence of each disease were assessed and finally, to confirm field diagnosis, pathogens were identified and tested for their pathogenicity in the laboratory. The agro ecological zones were chosen because they are identified in the literature as the high African plum production areas in Cameroon. The villages were randomly chosen and are 5 km apart from each other.

Description of the orchards and their physical environment

This step involved observing the general condition of the orchards and noting all observable symptoms and signs on the leaves and fruits of the young trees. All sampled trees were marked throughout the study period. The symptoms observed according to the organ were recorded on an observation sheet. The different technical itineraries were assessed based on the areas, and a qualitative Inventory of the plant

species associated with the orchards was drawn up. This approach was adopted in order to gain an initial insight into the causes of the symptoms observed. An inspection of the orchard's contours was conducted to identify possible factors that favour the development and growth of diseases.

Disease diagnosis in the field

Disease diagnosis in the orchards was mostly focused on observation of signs and symptoms of diseases on leaves and fruits of young trees aged between 3 and 5 years old. The geographical coordinates of all the trees sampled for disease diagnosis were recorded. A link was established between field observations and scientific data explaining the cause of plant diseases in the orchards. Symptoms and signs were recognised using previous plant disease diagnosis manuals and works (Han et al., 2024). The signs and symptoms observed on each infected organ were described.

Disease incidence and severity evaluation

Randomly, the orchards were chosen and the measurement of disease incidence and severity consisted of the random selection of one orchard per village. Disease incidence (DI) in the orchards was evaluated using the following relationship: I = (Number of infected trees/total number of trees assessed) × 100. Disease severity was assessed using the severity measurement scale (Table 1). In fact, visual observations on the north, south, east and west sides of the canopy of each tree. To assess the disease severity of fruit rot, the fruits were counted beforehand on two randomly selected sub-branches per tree from the cutting after the fruit set phase in the different agro-ecological zones. At the onset of blackening marking physiological maturity, on the same sub-branches, the fruits were counted again. The data collection periods were chosen with reference to the work of Mpemboura et al. (2021). Fruit detachment from the stalk during this time interval was considered to be the action of the peduncle rot. Disease severity on fruits (DSF) was determined using the following formula:

$$DSF = (NFR/NFT) \times 100 \quad (1)$$

where S = Severity; NFR = Number of Fruit Remaining; NFT = Number of Total Fruit Considered.

Table 1: Modified scale for disease severity assessment in orchards.

Degree of attack	(%) of the canopy affected	Symptoms characteristics
1	0	Apparently, healthy plants are marked by the absence of necrotic leaves and fruits.
2	25	The early stage of infection is characterised by the presence of browning on the leaves and marginal brick necrosis of the leaves on some branches.
3	50	Necrotic leaves with defoliation on about half the branches of the tree.
4	75	Necrotic leaves on the maximum number of branches with or without progressive defoliation.
5	100	Severe case, generalised infection on the whole canopy, death of the tree

Source: adapted from Dianda et al. (2018)

Disease diagnosis in the laboratory

After field diagnosis, fresh infected samples were collected and carried out to the laboratory for pathogen isolation, identification and to perform Koch postulates, which is an important tool to validate the field diagnosis.

The isolation technique used was as follows: the infected leaves and fruits were washed under running tap water and fragments of around 2 mm² were removed from the front of the lesions using a sterile scalpel.

These fragments were then disinfected in a 1% sodium hypochlorite (NaClO) solution for 5 min for the leaves and at 1% for 3 min for the fruit (Ganesh et al., 2024). These samples were rinsed three times with sterile distilled water to remove any traces of disinfectant. They were wrung out on cotton wool to remove excess water. The fragments were aseptically inoculated into 90 mm diameter Petri dishes containing 15 mL of a sterilised potato dextrose agar (PDA) culture medium obtained from 39 g of prefabricated PDA dissolved in 1000 mL of distilled water and supplemented with 1 g of chloramphenicol to control bacterial proliferation. The plates were then incubated at room temperature (22 ± 2°C). The fungal species isolated were identified on an ordinary Olympus microscope, using mycological identification keys (Aiga et al., 2023). The frequency of isolation (F) of each fungus was calculated using the following formula: F = (NF÷NT) × 100, NF is the total number of samples from which a particular fungus was isolated, and NT is the total number of samples from which isolations were carried out (An et al., 2020).

Determination of pathogenicity

For Koch postulates, given the fact that it was difficult to have healthy trees bearing fruit in the Lab, healthy leaflets from a one-year-old seedling and healthy mature fruit were considered for inoculation. These plant organs were washed with running tap water and disinfected with a 75% ethanol solution for 1 min, rinsed with sterile distilled water and wrung out with cotton wool (Pramod et al., 2024). Leaf samples were scarified on the outer surface using a sterilised needle and then inoculated with 5-mm-diameter mycelium of the fungal pathogen and plated in Petri dishes containing blotting paper previously soaked in sterile distilled water to maintain the moisture essential for fungal growth. Pathogen inoculation on the fruit consisted of creating openings of 5 mm in diameter near the fruit peduncle using a sterile cutter. A 5 mm diameter mycelial disc was then introduced into the wound on the peduncle and covered with a cello tape to prevent any external contamination. The inoculated leaves and fruits were incubated at room temperature (22 ± 2°C). Koch postulates were confirmed by re-isolating the inoculated pathogen from the organ. The number of replicates was five per pathogen. Lesion diameter on inoculated organs was measured using a graduated ruler along the two perpendicular axes. The lesion diameter (LD) was assessed as follows:

$$DL\ (mm) = [(\text{lesion length} + \text{lesion width})] / 2 \quad (2)$$

Mapping of African plum diseases

For disease mapping, an analytical cartographic approach based on geographic information systems was used. The base maps of Cameroon's administrative divisions, hydrography and road network for 2012 were used. The projection adopted was WGS1984, UTM-Zone 32N. The diseases observed in the orchards were marked by GPS (Global Positioning System) points, which were then grouped to produce the various disease distribution maps. Data layers (Feature Layers) corresponding to each disease were created using ARC GIS software version 3.2.1, based on the various geographical coordinates taken using a GARMIN GPS. Data processing consisted of calculating the Kernel density for each observed disease using the same software. This spatial approach constructs a surface from a seeding of points, with each point representing an observed disease case (Stanislaw, 2018). As a result, a density surface is constructed around each observed site such that the density is maximal at that point and decreases as one moves away from it. This method made it possible to determine which areas had the highest number of cases of each disease.

Data analysis

The data collected on disease incidence and severity and diameter of the lesion were subjected to the Kruskal-Wallis test for rank separation at the 5% probability threshold using R software version 3.5.1. The maps were produced using ARG GIS 10.3.1 and Kernel densities were calculated for the point clouds.

RESULTS

Description of the orchards and their general environment

The orchards in the three targeted agro-ecological zones (Monomodal and Bimodal rainfall forest and Western highlands) were between eight and fifteen years old. The seed was chosen on the basis of trees pre-selected according to the taste and size of the mother fruit. In these orchards, which are made up of several accessions, the basic plant material consists mainly of trees grown by direct seeding and, to a lesser extent, of trees grown by cutting. The diversity of fruit trees present in each agro-ecological zone in recorded in Table 2. In the Western Highlands of Cameroon, favourable climatic conditions, with moderate temperatures (19°C), high humidity (70–90%), and significant rainfall (1,500 to 2,000 mm/year), create an environment conducive to the development of fungal and bacterial diseases in orchards. In contrast, in the forest zone with monomodal rainfall, high temperatures (35°C) and relatively low humidity (30–70%) can limit the development of certain diseases, but favour others, particularly those related to heat and water stress in plants. In the forest zone with bimodal rainfall, climatic conditions, with moderate temperatures (25°C) and high humidity (70–90%), are similar to those in the Highlands, which can also lead to a high incidence of diseases, especially during periods of high humidity.

Table 2: Plant species present in orchards

Agro-ecological zones	Type of plant associations with *D.edulis*
WH	*D.edulis* + *Persea americna* + *Psidium guajava*
	D.edulis + *Musa parasidiaca* + *Persea americana*
	D.edulis + *Mangifera indica* + *Persea americana*
	D.edulis + *Persea americna* + Living culture
	D.edulis
BRF	*D.edulis* + *Citrus* sp + *Theobroma cacao*
	D.edulis + *Musa parasidiaca* + *Citrus* sp
	D.edulis + *Theobroma cacao* + *Cola* sp
	D.edulis
MRF	*D.edulis* + *Musa parasidiaca* + *Citrus* sp + *Cola* sp
	D.edulis + *Elaeis guineensis*
	D.edulis + *Citrus* sp + *Theobroma cacao*
	D.edulis + *Theobroma cacao*

Note: MRF = mono-modal rainfall forest zone, BRF = bimodal rainfall forest zone and WH = western highland zone.

Source: Authors' Analysis (2025).

Description of diseases associated with orchards of African plum in Cameroon

All diseases investigated in this study were attributed to pathogenic fungi, with the exception of *Cephaleuros virescens*, a parasitic green alga belonging to the division Chlorophyta. Based on signs and symptoms, the

following diseases were observed in the orchards of the three agro-ecological zones: 1) Anthracnosis, 2) Dieback, 3) Leaf chlorosis, 4) Peri peduncular fruit rot, 5) Red rust, 6) and Cercospora leaf spot.

Anthracnosis caused by *Colletotrichum gloeosporioides* is a widespread parasitic disease of fruit trees. In African plum, symptoms are characterised by the sudden appearance on leaves and fruit of round or elongated spots varying in colour from reddish-brown to blackish-brown, surrounded by a blackish halo (Figure 1). Symptoms are also characterised by the presence of white to greyish discolouration in the centre of each spot over time. The tissues become necrotic, leaving holes in the leaves. In the case of a heavy attack, this leads to the leaves of the shoot falling off, resulting in total defoliation. These symptoms are mainly observed on young leaves, which are more susceptible to the disease.



Figure 1: Anthracnosis symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Dieback caused by *Lasiodiplodia theobromae,* it is characterised by extensive necrosis in the form of dark brown to black patches on the upper surface of the leaves and light brown on the underside. It seems to first appear suddenly on the shoot apices and progresses rapidly, causing leaflets and shoots to dry out (Figure 2). There are no visible signs at the start of the attack, and only the yellowing of the upper leaf surfaces indicates the onset of the characteristic symptoms of the disease. This disease attacks both young and old leaves. Large numbers of biting and sucking insects were observed on the leaves and twigs of the trees.



Figure 2: Die-back or progressive leaf dryness symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Leaf chlorosis is characterised by yellowing along the main and secondary veins, resulting in a suppression of chlorophyll pigments and uniform chlorosis of the leaves on the same shoot, which turn yellow and detach. It is caused by *Cercospora sp*. The disease generally develops on twigs bearing older leaves. Attacks on young leaves or immature leaflets have not been observed. Leaf symptoms are characterised by the appearance of yellow stripes on the main and secondary veins, which eventually turn yellowish (Figure 3). During the yellowing phase, the leaflets retain their turgidity but their attachment to the shoot is weak, so that the slightest jolt causes them to detach and fall off. There have been cases of total defoliation of trees. Observation in all the orchards reveals that this disease is widespread.



Figure 3: Leaf chlorosis symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Peri peduncular fruit rot appears on ripening fruit. Caused by *Pestalotiopsis microspora*, this is because the part of the stalk connecting the fruit to the shoot is damaged or rotted. The colour of the lesion usually varies from light brown to black, depending on the physiological stage and the colour of the fruit pulp; for example, in the case of fruit with green pulp, black rot is observed, and in the case of reddish fruit, brown rot (Figure 4). This phenomenon of fruit drop is generally observed in trees located in areas of high humidity and shade. Once detached from the branch, the fruit falls and deteriorates, infecting healthy fruit from the ground.



Figure 4: Peri-peduncular fruit rot symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Red rust, caused by *Cephaleuros virescens* is characterised by the appearance of yellow-orange spots on the upper surface of the leaves. At the start of infection, the disease appears in the form of small oily spots on the upper surface of the leaves (Figure 5) and on the bark of the branch. These spots enlarge and become covered with a dusty, orange-coloured structure. The central part turns brown and necrosis over time. Younger trees are more susceptible, and dampness favours its spread.



Figure 5: Red rust symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Cercospora leaf spot is characterised by rounded spots on the leaves. Symptoms are most visible on older leaves. At the start of infection, small, round, yellowish spots can be seen on the leaf surface. Over time, these spots take on a greyish colour with irregular brownish outlines surrounded by a yellow halo (Figure 6). These necrotic spots gradually enlarge, taking on an angular appearance. Under conditions of regular humidity, the centre of the lesion becomes greyer with a yellowish outline, then disintegrates, leaving the leaf blade perforated.



Figure 6: Cercospora leaf spot symptoms observed in African plum orchards.

Source: Authors' Analysis (2025).

Mapping of African plum diseases in the three agro-ecological zones

Distribution of anthracnosis. In the *Western Highlands* zone, anthracnosis has a high-density value in *Haut-Nkam* division (Département). However, low-density values of anthracnosis were recorded in the *Noun and Ndé* divisions. In the bimodal rainfall zone, the *Mbam et Inoubou* division had a high anthracnosis density. However, in the monomodal rainfall zone, the anthracnosis density value was highest in the *Moungo* division (Figure 7).

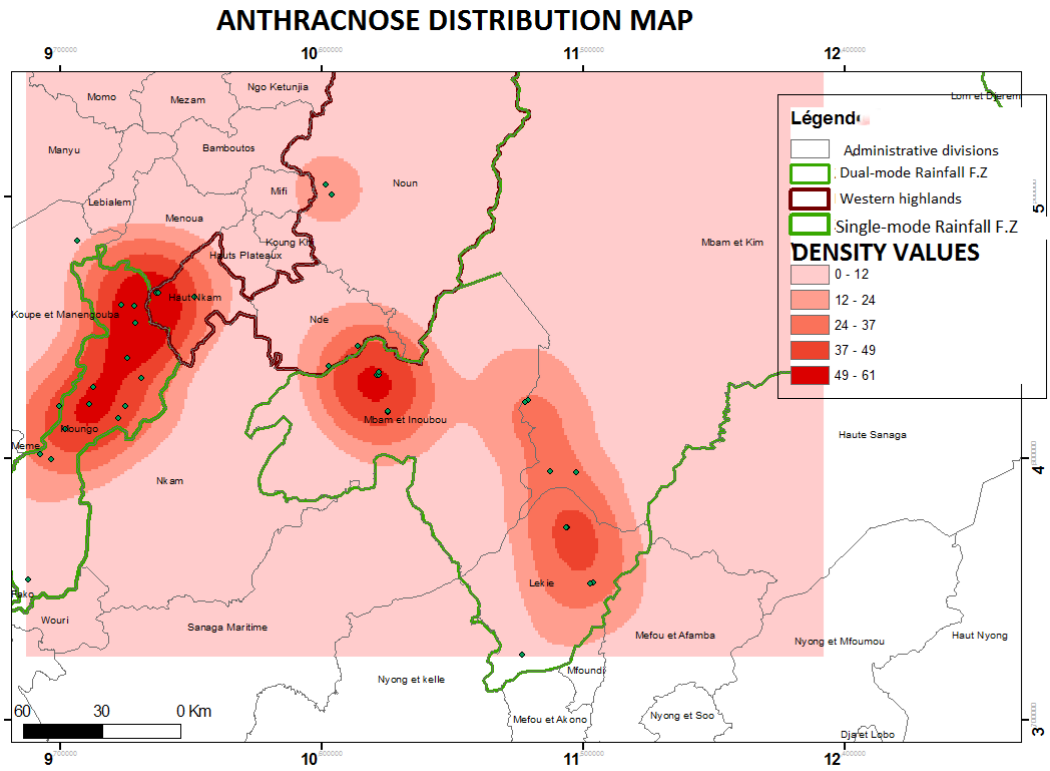


Figure 7: Distribution of Anthracnosis disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Distribution of Cercospora leaf spot. In the *Western Highlands* zone, the disease density value is very low in the *Noun* division compared with the value obtained in the *Ndé* division. However, a high disease density value was recorded in *Haut-Nkam* division. In the bimodal rainfall zone, the *Mbam et Inoubou* and *Lekié* divisions showed a uniform disease density value. The *Mbam et Kim* division, on the other hand, recorded a low density (Figure 8).

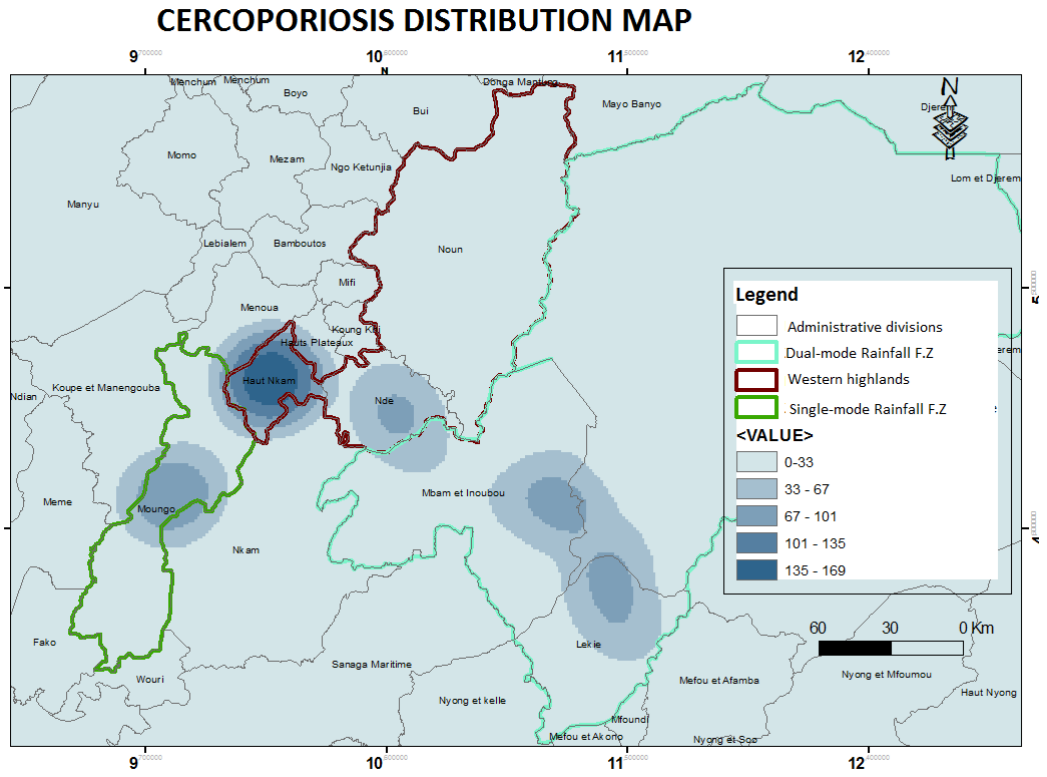


Figure 8: Distribution of Cercospora leaf spot disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Distribution of the peri-peduncular rot. In the bimodal rainfall zone, the *Mbam et Inoubou* and *Lekié* divisions showed similar high disease density values, unlike the *Mbam et Kim* division, which showed a low disease density value. In the *Western Highlands* zone, the low disease density value was uniform in all divisions, whereas in the monomodal rainfall zone, the *Moungo* division had a disease density value ranging from 15 to 31 (Figure 9).

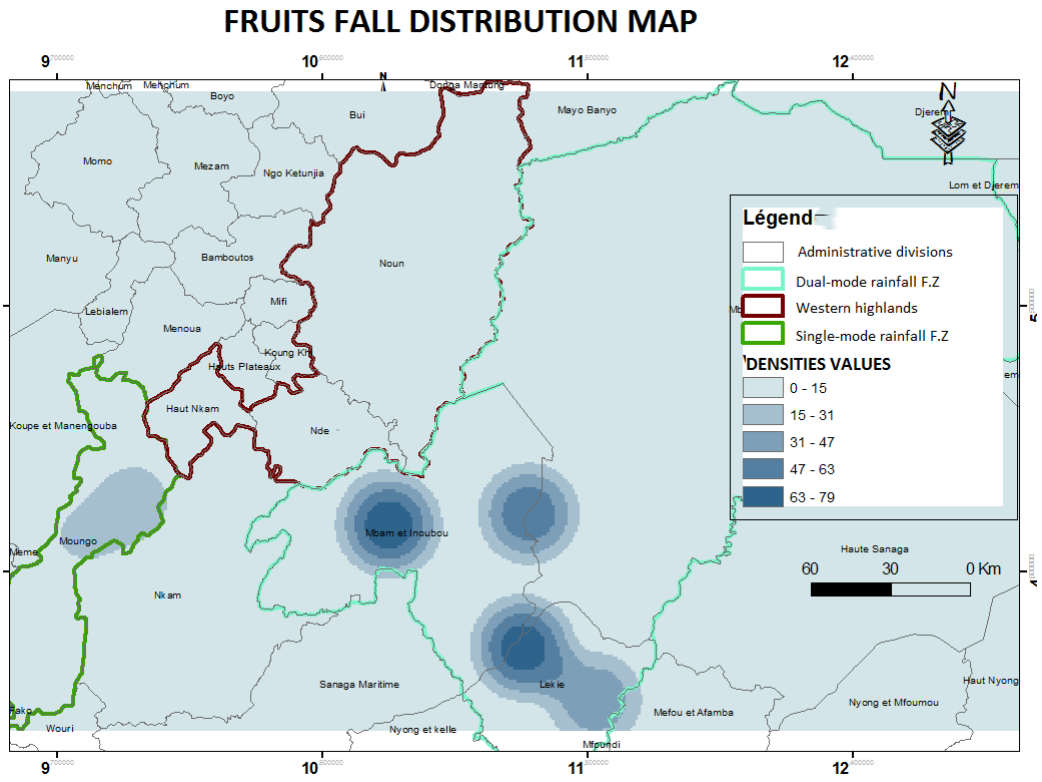


Figure 9: Distribution of Peri-peduncular fruit rot disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Distribution of dieback. Dieback can be a severe disease in Cameroon's three agro-ecological zones. In the *Western Highlands* zone, the disease showed a similar density value in the *Noun* and *Ndé* divisions. However, a high disease density value was observed in *Haut-Nkam* Division. In the monomodal rainfall zone, *Moungo* Division had the highest disease density value. However, in the bimodal rainfall zone, the *Mbam et Inoubou* and *Lekié* divisions showed a low disease density value compared with the value obtained in the *Mbam et Kim* Division (Figure 10).

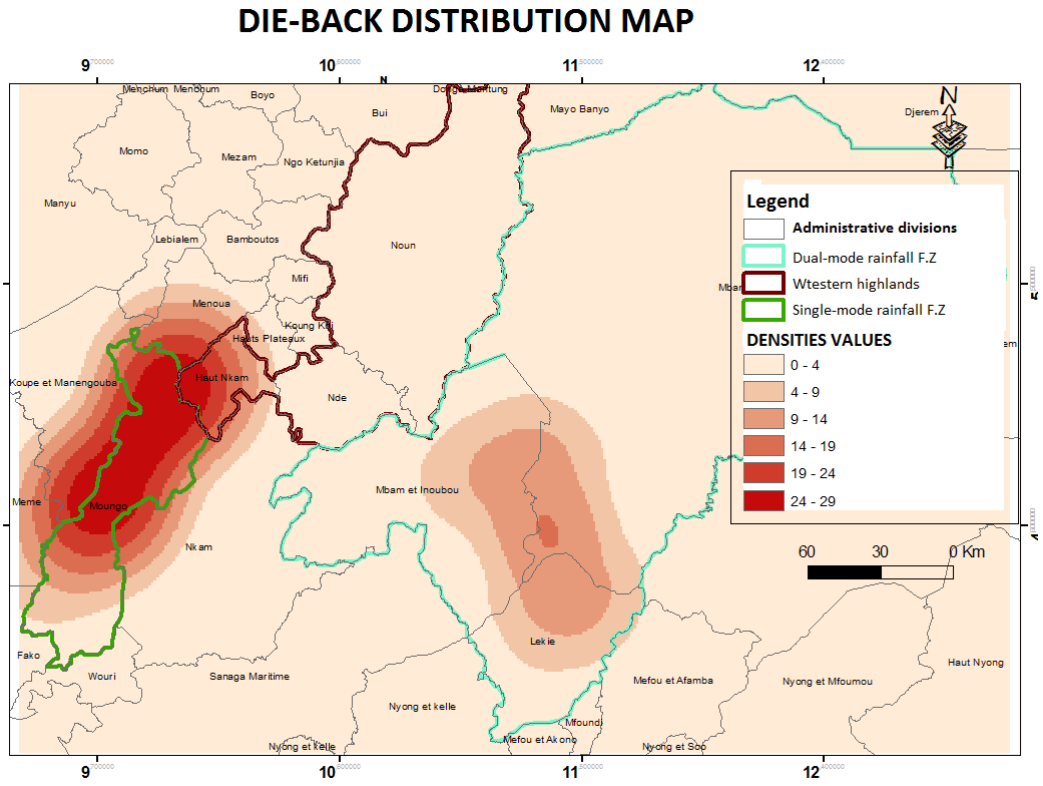


Figure 10: Distribution of Die-back disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Distribution of leaf chlorosis. In the *Western Highlands*, the disease density values are different. In the *Haut-Nkam* and *Ndé* divisions, the values are similar and higher than those obtained in the *Noun* division. In the monomodal rainfall zone, the *Moungo* division showed a disease density value of between 24 and 48. In the bimodal rainfall zone, the *Lekier* and *Mbam et Kim* divisions had a low disease density; however, the *Mbam et Inoubou* division had a higher disease density (Figure 11).

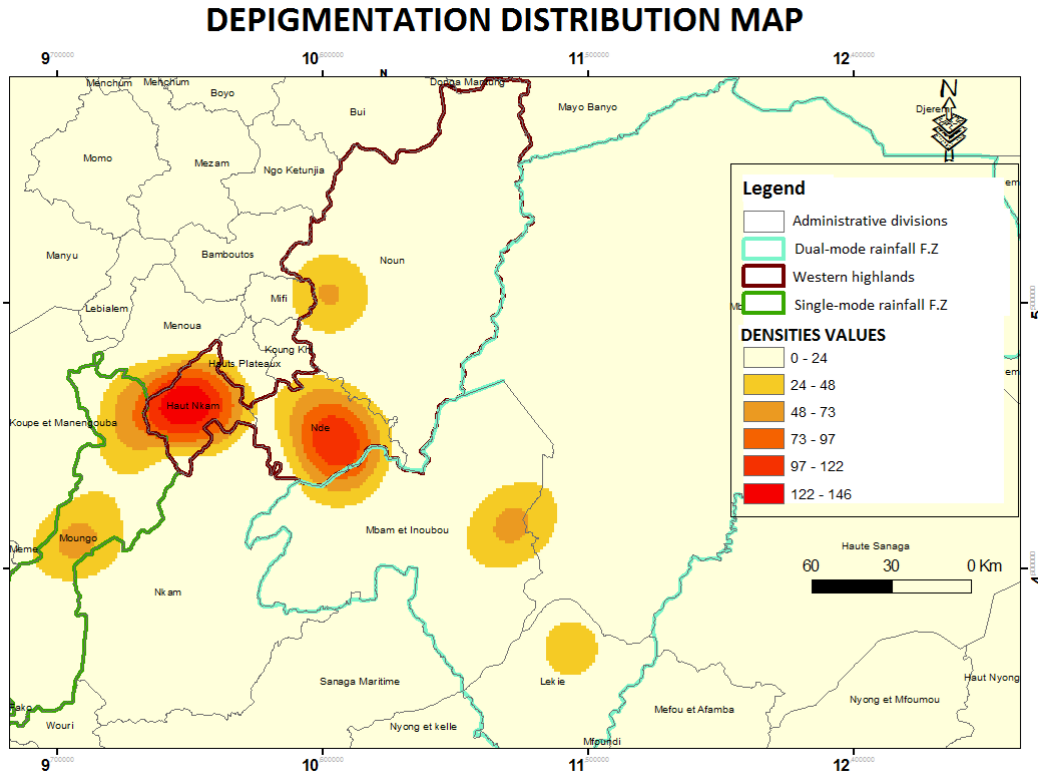


Figure 11: Distribution of Leaf chlorosis disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Distribution of red rust. In the western highlands, the *Haut-Nkam* and *Noun* division showed similar disease density values, different from the value obtained in the *Ndé* division. In the bimodal rainfall zone, the divisions showed different density values. The *Mbam et Inoubou* Division showed a high disease density compared with the values obtained for the others. The *Moungo* division in the monomodal rainfall zone showed a high disease density (Figure 12).

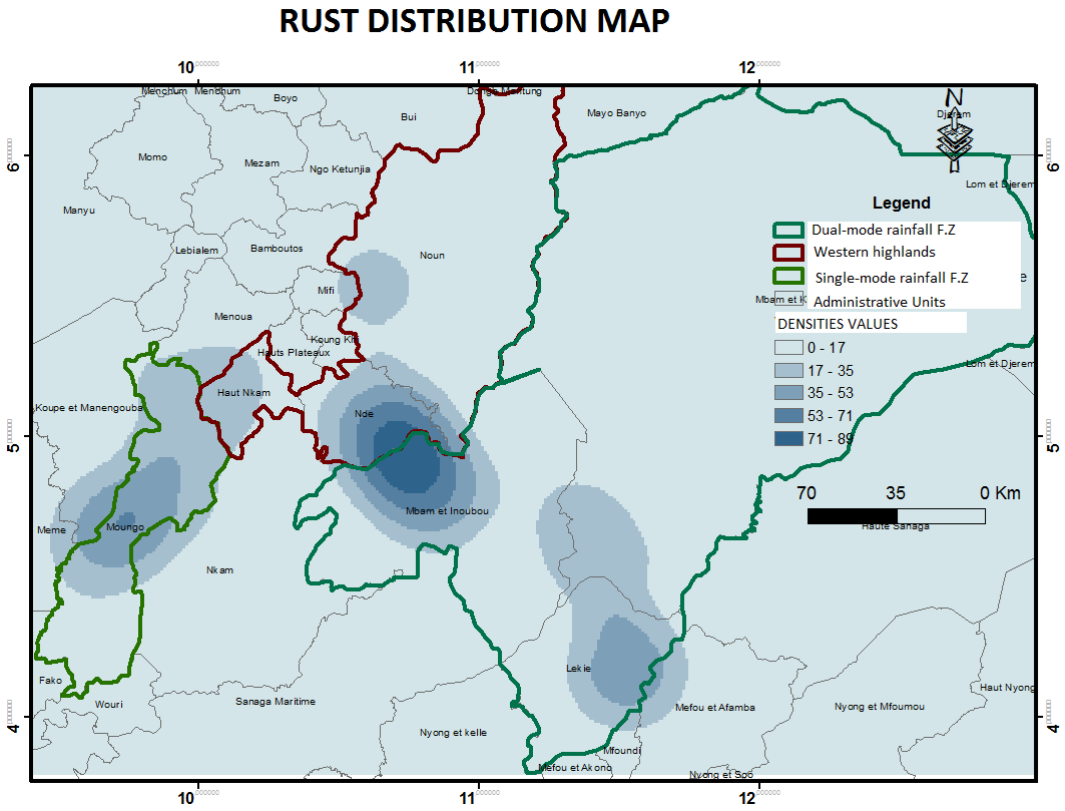


Figure 12: Distribution of Red rust disease of African plum in orchards in three agro-ecological zones of Cameroon.

Source: Authors' Analysis (2025).

Incidence and severity of African plum diseases in the agro-ecological zones of Cameroon

All the orchards visited in the three agro-ecological zones developed the same diseases. In the western highlands zone (WHZ), disease incidence of anthracnosis, Cercospora leaf spot and leaf chlorosis were highest (97.50, 100.00 and 99.55% respectively). There was significantly steady reduction observed in red rust, fruit rot and dieback in that order. In the bimodal rainfall zone (BRZ), incidence of anthracnosis, Cercospora leaf spot, peri-peduncular fruit rot and red rust were highest (99.68, 100.00, 98.75 and 98.41% respectively) while dieback had the lowest. In the monomodal rainfall (MRZ), anthracnosis (100%), Cercospora leaf spot (100%) and die-back (92.50%) were the most diseases observed (Table 3).

In Table 4, the *Western Highlands* zone showed a favourable cercosporosis development as showed through the highest disease severity (64.03%) recorded, followed by leaf chlorosis (54.88%). In the bimodal rainfall forest zone, Cercospora leaf spot was the more severe disease (51.04%) followed by anthracnosis and peri-peduncular fruit rot (38.96 and 38.79%, respectively). The monomodal rainfall forest zone was more favourable to anthracnosis (50.46%) and Cercospora leaf spot (46.90%).

Table 3: Disease incidence (%) of African plum in the agro-ecological zones of Cameroon.

AEZ	Anthracnosis	Cercospora leaf spot	Peri-peduncular fruit rot	Leaf chlorosis	Die-back	Red rust	Size of sampled trees
WH	97.50 ± 15.65a	100 ± 00a	60.73 ± 48.94c	99.55 ± 7.07a	46.76 ± 32d	74.61 ± 43.62b	170
BRF	99.68 ± 5.59a	100 ± 00a	98.75 ± 11.12a	90 ± 30.06b	74.92 ± 43.41c	98.41 ± 12.51a	180
MRF	100 ± 00a	100 ± 00a	62.25 ± 47.58c	77.50 ± 42.02b	92.50 ± 26.50a	75 ± 43.57bc	90

Note: a,b,c Means followed by the same letter in the line are not significantly different according to the Kruskal-Wallis test at 5%. AEZ = agro-ecological zone, MRF = mono-modal rainfall forest zone, BRF = bimodal rainfall forest zone and WH = western highland zone.

Source: Authors' Analysis (2025).

Table 4: Disease severity (%) of African plum in the agro-ecological zones of Cameroon.

AEZ	Anthracnosis	Cercospora leaf spot	Peri- peduncular fruit rot	Leaf chlorosis	Die-back	Red rust	Size of the sampled trees
WH	21.21 ± 11.59c	64.03 ± 16.79a	2.57 ± 2.13f	54.88 ± 20.13b	8.24 ± 6.58e	10.41 ± 9.33d	170
BRF	38.96 ± 16.98b	51.04 ± 19.38a	38.79 ± 20.69b	13.80 ± 8.93d	15.11 ± 13.25d	34.28 ± 19.70c	180
MRF	50.46 ± 13.38a	46.90 ± 17.44a	10.41 ± 7.08e	22.15 ± 15.57c	34.53 ± 29.98b	12.92 ± 11.22d	90

Note: a,b,c Means followed by the same letter in the line are not significantly different according to the Kruskal-Wallis test at 5%. AEZ = agro-ecological zone, MRF = mono-modal rainfall forest zone, BRF = bimodal rainfall forest zone and WH = western highland zone.

Source: Authors' Analysis (2025).

Fungi associated with African plum and their pathogenicity

A diversity of fungal species was associated with infected trees in the orchards irrespective to the agro-ecological zones. The most frequently isolated fungal species in the orchards were *Cercospora* sp and *Colletotrichum gloeosporioides*. Their frequency of occurrence were respectively highest in the Western highland (15.49 and 17.03%), Bimodal rainfall forest (17.26 and 16.67%) and Monomodal rainfall forest zones (18.12 and 13.25%). (Table 5).

Table 5: Occurrence frequency (%) of isolated fungi associated with African plum orchards in three agro-ecological zones of Cameroon.

Fungal species	Western highland zone	Bimodal rainfall forest zone	Monomodal rainfall forest zone
Alternaria alternata	8.86	8.83	11.09
Aspergillus niger	2.67	0.00	4.03
Cercospora sp	15.49	17.26	18.12
Colletotrichum gloesporoides	17.03	16.67	13.25
Fusarium oxysporum	11.66	8.81	11.96
Fusarium verticillioides	0	3.46	6.76
Geotrichum sp	4.60	2.10	2.36
Lasiodiplodia theobromae	3.24	3.53	5.60
Nigrospora sp	1.09	1.10	0.00
Penicillium digitatum	2.02	4.03	1.06
Pestalotiopsis guepinii	7.10	6.11	1.43
Pestalotiopsis microspora	10.08	14.03	8.69
Rhizoctonia solani	10.63	8.07	7.58
Rhizopus nigricans	2.04	3.07	8.07
Trichoderma sp	3.49	3.03	0.00

Source: Authors' Analysis (2025).

Pathogenicity of isolated fungi on detached leaves and fruits of African plum

Plant organs inoculation was positive with *Cercospora* sp, *C. gloeoesporioides*, *Lasiodiplodia theobromae* and *Pestalotiopsis microspora* and the symptoms developed were similar to those observed in the orchards. The diameter of lesions vary from one fungal species to another with *Cercospora* sp inducing the significant ($p < 0.05$) largest lesion diameter on leaves (55.66 mm), followed by *P. microspora* on fruits (47.50 mm), 10 day after inoculation (Table 6).

Table 6: Pathogenicity of isolated fungi on detached leaves and fruits of African plum.

Diseases	Fungi	Plant organs	Presence (+) or absence (–) of lesion	Lesion diameter (mm) 10 DAI
Anthracnosis	*Colletotrichum gloeosporoides*	Leaves	+	38.00 ± 0.08c
Cercospora leaf spot	*Cercospora* sp	Leaves	+	55.66 ± 0.22a
Die-back	*Lasiodiplodia theobromae*	Leaves	+	27.50 ± 0.22d
Peri-peduncular fruit rot	*Pestalotiopsis microspora*	Fruits	+	47.50 ± 0.47b

Note: a, b, c Means followed by the same letter in the column are not significantly different according to the Kruskal-Wallis test at 5%; DAI: day after inoculation.
Source: Authors' Analysis (2025).

DISCUSSION

Diagnosis of diseases in orchards

In the Western Highlands, moderate temperatures and high humidity create an ideal environment for the development of fungal and bacterial diseases, which are favoured by abundant rainfall. Conversely, in the forest zone with monomodal rainfall, high temperatures and relatively low humidity can limit certain diseases, while favouring others, particularly those related to heat and water stress in plants. This means that pathogen pressure varies not only according to the presence of diseases, but also according to the resistance of crops to climatic conditions. In the forest zone with bimodal rainfall, although conditions are similar to those in the Highlands with moderate temperatures and high humidity, the seasonality of rainfall can influence how diseases develop, increasing their incidence during periods of high humidity.

The results show that, depending on the agro-ecological zone, growers associate several other fruit and stimulant species with *D. edulis* in their orchards, such as avocado, banana, *Citrus* spp, cola, oil palm, cocoa and coffee. These results are similar to those Awazi et al. (2025), who showed that in agroforestry plots in the central and coastal regions, there are several plant species such as cocoa trees, coffee trees, kola trees and banana trees. Cercospora leaf spot, die-back, anthracnosis, red rust, peri peduncular fruit rot and vein yellowing were observed on the different organs of the tree. These results are similar to those obtained by Kouakou (2014), Yach (2015), who listed some of these diseases in fruit tree orchards in Ivory coast and Cameroon. The symptoms described in this study were also described on other fruit trees by Regis (2018) and Isabelle (2020), respectively for cercospora leaf spot, anthracnosis, die-back, vein yellowing and red rust. However, diseases such as peduncle rot and vein yellowing were observed for the first time on *D. edulis*, as they have not yet been documented to the best of our knowledge.

Disease severity of African plum in the agro-ecological zones of Cameroon

The Western Highlands zone showed reduced severity values for all diseases. This result could be due to the quality of the agroforestry systems in the zone. In fact, agroforestry systems are found here, as the

presence of agroforestry systems consisting mainly of annual crops in which trees are present in a scattered manner without any arrangement imposing an environment that is constantly open to the sun's rays, thus reducing the humidity level, which favours the appearance and spread of diseases. In the bimodal rainfall zone, the severity of cercospora leaf spot and peri-peduncular fruit rot was higher than for other diseases; this result could be justified by the fact that these two diseases share the same pathogen, *Cercospora* sp. Die-back, which is thought to have originated in the cocoa trees present in the orchards, has also been observed. During cocoa harvests, cocoa pods are removed at the foot of a tree or anywhere on the plantation. The pods are abandoned after the operation and, as they decompose, the fungus spores are carried by the dissemination agents throughout the orchard. In monomodal and bimodal rainfall zones, we generally see higher severity values than those obtained in the western highland, because the very low tree densities and the forest environment generate persistent shade that creates humidity conducive to the development of diseases. There was also a high recurrence of fruit trees hosting several of the diseases described for African plum in this study, which could be a factor contributing to the spread of diseases.

Pathogenicity of isolates

The pathogenicity tests were all positive for the diseases except for vein yellowing. On the Leaves, *Cercospora* sp which cause cercospora leaf spot and *P. microspora* (peri-peduncular fruit rot) caused high lesion diameters compared with other diseases. This could be justified by the high severity values obtained in orchards in all agro-ecological zones. The pathogens isolated from the vein yellowing symptoms did not show the symptoms observed in the field; this symptom could have an abiotic cause, in particular through soil nutrient deficiency. However, many authors showed that the species *Dacryodes edulis* belongs to the group of trees that do not have problems linked to soil fertility. The symptoms observed could therefore have a viral origin, as Regis (2018) described this symptom on cocoa leaves as swollen shoot. In addition, Poligui (2014) showed the presence of several pest species, including psyllids, which are responsible for plant viruses

CONCLUSION

In this work we observe that in the agro-ecological zones of Cameroon, African plum are under threat from several diseases: anthracnosis, cercospora leaf spot, Die-back, peri peduncular rot, red rust and vein yellowing. In all agro-ecological zones, cercospora leaf spot showed a high severity value compared with the other diseases. However, in the mono-modal rainfall zone, the severity of anthracnosis was high and significantly similar to that of cercosporosis. The pathogenicity tests were positive, with the exception of the vein yellowing test. African plum diseases, cercospora leaf spot and anthracnosis showed high densities in all agro-ecological zones. The diagnosis highlighted the presence of several diseases in the African plum orchards. The map representation confirms and visualizes the spatial distribution, showing the disease densities across the agro-ecological zones.

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CONFLICT OF INTEREST

The authors declared no conflicts of interest concerning the research, authorship, and publication of this article.

DECLARATION OF GENERATIVE AI USE

The authors state that they did not use any generative artificial intelligence tools or systems in the design, analysis, interpretation, or writing of this article. All scientific content, analyses, interpretation of results, and writing were carried out and validated exclusively by the authors.

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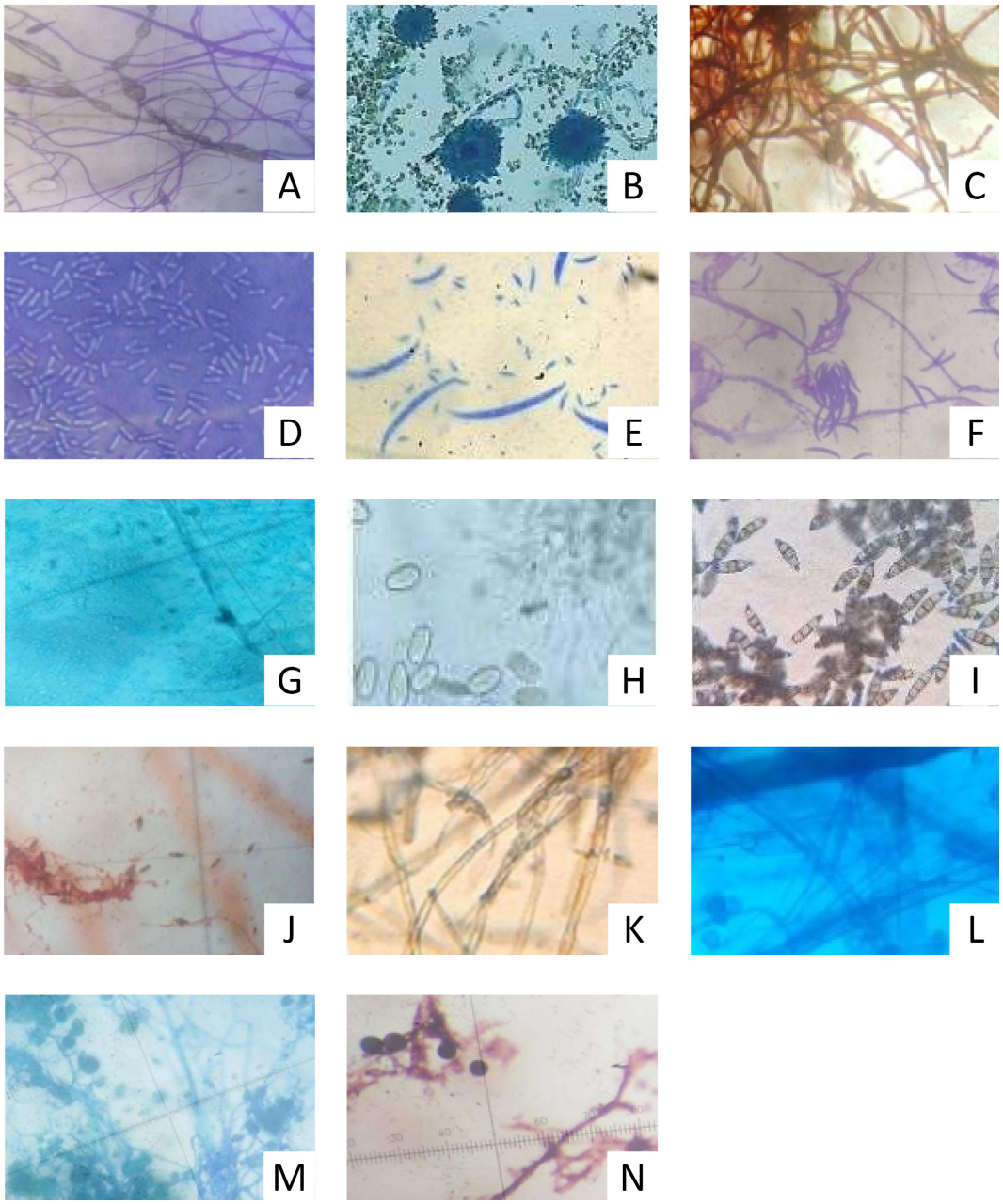
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APPENDIX



Appendix 1: Fungi associated with African plum 10 days after inoculation, 400 X. A: *Alternaria alternata*, B: *Aspergillus niger*, C: *Cercospora sp.*, D: *Colletotrichum gloeosporioides*, E: *Fusarium verticiloides*, F: *Fusarium oxysporum*, G: *Geotrichum sp.*, H: *Lasiodiplodia theobromae*, I: *Pestalotiopsis microspora*, J: *Pestalotiopsis guepinii*, K: *Rhizoctonia sp.*, L: *Rhizopus nigricans*, M: *Trichoderma sp.*, N: *Nigrospora sp*.

Source: Authors' Analysis (2025).