GVU-J.SHT *GVU Journal of Science, Health and Technology*

GVU-J. SHT 2025; **1**, 186–193, doi:10.5281/zenodo.17148638

Studies on the Incidence of Stem and Root Rot Diseases of Cucumber (*Cucumis sativus* L.) in Some Towns in Edo Central Senatorial District of Edo State, Nigeria

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Received: *13 May 2025 []* ***Published:*** *19 September 2025*

A survey of root and stem rot diseases in cucumber (*Cucumis sativus* L.) was conducted during the 2014 to 2016 growing seasons across three locations: Ubiaja, Irrua, and Ekpoma in Edo Central Senatorial District of Edo State, Nigeria. The study evaluated disease incidence and varietal resistance using three cucumber varieties: Technisem, Marketmore, and Poinsett. Soil samples from the rhizosphere were analyzed for temperature, pH, and color to determine optimal conditions for cucumber growth and pathogen proliferation. Microbial analysis was performed to assess the role of soil microflora in the disease environment. Pathogen isolation was achieved through serial dilution and direct plating on Potato Dextrose Agar (PDA). Pathogenicity tests confirmed *Pythium aphanidermatum* as the causal agent of root and stem rot, verified by Koch's postulates. The highest disease incidence was observed in Irrua (75%), followed by Ubiaja (70%), with Ekpoma showing the lowest (20%). Among the cucumber varieties, Marketmore exhibited the greatest resistance (40% infection), compared to Poinsett (55%) and Technisem (75%). These findings underscore the importance of varietal selection in disease management and suggest that the Marketmore variety may be a more resilient option for cultivation in affected regions.

Keywords: Cucumber, Disease, Root rot, Stem rot, Edo State

Introduction

Cucumber (*Cucumis sativus* L.) is a monoecious annual crop belonging to the Cucurbitaceae family, a family which encompasses 90 genera and 750 species (Thoa, 1998; Best, 2000). Cucumber is widely cultivated across the globe and is a highly valued vegetable due to its rapid development and short time from planting to harvest compared to many other crops (Wehner and Gunner, 2004). In Asia, it ranks as the fourth most important vegetable, following tomatoes, cabbage, and onions (Jia and Wang, 2021), and in Western Europe, it is second only to tomatoes (Phu, 1997; Onuwa et al., 2023). Globally, cucumber is the fourth most cultivated vegetable after tomatoes, brassicas, and onions (Food and Agricultural Organization of the United Nations [FAO], 2023). Despite its global significance, cucumber remains underutilized in tropical Africa, where it has not yet been ranked among major crops due to limited use (Ohiaeri and Akor, 2023).

Cucumber plants flourish in both temperate and tropical climates, with optimal growing temperatures ranging from 15 to 33°C. Evolutionarily, cucumbers are believed to have originated in Western Asia or the Middle East, and historical records dating back over 5,000 years suggest their importance in early civilizations (Jyoti et al., 2014). References to cucumber can be found in ancient texts such as the Epic of Gilgamesh, and in the Holy Bible, where it was mentioned as part of the diet of the Israelites during their time in Egypt (Numbers 11:5). Domesticated in Asia, cucumbers spread to Greece, Italy, and later, to China and Russia, cementing their role as an essential vegetable in various cultures (Doijode, 2001). Today, cucumber is cultivated extensively worldwide, both in open fields and greenhouses, particularly in regions like northern Europe and North America (Suma et al., 2025). In Nigeria, the crop has experienced increased cultivation due to its adaptability to both rain-fed and irrigated conditions, allowing year-round production (Eifediyi and Remison, 2009). Although cucumbers are a relatively recent addition to the Nigerian diet, they have become a staple in many households and markets across the country, especially due to increased awareness of the health benefits of consuming them and their use in skin care (Umeh and Ojiako, 2018; Arogundade et al., 2021; Li et al., 2024; Safitri et al., 2024).

Nutritionally, cucumbers are low in calories, with high water content (about 95%) and are a good source of lignans, vitamin K, and cucurbitacins (Mukherjee et al., 2013). They offer numerous health benefits, including their role in managing blood pressure, promoting nutrient absorption, and their use in skincare for treating wrinkles, sunburns, and hydrating the skin (Lopes et al., 2007; Katiyar et al., 2014; Mallick, 2022).

However, the sustainability of cucumber cultivation faces challenges, particularly in developing economies like Nigeria, where

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continuous cropping has led to declining soil fertility and reduced yields (Top et al., 2002). Fungal pathogens, particularly those causing stem and root rot diseases, are significant threats to cucumber production worldwide. These pathogens can cause severe damage to crops, leading to economic losses, especially in regions where soil fertility management is inadequate. Organic and inorganic fertilizers have been suggested as potential solutions to maintain soil fertility and improve yields (Nwogbaga and Iwuagwu, 2015).

Edo Central Senatorial District is an important agroecological region with environmental variables that can favor the cultivation and production of several crops, including cucumber. However, farmers venturing into cucumber cultivation in this senatorial district face several challenges, including stem and root rot diseases. These diseases cause significant losses, hinder optimal utilization of resources, and lead to economic loss and several socioeconomic challenges in cucumber production (Umeh and Ojiako, 2018). Boosting cucumber production, which could bring about fortune and diverse socioeconomic benefits for people in the senatorial district, requires understanding the incidence of these diseases and other factors limiting the productivity of cucumber in the region. This would aid in developing solutions that fit the region and would thus be highly effective and rapidly adopted. However, there are not enough studies that provide such highly needed information. This study was conducted to bridge this gap. The study assessed root and stem rot diseases of cucumber across Edo Central Senatorial District with the aim of identifying the causative agent, factors that aid in the proliferation, spread, and survival of the pathogen, as well as the susceptibility/resistance of various cucumber varieties to the disease.

Materials and Methods

Survey of Root and Stem Rot of Cucumber and Sample Collection

The survey of root and stem rot diseases in cucumber was conducted during the growing seasons from 2014 to 2016 across various plots in Edo Central Senatorial District, Edo State. The locations surveyed included Irrua (Esan Central Local Government Area), Ekpoma (Esan West Local Government Area), and Ubiaja (Esan South East Local Government Area) (Figures 1 and 2). Esan land is located between Latitude 6°44N and 6°45N of the Equator and Longitude 6°06E and 6°08E of the Greenwich Meridian (Okhakhu, 2017). Disease incidence was calculated as the percentage of infected plants relative to the total number of plants per plot. Disease severity was assessed following the method of Emua (1980) and expressed using infection indices (Table 1).

Sample Collection

Soil samples were collected from the rhizosphere of infected cucumber plants across three cucumber fields in the senatorial district. The samples were stored in bags and transported to the laboratory for analysis. Infected roots and stems were carefully uprooted and placed in polyethylene bags for further studies. Collections were made immediately after symptoms of root and stem rot appeared (Plates 1 and 2).

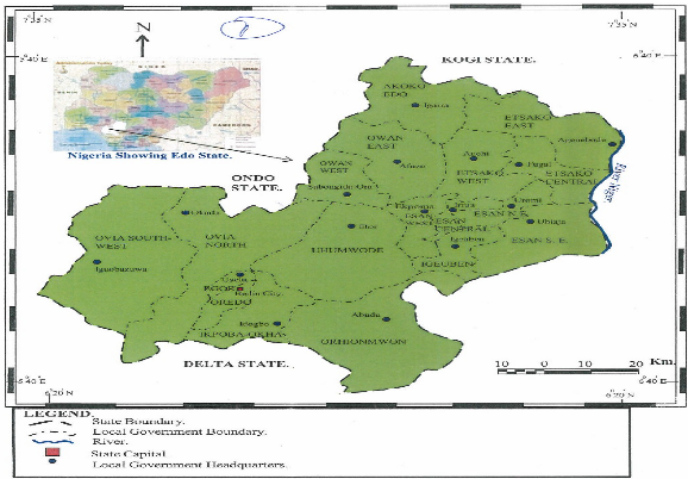


Figure 1 Map of Nigeria and Edo State



Figure 2 Map of Edo State showing the study areas



Plate 1: Heavily infected plots with stem rot disease of cucumber.

Sterilization of Materials

All glassware, including Petri dishes, conical flasks, test tubes, and McCartney bottles, were soaked in detergent for 24 hours, thoroughly rinsed with distilled water, and air-dried before being



Plate 2: Uninfected and infected cucumber plants in the field



Plate 3: Seeds of cucumber cultivars used for the experiment (A. Poinsett B. Marketmore. C. Technisem).

Table 1 Infection indices for different levels of disease severity of root and stem rot of cucumber.

Index	Infected Roots/Stems (%)	Description
0	0	No infection
1	1–30	Very light infection
2	31–55	Moderate infection
3	56–75	Severe infection
4	> 75	Very severe infection

sterilized at 180ºC for 6 hours. Laboratory benches were cleaned and surface-sterilized with 75% ethanol. The inoculation chamber was sterilized using ultraviolet (UV) light for 6 hours prior to use to eliminate airborne contaminants and ensure aseptic conditions during inoculation. New polyethylene bags used for specimen collection and humidity control during pathogenicity tests were disinfected with absolute alcohol. The inoculating needles, scalpels, cork borers, and forceps were sterilized by heating to red-hot, then cooled in 75% alcohol.

Fungal Isolation

Three methods of fungal isolation were employed: the soil dilution plate method, soil plate method, and direct isolation from infected roots.

- **Soil Dilution Plate Method** (Waksman, 1922; modified by Amoo et al., 2007): 1 g of rhizosphere soil was mixed with 10 ml of sterile distilled water in a test tube. From this, 1 ml was transferred to a second tube containing 9 ml of sterile distilled water, and a tenfold dilution series was made up to 10. Dilution levels 10^3, 10, and 10 were used for fungal isolation by adding 1 ml of suspension to PDA plates. Streptomycin (1%) was added to prevent bacterial growth, and the plates were incubated at 27 ± 2ºC for 48 hours.
- **Soil Plate Method** (Warcup, 1950; Yasanthika, 2022): 0.005 g of soil was scattered on sterile Petri dishes, and molten PDA (40–45ºC) was poured over it. The plates were incubated at 27 ± 2ºC and observed daily for 7 days.
- **Direct Isolation** from infected roots involved cutting 5–10 mm sections from the lesion margins (Ali et al., 2023). The sections were surface-sterilized with 70% alcohol, rinsed in distilled water, blotted dry, and inoculated onto PDA in sterile Petri dishes. The plates were incubated at 27 ± 2ºC and observed daily for seven days.

Identification of Isolates

Fungal colonies were examined macroscopically for colour and texture and microscopically using lactophenol cotton blue stain to observe sporangiophores and sporangia. Identification was based on descriptions by Cheesebrough (1991). Further confirmation was conducted at the International Institute of Tropical Agriculture (IITA), Ibadan.

Pure Culture Preparation

Pure cultures were obtained by sub-culturing fungal colonies onto fresh PDA until pure isolates were achieved. These were maintained on PDA slants in McCartney bottles at 28°C.

Pathogenicity Tests and Host Range

Pathogenicity tests were conducted by inoculating potted cucumber seedlings from three cultivars (Technisem, Marketmore, and Poinsett) obtained from the Institute of Agricultural Research, Ahmadu Bello University. Plate 3 shows the seeds of the three varieties of cucumber used for the study. Sterile soil, treated in an oven at 180ºC for 48 hours, was used for planting. Seven-day-old cultures of mycelia and sporangial suspensions (3 x 10 sporangia/cm^3 of *Pythium*) were used to inoculate seedlings. Control plants were watered with distilled water. Plants were covered with polyethylene bags to create humid conditions, following the method of Amoo et al. (2007). Tomato (*Solanum lycopersicum* L.) was also tested as a potential alternate host for the pathogen.

Evaluation of Soil Physicochemical Parameters

Soil temperature, colour, and pH were recorded on-site. pH was measured using the procedure described by Vinay et al. (2015). Soil samples were dried at 60ºC for 72 hours, sieved, and dissolved in distilled water (2.5 w/v). The pH was then measured using a digital pH meter. Temperature was determined using a thermometer.

Table 2 Incidence and Severity of the Root and Stem Rot Disease of Cucumber at Different Study Areas

Cucumber Cultivar	Irrua		Ekpoma		Ubiaja	
	% I	S.I	% I	S.I	% I	S.I
Technisem	75.00	3	66.00	3	70.00	3
Marketmore	40.00	2	20.00	1	30.00	2
Poinsett	55.00	2	22.00	1	45.00	2

Key: % I: % Incidence; S.I: Severity Index

Evaluation of Soil Microflora

Soil samples were collected from Ubiaja, Ekpoma, and Irrua between November 2014 and July 2016. The number of colonies per gram of soil was recorded, and the percentage contribution of each isolate was calculated using the formula by Vinay et al. (2015):

$$\% \text{ contribution} = \frac{\text{Total No. of CFU of an individual species} \times 100}{\text{Total No. of CFU of all species}}$$

Results

Survey of Root and Stem Rot of Cucumber

The survey conducted across the three locations revealed that the Technisem cultivar exhibited the highest susceptibility to root and stem rot disease, with the greatest percentage incidence. This was followed by Poinsett, while Marketmore was the least susceptible, showing the lowest percentage incidence of disease (Table 2). Among the locations, Irrua recorded the highest disease incidence, followed by Ubiaja, with Ekpoma having the least incidence.

Morphology of the Isolate

The fungus isolated from infected cucumber roots and soils across the study locations in Edo Central Senatorial District was identified as *Pythium aphanidermatum*. This fungus was also associated with the roots of other plants, such as tomato, in the surveyed areas. *Pythium aphanidermatum* is classified as a Phycomycete, characterized by coenocytic (aseptate) hyphae. The vegetative mycelium appeared whitish to off-white, richly branched, slender, and hyaline. The mycelium was fast-growing, covering the entire Petri dish within seven days. Sporangia were terminal or intercalary, typically produced in vesicles during sexual reproduction. The sporangia were globular to oval or irregular in shape and germinated to produce germ tubes (Plates 4 and 5).

Pathogenicity Test

The pathogenicity tests conducted on three cucumber varieties: Technisem, Marketmore, and Poinsett, confirmed the presence of root and stem rot symptoms across all cultivars. The Technisem variety exhibited the highest susceptibility, with 10 out of 30 seedlings becoming infected within five weeks of planting. In comparison, Marketmore showed the least susceptibility with 5 infected seedlings, while Poinsett had 7 infected seedlings (Table 3). Re-isolation of the fungus from the infected roots and stems revealed that the causal organism was identical to the isolate obtained from field-infected hosts. The observed symptoms included stunted growth, chlorosis, drooping of leaves, premature leaf shedding, and withering. Affected plants also showed brownish-purple discoloration in their roots and stems, which often extended throughout the plant, leading to plant death in severe cases.

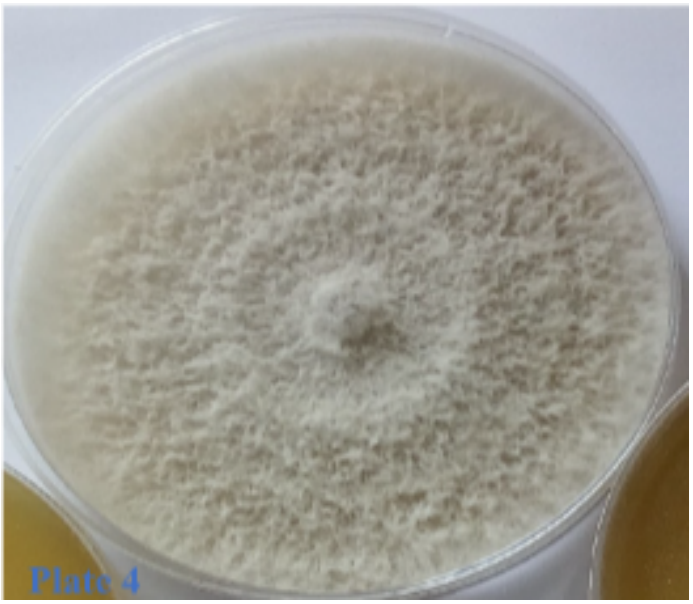


Plate 4: *Pythium aphanidermatum* (pure culture) on PDA medium

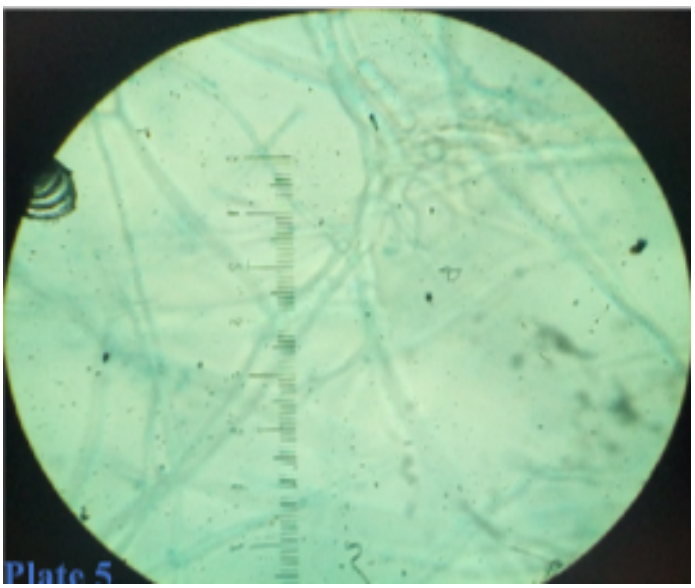


Plate 5: Microscopic examination of *Pythium aphanidermatum* showing coenocytic hyphae with sporangia

Table 3 Susceptibility Test of Three Cucumber Cultivars to the Root and Stem Rot Disease of Cucumber

Cucumber Cultivars	No. of Seeds Planted	No. of Seeds Germinated	% Germinated	No. of Infected Seedlings	% of Seedlings Infected
Technisem	30	26	86.7	10	38.5
Marketmore	30	18	60.0	5	27.8
Poinsett	30	21	70.0	7	33.3

Table 4 Some Physicochemical Parameters of Soil Samples Obtained from Different Locations

Locations	Colour	Temperature (°C)	pH
Ubiaja	Black	26.1	8.61
	Grey	27.2	8.55
	Brown	28.1	8.51
Ekpoma	Black	26.2	8.71
	Brown	26.2	8.52
Irrua	Black	27.8	8.54
	Brown	26.4	8.53

Physicochemical Characterization of Soil Samples

Soil characteristics, including colour, temperature, and pH, were evaluated across the three surveyed locations. Soil colors ranged from black and grey to brown in Ubiaja, Ekpoma, and Irrua (Table 4). The soil temperature was recorded between 26.1^{o}C and 28.1^{o}C. pH values, determined following standard protocols, ranged from 8.51 to 8.71. There were no significant differences in the temperature and pH values across the locations (Table 4).

Frequency of Distribution of Soil Mycoflora at the Sampled Sites

The distribution of soil mycoflora across the three surveyed fields was assessed over a 12-month period from January to December 2014. A total of 60 fungal colonies, representing seven distinct species, were isolated (Table 5). The majority of the fungi were from the Ascomycotina and Zygomycotina groups. The dominant fungal species identified were *Aspergillus flavus* (23.3%), *Aspergillus niger* (20%), *Aspergillus fumigatus* (18.3%), *Pythium sp.* (16.7%), and *Rhizopus sp.* (18.3%). These species were consistently abundant due to their vigorous growth and frequent occurrence. The less common species included *Fusarium sp.* (8.3%) and *Trichoderma sp.* (8.3%). The frequency distribution of mycoflora across the different fields is detailed in Table 5, with the percentage contributions of each species shown in Figures 3, 4, and 5.

Discussion

The primary objective of this study was to investigate the incidence of stem and root rot diseases of cucumber (Cucumis sativus L.) in Edo Central Senatorial District of Edo State, Nigeria. The pathogen consistently isolated from infected roots, stems, and soil samples across the three cucumber cultivars grown in the study locations was identified as *Pythium aphanidermatum*. This pathogen was confirmed to be the causal agent of root and stem rot in all three locations. These findings align with the report by Zhi-Hong et al. (2000), who identified *P. aphanidermatum* as the root rot pathogen in hydroponically grown cucumbers.

The survey conducted between 2014 and 2016 revealed the widespread prevalence of root and stem rot in cucumber crops across the study region. This observation corroborates Akueshi (1975), who similarly identified *P. aphanidermatum* as a causative agent of root and stem rot in both cucumber and tomato (*Solanum lycopersicum*). The fungus has been widely documented as a pathogen responsible for "damping off" and root rot in various crops, primarily affecting the root tips, thus inhibiting nutrient and water uptake. Dutta (2005) suggested that *P. aphanidermatum* may enter plant hosts through wounds, a phenomenon also observed in this study.

Additionally, Al-Mawaali et al. (2012) reported *P. aphanidermatum* as a major fungal disease of cucumber worldwide, responsible for killing up to 75% of seedlings and mature plants. The morphological features of the pathogen in the present study, such as coenocytic hyphae, branched, fast-growing mycelium, and globose to irregular-shaped sporangia, matched those described by Klemsdal et al. (2007), Agrios (2005), and Pandey and Trivedi (2008).

Pathogenicity tests confirmed the virulence of *P. aphanidermatum*, with 38.5% of the inoculated cucumber plants developing typical root rot symptoms, while no symptoms were observed in control plants. Re-isolation of the pathogen confirmed its identity as *P. aphanidermatum*, fulfilling Koch's postulates. Infected plants displayed symptoms such as chlorosis, stunting, leaf wilting, and eventual death, consistent with the observations of Al-Mawaali et al. (2012).

Among the three cucumber varieties tested, Marketmore exhibited the highest resistance to *Pythium* infection, followed by Poinsett, with Technisem being the most susceptible. Disease susceptibility appeared to decrease from flowering to maturity, likely due to increased lignin production, which is known to strengthen plant resistance to abiotic and biotic stresses such as rot (Cao et al., 2022; Wang et al., 2023). Cao et al. (2022) showed that *Brassica napus* strains with improved stem strength demonstrated improved resistance to *Sclerotinia sclerotiorum* pathogen. In this study, Technisem's higher susceptibility may be linked to its lower lignin content and thinner cuticle, making it more vulnerable to pathogen invasion.

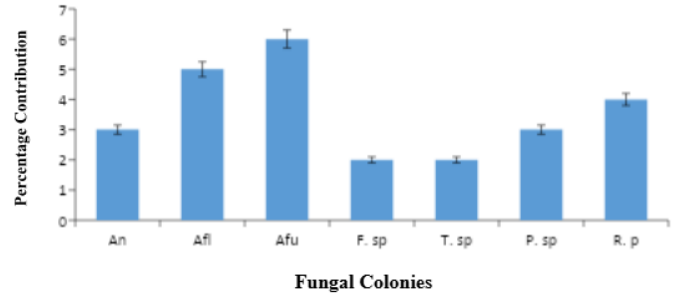
Geographically, Ekpoma recorded the lowest incidence of the disease, followed by Ubiaja, with Irrua showing the highest infection levels. The presence of *P. aphanidermatum* in tomato plants within the study area further confirmed the pathogen's ability to infect other hosts.

The physicochemical analysis of soil samples revealed three predominant soil colours: black, grey, and brown, indicating a high humus content. Soil temperatures ranged from 26.1 to 28.1°C, consistent with typical tropical conditions, while pH values between 8.51 and 8.71 were observed. These factors, especially soil pH, moisture, and organic content, have been reported to significantly influence fungal populations and diversity (Bissett and Parkinson, 1979; Deka and Mishra, 1984; Yu et al., 2007;

Table 5 Frequency of Soil Mycoflora at the Sampled Sites

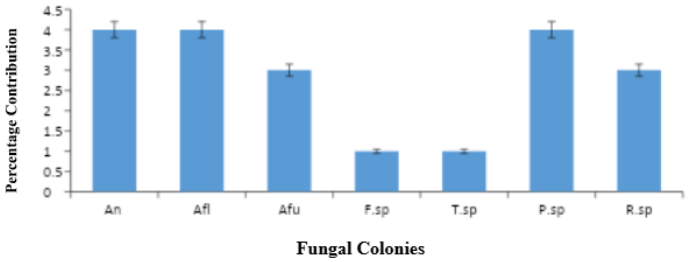
S/N	Locations	Ave. No. of Colonies	*A. niger*	*A. flavus*	*A. fumigatus*	*Fusarium sp.*	*Trichoderma sp.*	*Pythium sp.*	*Rhizopus sp.*
1	Ubiaja	20	3	5	6	2	2	3	4
2	Ekpoma	22	4	4	3	1	1	4	3
3	Irrua	18	5	5	2	2	2	3	4
Total		60	12	14	11	5	5	10	11
% Contribution			20%	23.3%	18.3%	8.3%	8.3%	16.7%	18.3%

Key: Ave.: Average; *A. niger*: *Aspergillus niger*; *A. flavus*: *Aspergillus flavus*; *A. fumigatus*: *Aspergillus fumigatus*



An = *Aspergillus niger*
Afl = *Aspergillus flavus*
Afu = *Aspergillus funigatus*
F. sp = *Fusarium* sp
T.sp = *Trichoderma* sp
P.sp = *Pythium* sp
R.sp = *Rhizopus* sp

Figure 3 Percentage Contribution of Mycoflora at Ubiaja

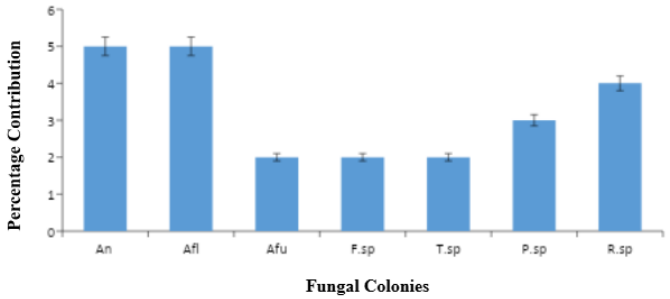


An = *Aspergillus niger*
Afl = *Aspergillus flavus*
Afu = *Aspergillus funigatus* sp
F. sp = *Fusacuim* sp
T.sp = *Trichoderma* sp
P.sp = *Pythium* sp
R.sp = *Rhizopus* sp

Figure 4 Percentage Contribution of Mycoflora at Ekpoma

Luo et al., 2021). The results showed a peak in fungal colony counts during the wet season, when humidity and temperature are optimal for fungal growth.

A total of 60 fungal colonies, representing seven species, were identified in the soil samples. The dominant species included *A. flavus* (23.3%), *Aspergillus niger* (20%), *A. fumigatus* (18.3%), *Rhizopus sp.* (18.3%), and *Pythium sp.* (16.7%), with lower occurrences of *Fusarium sp.* and *Trichoderma sp.* (8.3% each). These results align with previous studies, such as that of Duan (2023)



An = *Aspergillus niger*
Afl = *Aspergillus flavus*
Afu = *Aspergillus funigatus*sp
F. sp = *Fusarium* sp
T.sp = *Trichoderma* sp
P.sp = *Pythium* sp
R.sp = *Rhizopus* sp

Figure 5 Percentage Contribution of Mycoflora at Irrua

and Vinay et al. (2015), which demonstrated that fungal diversity is influenced by factors such as temperature, humidity, and soil composition.

Conclusion

This study provides data confirming that *Pythium aphanidermatum* is the causal agent of cucumber root and stem rot, posing a significant threat to agriculture in the Edo Central Senatorial District of Nigeria. The marked differences in varietal resistance where Marketmore exhibited the highest resilience and Technisem the greatest susceptibility offer critical insights for breeding programs aimed at enhancing crop resistance. Ekpoma's higher disease resistance compared to Ubiaja and Irrua further informs targeted regional management strategies. Importantly, the identification of tomato as an alternate host expands the scope of potential pathogen reservoirs, underscoring the need for integrated disease management approaches that consider multiple crops within the ecosystem.

Funding

The authors received no specific funding for this work.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Ethical Statement

This article does not contain any studies involving animals/human participants performed by any of the authors.

Data Availability

The authors confirm that the data supporting the findings of this study are available within the article.

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