Survey and in Vitro Control of Cercospora Leaf Spot of Groundnut from Some Selected Districts of Hong Local Government Area, Nigeria

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ABSTRACT

This study investigates the incidence, severity, management practices, and in vitro control of Cercospora leaf spot (CLS) disease from groundnut (Arachis hypogaea L.) farms in Hong, Adamawa State, Nigeria, focusing on farmers' knowledge and practices. 60 farmers from six communities within the Hong Local Government Area were surveyed using structured questionnaires to assess their awareness and management strategies for CLS while seed, stem-bark and leaf extracts of A. indica were used at different concentrations (100, 200, 400 and 800 mg/ml) with a positive (Tebuconazole) and negative (5 ml of water) control for in vitro control trials. The results revealed that the majority of farmers lacked adequate knowledge about the disease and its causal agent, Cercospora arachidicola. Chemical control methods were the most commonly used, although not universally accessible or sustainable, while cultural control practices were rarely implemented. Disease incidence varied across locations, with Bangshika showing the highest incidence at 43.16%, while Pella had the lowest. Disease severity ranged from 41-60% in most farms, with some locations like Zhedinyi reporting higher severity (61-80%). In vitro antifungal investigation showed that seed extract of A. indica had the least radial mycelial growth (2.21 mm) compared to the stem-bark (3.47 mm) and the leaf (4.24 mm). These findings highlight the critical need for more effective disease management strategies, as well as farmer education on sustainable disease control measures. This study emphasizes the importance of integrated pest management (IPM) strategies for reducing groundnut yield losses due to CLS, more especially using A. indica as a biocontrol agent with recommendations for further research into identifying the active metabolites present in the botanical.

Keywords: Disease Incidence, Severity, *Cercospora* leaf spot and Management practice

INTRODUCTION

Groundnut (Arachis hypogaea L.), commonly known as peanut, is an important oilseed crop cultivated worldwide. The crop is native to Central America and has never been found uncultivated. It is a vital source of edible oil, protein, and essential nutrients for human consumption and livestock feed (Varshney et al., 2016). The local names of groundnut include; English: Groundnut (Kumar et al., 2021), Spanish: (Ugarte, 2024), French: Arachide (Kouamé et al., 2017), Portuguese: Amendoim (Calacina et al., 2024), Swahili: Karanga (Utenga and Lusekelo 2025), Hindi: Mungphali (Singh et al., 2020), Bengali: Badam (Paul et al., 2018), Mandarin Chinese: Huasheng (Zhang et al., 2019), Japanese: Pīnattsu (Yamada et al., 2020) and Russian: Arakhis (Kozlov et al., 2017). In Nigeria's local languages, Hausa: Gyada (Yakubu et al., 2019), Yoruba: Èpè (Adegbite et al., 2021), Igbo: Ùhòkè (Anyanwu et al., 2018). Groundnut production is crucial in global food security and rural livelihoods, particularly in developing countries where it is a staple crop (Nigam et al., 2019). Groundnut kernels are consumed directly as raw, roasted, or boiled kernels, or oil extracted from the kernels is used as culinary oil (Reddy et al., 2011). The major groundnut-producing countries include China, India, Nigeria, the United States, and Senegal (FAOSTAT,2022). With a global cultivation area of 29.55 million hectares, peanuts yield an impressive annual

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production of 44.5 million metric tons, translating to an average productivity of approximately 1.51 metric tons per hectare (FAO, 2023). Its seeds, rich in protein (25-28%) and oil (48-50%), offer significant nutritional value, and its byproducts, such as hay (haulms), provide essential animal feed, especially during dry periods. Furthermore, the crop is an important source of income for smallholder farmers, including rural women, who sell its seeds and hay in local markets.

Originating in South America, groundnut spread across the globe through the voyages of European explorers in the 16th and 17th centuries. Today, it is cultivated in 108 countries across various climatic zones, with significant production in Asia (India, China) and Sub-Saharan Africa. In Nigeria, for instance, groundnut is grown on about 1-2.5 million hectares, making it a vital crop in the region. Despite its importance, groundnut yields in developing countries, including Nigeria, remain low—significantly below those in developed nations—due to various factors, including disease pressure (Ajeigbe *et al*., 2015). Foliar disease is the major factor limiting groundnut productivity (Thakur *et al*. 2013) with CLS being predominant among the major diseases affecting groundnut production (Khan *et al*., 2014). This fungal disease can cause substantial yield losses to 78% in Nigeria—by inducing premature leaf defoliation and damaging groundnut plants by reducing the available photosynthetic leaf area (Naab *et al*., 2009). While improved groundnut cultivars have been developed, many farmers still grow susceptible varieties, and disease management remains a significant challenge. Current control measures, including fungicides, are often expensive, environmentally harmful, and inefficient due to the development of pathogen resistance. This underscores the need for alternative, sustainable control strategies, such as plant-based antimicrobial treatments, which have shown promising potential in combating *Cercospora* leaf spot.

Most farmers around Adamawa State and its environs do not practice any disease control measures for *Cercospora arachidicola* Hori. on their fields, and they often see leaf defoliation as a sign of crop maturity (Nutsugah *et al*., 2007) and as a result, recorded a huge economic damage of their groundnut annually right from their farmland due to infection caused by these pathogenic fungi. Although groundnut cultivation is common in Adamawa State, there is so far little empirical data on fungal infestation and control, especially in the selected local government areas of study in the geopolitical zones of Adamawa State.

The primary aim of this study is to assess farmers' knowledge and management practices regarding CLS, determine the incidence and severity of CLS in selected groundnut farms and to test in vitro efficacy of *A. indica* extracts.

MATERIALS AND METHODS

Field Survey

The study was conducted in six communities within the Hong Local Government Area of Adamawa State, Nigeria: Zhedinyi, Pella, Bangshika, Hong, Gashala, and Hildi (Figure 1). A total of 60 farmers were selected through random sampling to participate in a survey on their knowledge, perception, and management practices regarding CLS. A structured questionnaire was used to gather data on demographic information, awareness of CLS, and current disease management practices.

Figure 1: Map of the Study Area

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Determination of Disease Incidence and Severity

The incidence of CLS was measured by sampling a 3x3 meter quadrant from each farm, counting the number of diseased versus healthy plants, and calculating the disease incidence percentage. Disease severity was assessed using a visual scale from 1-5 based on the percentage number of infected plants. The incidence of CLS infection was expressed in percentage using the adopted formula given by Singh et al. (2012) and Isa et al. (2020)

Disease Incidence = (Number of infected groundnut plants)/(Total number of groundnut plants sampled) X 100%

The severity of the disease on the infected plant was determined by using the visual scale of 1-5 as adopted by Zakawa et al. (2025) with little modifications, in which:

1=1-20% of Groundnut Plants infected,

2=21-40% of Groundnut Plants infected,

3=41-60% of Groundnut Plants infected.

4=61-80% of Groundnut Plants infected,

5=More than/80% of Groundnut Plants are infected.

Plant Extract Preparation for In vitro Study

The maceration method of extraction was used to extract the plant constituents using ethanol as a solvent. About 300 g of the pulverized (ground) *Azadirachta Indica* seed, bark, and leaf powder were weighed and placed in one liter of ethanol in a conical flask and covered with aluminum foil. The mixtures were shaken vigorously from time to time and allowed to stay for 24 hours. The mixture after 24 hours was filtered first using muslin cloth and finally using Whatman No. 1 filter paper. The filtrate was then concentrated using a rotary evaporator at 600°C. The concentrate was then collected in a sample bottle and kept in a refrigerator at 40°C pending analyses.

The ethanolic leaf, bark, and seed extract were prepared into four (4) different concentrations ranging from 100 to 800mg/ml (i.e. 100,200,400, and 800 mg/ml). The extract concentration was prepared by weighing 80g of the extract into 1000 ml of sterile distilled water (800 mg/ml). A doubling dilution of the extract was carried out into three (3) different labelled bottles to obtain concentrations 400, 200, and 100 mg/ml respectively (Zakawa et al., 2021).

Media Preparation and Amendment with Plant Extracts

The medium used for the isolation and in vitro control trials was using Potato Dextrose Agar (PDA) and was prepared according to the standard method recommended by the manufacturer (Zakawa et al., 2018). To amend the PDA with plant extracts at each concentration (100 mg/ml, 200 mg/ml, 400 mg/ml, and 800 mg/ml) and Tebuconazole, each was dispensed into Petri dishes (9cm diameter) using a sterile pipette. To this, 20 ml PDA was added, agitated and allowed to solidify. For the positive controls, 1.5 ml of Tebuconazole was prepared at the recommended rate (1.5ml/1L) and used for the amendment. 5 mm of sterile distilled water were used as negative controls.

Isolation and Identification of C. arachidicola

Infected groundnut leaves collected from farmers' fields during the survey were kept in sterile polythene bags, labelled and brought to the Laboratory for isolation of CLS pathogens. The infected leaves were washed twice with tap water and rinsed twice with sterile distilled water for one minute. The pathogen, *C. arachidicola* was isolated from infected groundnut leaves by using the tissue segment method. The affected portion and a bit of healthy tissue were cut with a sterilized scalpel into 1 x 1 cm^2 pieces. The leaf fragments were soaked in sterilized distilled water for 1 min and surface sterilized in 1 % Sodium hypochlorite for 3 min, rinsed in 3 changes of sterile distilled water; blot dried with sterilized tissue paper in a laminar flow hood and plated on PDA in a 9cm Petri dish. Four of the cut sections were placed in each Petri dish containing about 25 ml PDA. The plates were sealed, incubated at 25°C and the cultures were observed for seven consecutive days. The mycelia that grew were sub-cultured onto fresh PDA. Further sub-culturing was carried out until pure cultures of the pathogens were obtained. Pure cultures were preserved in McCartney bottles containing solidified PDA in the slant position and placed in the refrigerator to serve as stock culture.

The pathogen was then identified through microscopic examination, which was made after examining the colony characteristics such as colony colour (front and reverse), growth pattern and rate on the media. A sterile needle was used to take a portion of the hyphae containing spores onto the glass slide, which was stained with Lactophenol cotton blue and was observed under the light microscope with a power objective lens X 40 for the structures of the fungi (Isa et al., 2024). Morphological structures such as septation of mycelia and nature of spores were observed under the microscope and were compared with the structures in Alexosoulus et al. (2002).

Determination of the Inhibitory Effect of the Extract Materials on Radial Mycelial Growth of *C. arachidicola*

The approach of Ijato *et al*. (2011) was used to measure the antifungal effects of the extracts. This involves creating four equal sections on each plate by drawing two perpendicular lines at the bottom of the plates. The point of intersection indicates the center of the plates. This was done before dispensing PDA into each of the plates. The prepared medium was poured into the sterilized petri dishes and 2ml of each plant extract at different levels of concentration was poured into the petri dishes containing the media separately, mixed well, and was allowed to solidify. The solidified medium was then inoculated centrally with the pathogen at the point of intersection of the two perpendicular lines drawn at the bottom of the plate, three replicates were made for each treatment concentration, including the positive control (Tebuconazole 1.5mg/ml) and the negative control (5 ml of distilled water). The length of mycelial growth in each of the treatments was then measured using a meter rule.

Data analysis

The data derived from field surveys was subjected to descriptive analysis using charts, figures, and tables. The incidence of CLS was analyzed using one-way analysis of variance (ANOVA) and means were separated using the Duncan Multiple Range Test (DMRT) at a probability level of $P < 0.05$ while data obtained on the management practices were analyzed using a chi-square test.

RESULTS

Demographic Characteristics of Respondents

It was revealed that the majority of the respondents were within the age of 36-50 years, followed by those between 26-35 years of age. The result also shows that most of the respondents were literate, those with tertiary education were more than 51%. Also, females constitute the bulk of the farmers in the study area (Figure 2).

Groundnut Cultivation Experience in the Study Area

The results showed that most of the respondents had been cultivating groundnut in the study area for more than 10 years, followed by those that had been cultivating it for 4-6 years. However, less than 10 of the respondents had been observed to be cultivating groundnut for only 1-3 years. Similarly, the majority of the respondents (38) preferred to cultivate 'Jan gyada' groundnut cultivars over 'Kampala' and 'Kwa-chamba' with those that cultivated 'Kwa-chamba' having the lowest (26). Most of the respondents cultivated the groundnut cultivar of their choice because of its marketability while the rest was because of its early maturity (Figure 3).

Respondents' Knowledge of Cercospora leaf spot

The results indicated that there was a relationship between the knowledge of the respondents and their responses at $p>0.05$ (Table 1).

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Management Practices of *Cercospora* Leaf Spot in the Study Area

It was observed that most of the respondents neither adopted cultural nor chemical methods for the management practices for *Cercospora* leaf spot disease in the study area. However, those who adopted the chemical method as the management practice for *Cercospora* leaf spot disease of groundnut were more than those who adopted the cultural method (Figure 4).

Incidence and Severity of *Cercospora* Leaf Spot Disease on Groundnut Farms in Sampled

It was revealed that the groundnut farms in Bangshika had a significantly higher incidence of *Cercospora* leaf spot disease (43.16) than those in other sampled locations at P≤0.05. This was followed by those in Hong. However, the groundnut farms in Pella had the lowest incidence of *Cercospora* leaf spot which was significantly similar to that of Zhedinyi and Hildi (Figure 5).

The results also revealed that most of the groundnut farms in Pella, Hildi, Bangshika, Hong and Gashala had a severity of *Cercospora* leaf spot disease that was between 41-60 % with the groundnut farms in Hildi and Gashala having the highest (7). The majority of groundnut farms in Zhedinyi (5), however, had 61-80 severity of *Cercospora* leaf spot disease. The severity of *Cercospora* leaf spot disease of more than 80 % was not observed in any of the farms sampled in the study area (Figure 6).

Determination of the Inhibitory Effect of the Extract Materials and concentrations on Radial Mycelial Growth of *C. arachidicola*

From the *in vitro* study of the effect of different extract materials on the radial mycelial growth of the CLS pathogen (Figure 7), there were statistically significant differences between all three extract materials. The seed extract gave the least mean radial mycelial growth (3.15 mm), followed by the stem-bark extract (3.47 mm), while the leaf extract had the highest mean radial mycelial growth as shown in Table 2, which indicates that the seed extract best inhibits the growth of the pathogen compared to the other two extracts. For the different concentration levels used, there were also statistically significant differences between all treatment concentrations at P≤0.05 with the positive control (Tebuconazole) having the least radial mycelial growth (1.40 mm), while the positive control had the highest (5.60 mm). The rate of inhibition increases with an increase in the concentration of the extract materials, 800 mg/ml had the least radial mycelial growth (2.21 mm), while the concentration with 100 mg/ml had the highest (5.60 mm) as shown in Table 2.

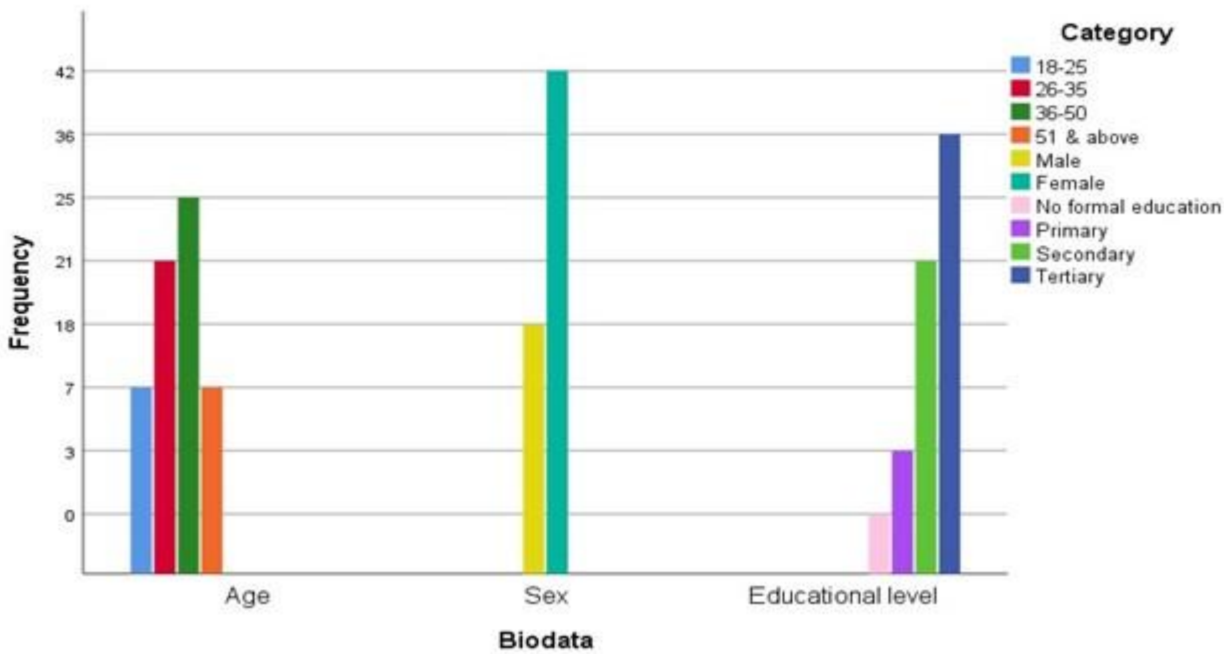

Figure 2: Demographic Characteristics of Respondents in the Study Area

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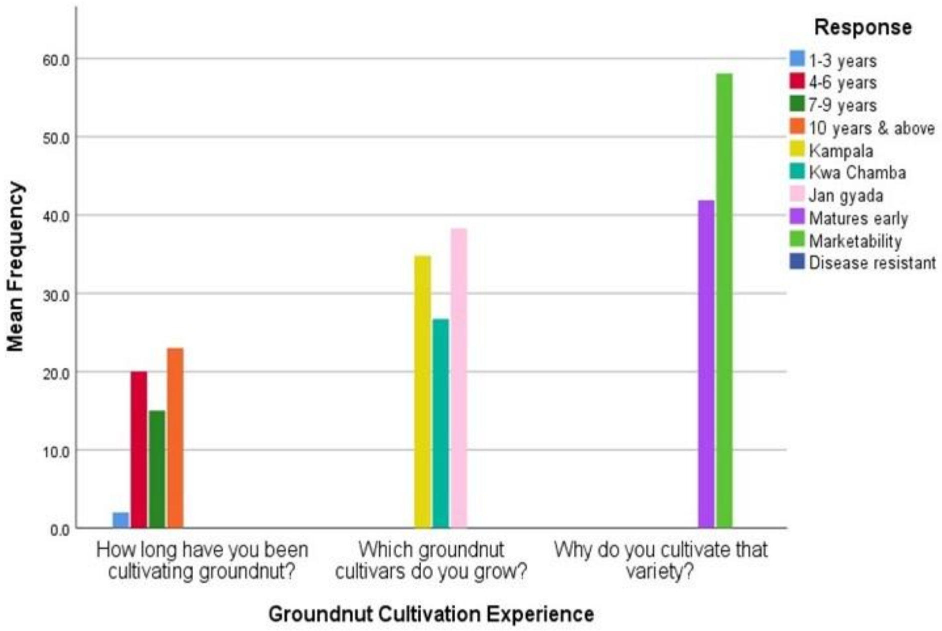

Figure 3: Respondents Groundnut Cultivation Experience

Table 1: Respondents' Knowledge of Cercospora Leaf Spot

Question	**Response**	**Observed**	**Expected**	**Chi-square**	**p-Value**
Have you heard of leaf spot disease of groundnut before?	Yes	–	0.5	104	0.96
	No	–	0.5	–	–
Are you aware of the symptoms of the disease?	Yes	–	0.5	–	–
	No	–	0.5	–	–
Can you show me some diseased samples in your field?	Yes	–	0.5	–	–
	No	–	0.5	–	–
Does the farmer know the disease?	Yes	–	0.5	–	–
	No	–	0.5	–	–
Do you have any knowledge about the causal agent of the disease?	Yes	–	0.5	–	–
	No	–	0.5	–	–
What is the cause of the disease?	Insect	–	0.2	–	–
	Early rainfall	–	0.2	–	–
	Maturity	–	0.2	–	–
	Heavy rainfall	–	0.2	–	–

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How will you describe the incidence of the disease in your field?	Low (less than 50%)	–	0.1	–	–
	High (50% & above)	–	0.1	–	–
Are you aware of the effect of the disease on the yield?	Yes	–	0.5	–	–
	No	–	0.5	–	–
What time and stage of growth do you encounter the disease?	1–3 weeks after planting	–	0.1	–	–
	4 weeks & above	–	0.1	–	–
How will you estimate the severity of the disease on a scale of 5?	0 (not severe)	–	0.2	–	–
	1 (slightly severe)	–	0.2	–	–
	2–3 (severe)	–	0.2	–	–
	4–5 (highly severe)	–	0.2	–	–
Are you aware of how to control the disease?	Yes	–	0.5	–	–
	No	–	0.5	–	–

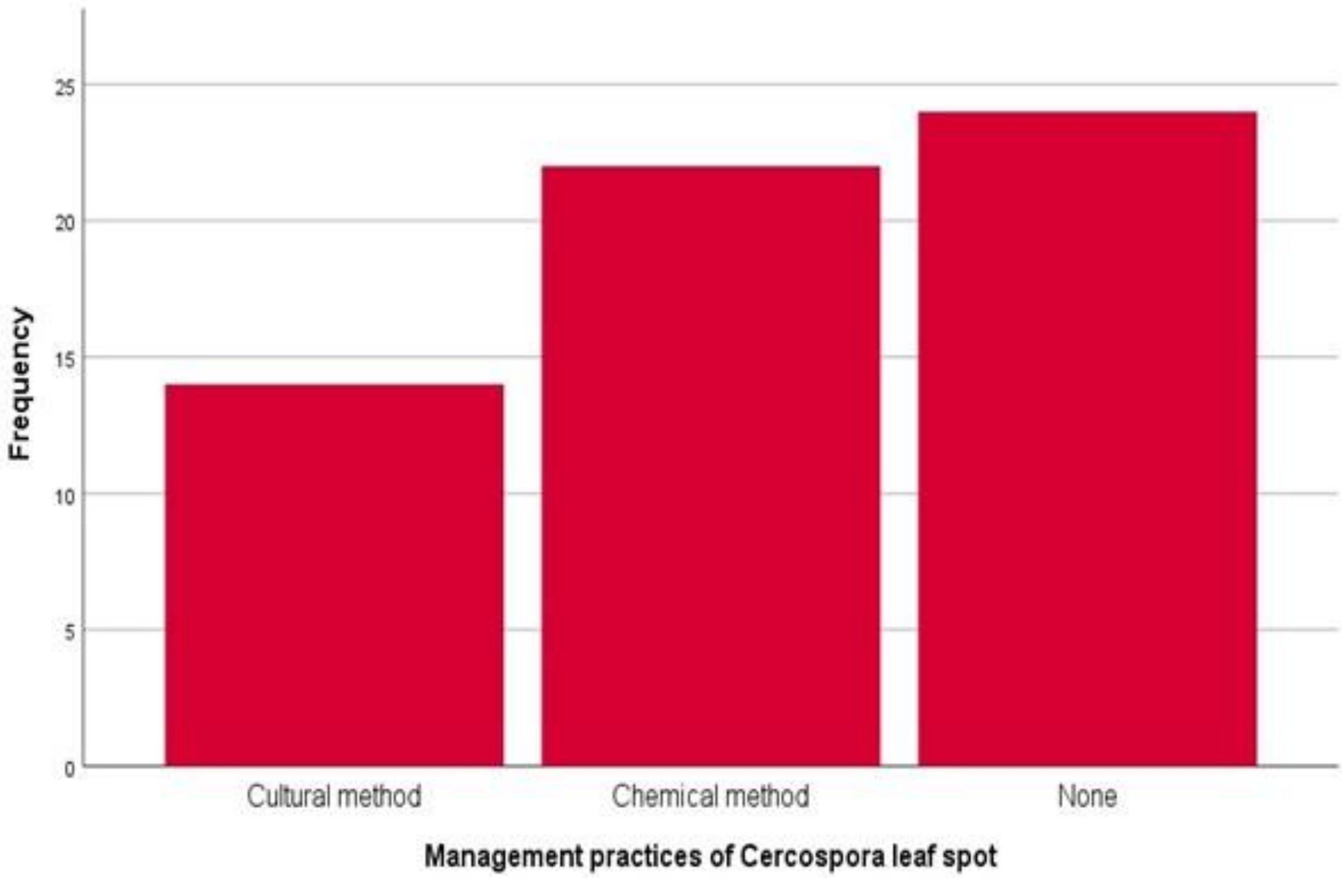

Figure 4: Management Practices of Cercospora Leaf Spot Disease of Groundnut

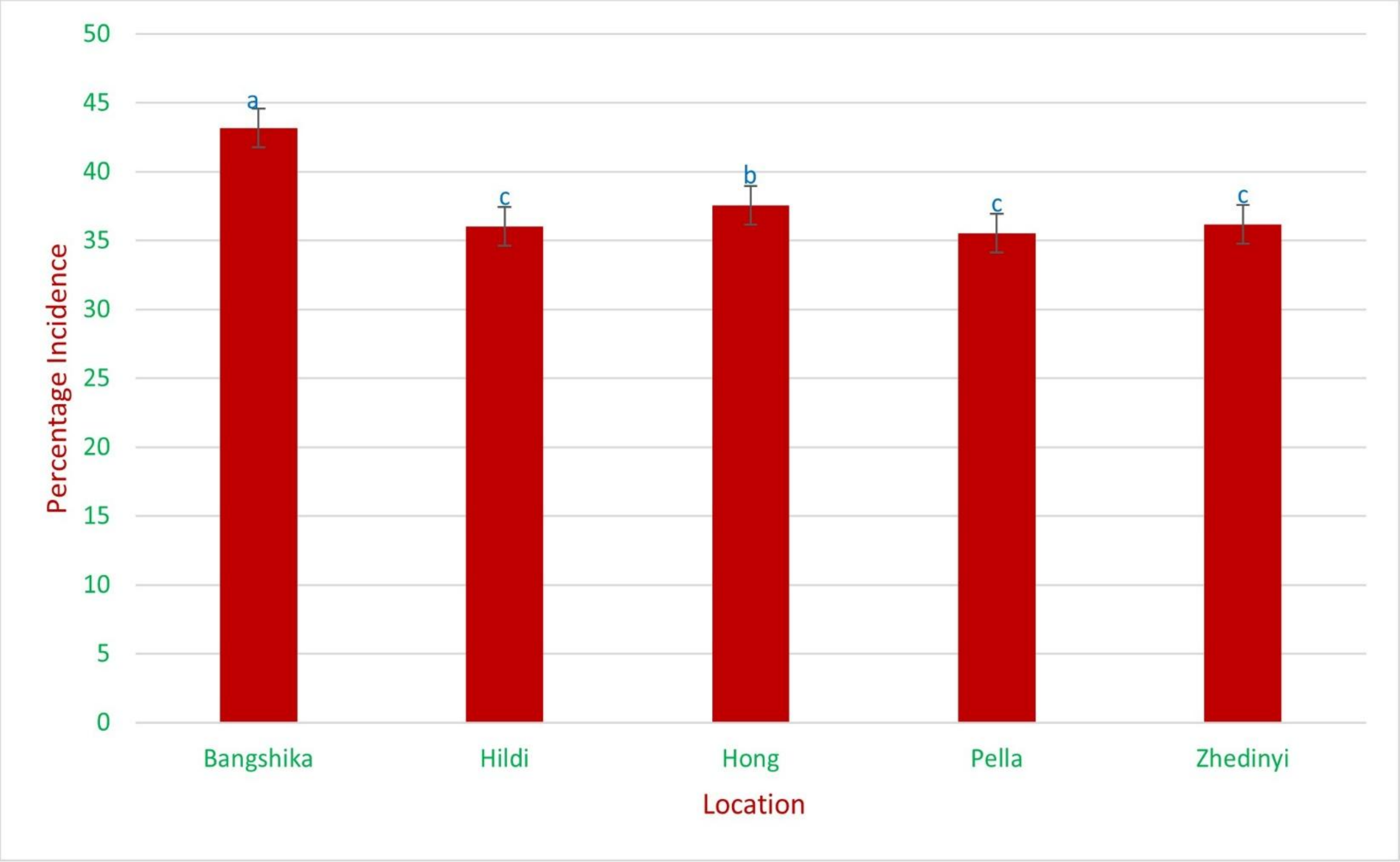

Figure 5: Incidence of *Cercospora* Leaf Spot Disease on Groundnut Farms in Sampled

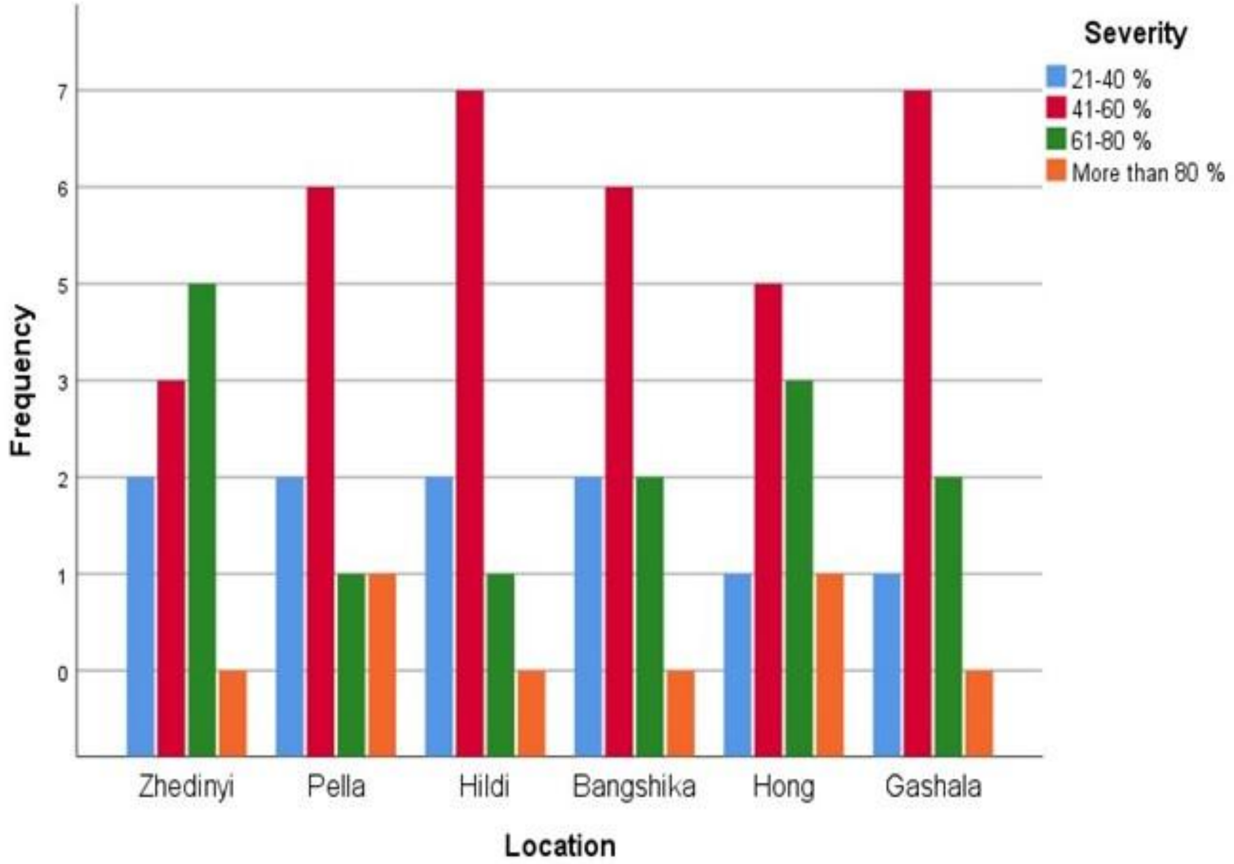

Figure 6: Severity of *Cercospora* Leaf Spot on Groundnut Farms in Sampled Locations

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Figure 7: (a) Photomicrograph of CLS pathogen X40 (b) 7-day old Pure culture of CLS pathogen from Hong District (c) 7-day old Pure culture CLS pathogen from Garaha District

Table 2: Mean Effect of the Different Plant Extract Materials on the Radial Mycelial Growth of CLS Pathogen *In vitro*

Treatment	Mean Radial Mycelial growth (mm)
Plan parts (P)	
Seed	3.15^{c}
Stem-bark	3.47^{b}
Leaf	4.24^{a}
SE ±	0.02
Concentration mg/ml (C)	
100	5.10^{e}
200	4.80^{d}
400	2.61^{c}
800	2.21^{b}
-ve Control	5.60^{f}
+ve control (Tebuconazole)	1.40^{a}
SE ±	0.16
Interaction	
P × C	*

Mean followed by the same superscript in the same column are not significantly different at $P \leq 0.05$(D.M.R.T)

DISCUSSION

This study revealed that most of the farmers interviewed were aware of the disease because the majority of them were educated. Females constituted the bulk of the farmers and the survey highlights significant gaps in farmers' knowledge of CLS management. While chemical methods are commonly used, they are not always accessible or sustainable. It was observed that most of the respondents had been cultivating groundnut in the study area for more than 10 years. Their choice of groundnut cultivar was purposely for its marketability while the rest was because of its early maturity. Most of the farmers (79 %) were able to identify the symptoms on the leaves of groundnuts on their farms. This indicates that farmers in the study area have observed the disease for a very long time. It also shows that the disease is common in all groundnut growing areas and also commonly found on the leaves of the crop. The report that the Cercospora Leaf Spot (CLS) disease is commonly found wherever groundnut is grown is true (Nutsugah *et al*., 2007; Chaube and Pundhir, 2009). The majority (91 %) of the smallholder farmers attributed the disease to poor soil fertility, high rainfall, wind or air, and herbicide applications. This implies that farmers have critically observed the disease for a very long time to determine the factors that cause or increase the incidence and severity of the disease. The farmers who used chemicals to control the disease were more than those who only used cultural methods. This could only be attributed to their level of education and knowledge of how devastating *Cercospora* disease could be. Female farmers recorded a higher percentage of disease incidence than male farmers. This can be attributed to the fact that most women are restricted to continuous cultivation on marginal lands and old groundnut fields where there is a build-up of inoculum and loss of nutrients. This agrees with Pazderka and Emmott (2010) report that factors that limit yields of groundnut in Ghana include increased cultivation on marginal lands and outbursts of pests and diseases. The fact that most farmers, especially women, were restricted to continuous cultivation of groundnuts on the same land supports the findings of Ijaz et al. (2019) who reported a decreased infection rate (%) of CLS with two-year crop rotation of groundnuts with non-host crops.

The survey revealed that the groundnut farms in Bangshika had a significantly higher incidence of *Cercospora* leaf spot disease than those in other sampled locations. The severity of Cercospora leaf spots in most of the groundnut farms in Pella, Hildi, Bangshika, Hong, and Gashala was between 41-60 %, while the groundnut farms in Hildi and Gashala had the highest. The majority of groundnut farms in Zhedinyi, however, had 61-80 severity of *Cercospora*

leaf spot disease. The severity of *Cercospora* leaf spot disease of more than 80 % was not observed in any of the farms sampled in the study area. Cercospora leaf spot was prevalent in all farms surveyed. This is also an indication that the levels of disease severity differ from locality to locality, district to district, and ecology to ecology due to differences in environmental conditions as indicated by Nutsugah *et al.* (2007). *Cercospora* leafspot causes severe damage to groundnuts particularly towards the pod formation stage of the crop, leading to lower seed and haulms yield. The disease also induces false maturity, and low yields and adversely affects the quality of groundnut. premature defoliation can occur in severe cases, while petioles and stems may also become infected (Bdliya 2007).

The study revealed that farmers were aware of the Cercospora leaf spot (CLS) disease and its devastating effects, and perceived it as a major constraint to groundnut production in the study area. Farmers described the disease incidence as well as the disease severity on their farms to be above 50% which is in agreement with Ngwamdai and Tuti (2021) who reported CLS incidence of 100% and severity of 57.77% when ground plants were exposed to 104 spores/ml suspensions in Mubi, Adamawa State Nigeria. The study also showed that leaf spot disease severity differs from one locality to another depending on environmental factors and control measures adopted by farmers. Farmers also expressed various opinions on the future management strategies for lessening the CLS problem in the area, which included spraying with effective plant extracts. This is in agreement with the works of Chotangui *et al*. (2020), who reported a decrease in disease severity of CLS when ethanolic extracts of neem seeds and garlic bulbs were applied at 65 DAP.

In vitro control using different neem materials (seed, stem-bark and leaf) showed promising means of biocontrol of the CLS pathogens. The extract materials were able to inhibit the mycelial growth of the CLS pathogen at different rates, with the seed extract providing the least mycelial growth when compared with other treatment concentrations and also with the negative control. This agrees with Ali et al., (2024) who reported that seed, leaf, and stem-bark extracts of *A. indica* were able to inhibit the mycelium and spore germination of fungal pathogens with the seed extract significantly better than the leaf. Ezeonu et al. (2018) also reported that both aqueous and ethanolic extracts of seed, stem-bark and leaf of *A. indica* were able to inhibit fungal rot pathogens of yam and cocoyam. However, the findings of this research were contrary to that of Raja et al. (2013) who reported that both leaf and stem-bark extracts of *A. indica* inhibit both bacterial and fungal pathogens compared to seed extracts *in vitro*. This may be as a result of differences in the solvent used for extraction due to their polarity and ability to extract antifungal components from the different plant materials used. *A. indica* have been proven to have antifungal activities against plant-based pathogens, from the present study, it was shown that all concentration of the extract materials (seed, stem-bark and leaf) where able to inhibit the mycelial growth of CLS pathogen in vitro and it was also observed that there was increase in the rate of inhibition of mycelia with increase in concentration of the extracts. Similarly. Zakawa et al. (2018) also reported *A. indica* leaf extracts to inhibit the mycelial growth of three pathogenic fungal pathogens isolated from two varieties of mango both *in vitro* and *in vivo*, there was also an increase in the inhibition level with increase in concentration from which the highest concentration of 60 % had the best mycelial inhibition. Shaheen et al. (2024) screened 44 phyto-extracts for their potency in preventing Brown Leaf Spot (BLS) disease in rice, from which 8 most effective phyto-extracts were selected and *A. indica* exhibited the best inhibition results *in vitro*. This antifungal potential of *A. indica* could be due to the presence of several phytochemical components present in all the parts of the plant at different rates, and also the difference in inhibition level by different parts confirms that the phytochemicals are present at different concentrations depending on the part of the plant. Orumwensodia and Uadia (2024) and Kumatia et al. (2024) reported different phytochemicals to be present in different parts of *A. indica*. Farmers need to be educated by the Government and Nongovernmental organizations on the practices that increase the incidence and severity of the disease, and an integrated management approach which may include the use of plant extracts (such as *A. indica*) since the disease is widely distributed in the study area.

CONCLUSION

From the findings of this research, it can be concluded that a significant gap exists in farmers' knowledge regarding CLS and its causal agent, Cercospora arachidicola in the study area, and while a majority of respondents were aware of the disease, many lacked a detailed understanding of its symptoms and effective management strategies.

Chemical control methods were predominantly used; however, these methods are not universally accessible or sustainable. Cultural control practices were notably underutilized, indicating a need for farmer education on integrated pest management (IPM) strategies in the study area.

The incidence of CLS varied significantly across different locations, with Bangshika reporting the highest incidence at 43.16%, while Pella had the lowest. Disease severity was also concerning, with many farms experiencing severity levels between 41-60%, and some areas like Zhedinyi reporting even higher levels.

A. indica seed, stem-bark and leaf extracts have demonstrated some degree of antifungal potential by inhibiting the rate of radial mycelial growth of CLS pathogen *in vitro*, however, the seed extract performed better compared to the other two extracts. This antifungal potential of *A. indica* could largely be due to the presence of several phytochemical components present in all the parts of the plant at different rates, and also the difference in inhibition level by different parts confirms that the phytochemicals are present at different concentrations depending on the part of the plant.

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REFERENCES

1. Ajeigbe, H. A., Waliyar, F., Echekwu, C. A., Kunihya, A., Motagi, B. N., Eniaiyeju, D., & Inuwa, A. (2015). A farmer’s guide to profitable groundnut production in Nigeria.
2. Adegbite, A. E., Egharevba, R. K. S. ans Okhidievbie, O. (2021). The occurrence and control of groundnut (Arachis hypogaea L.) diseases in Nigeria. Journal of Plant Protection Research.**61**(2): 207-219.
3. Alexopoulas, C.O., Mims, C. W and Blackwell, M. (2002). Introductory Mycology (2002). (3rd Edition), John Wiley and Sons, New York, pp 204-340.
4. Ali, J., Hussain, A., Siddique, M., and Rahman, Z. U. (2024). Evaluation of some bioactive compounds of Azadirachta indica extracts and its application as safe fungicide against different plant pathogenic

fungi. International Journal of Engineering, Science and Technology, 16(1), 44-54.

5. Anyanwu, A. C., Ibeawuchi, I. I. and Ohiri, R. C. (2018). Assessment of yield and profitability of different improved varieties of groundnut (Arachis hypogaea L.) in Imo State, Nigeria. International Journal of Current Microbiology and Applied Sciences. **7** (11): 2875-2885.
6. Bdliya, B. S. (2007). Groundnut haulm quality as affected by Cercospora leaf spot severity. Journal of Plant Protection Research 47: 3.
7. Calacina, G., Silva, V. S., de Souza, C. S., de Oliveira, J. C., de ASSIS, G. M. L., and Campos, T. D. (2024). Identification of hybrids in forage peanuts using RNA-Seq microsatellites.
8. Chaube, H.S. and Pundhir, V. S. (2009). Crop diseases and their management. Department of Plant Pathology, College of Agriculture. G. B. Pant University of Agriculture and Technology, Pantnagar, pp. 417-420.
9. Chotangui, A. H., Betigne, M., Mandou, M. S., Kamaleu, N. G. F., and Kouam, E. B. (2020). Effect of phyto-extracts of neem (Azadirachta indica) and garlic (Allium sativum) on leaf spot disease of groundnut (Arachis hypogaea L.). Open agriculture, 5(1), 441-449.
10. Ezeonu, C. S., Imo, C., Agwaranze, D. I., Iruka, A., and Joseph, A. (2018). Antifungal effect of aqueous and ethanolic extracts of neem leaves, stem bark and seeds on fungal rot diseases of yam and cocoyam. Chemical and Biological Technologies in Agriculture, 5, 1-9.
11. Food and Agriculture Organization. (2022). FAOSTAT Database. Retrieved from http://www.fao.org/faostat/en/#data
12. Food and Agriculture Organization. (2023). World Food and Agriculture Statistical Year Book. Retrieved from Rome, Italy.
13. Ijaz, M., Ali, S. R., and Afzal, A. (2019). Impact of crop rotation on Cercospora leaf spot of peanut. Plant Protection, 3(1), 41-45.
14. Ijato, J. Y, Otoide J. E, Ijadunola J. A and Aladejimokun A.O. (2011). Efficacy of antimicrobial effect of Venonia amygdalina and Tridax procumbens in invitro control of tomato (Lycopersicum esculentum) post-harvest fruit rot. Report and Opinion. **3**(1): 120-123.
15. Isa, A., Zakawa, N.N., Ibrahim, U.K. and Modibbo, A.A. (2024). In vitro efficacy of seed extracts of Allium sativum against stem rot pathogen and its effect on proximate composition of Groundnut (Arachis hypogea L.) in Adamawa State, Nigeria. International Journal of Advances in Engineering and Management (IJAEM) 6(2): 496-503
16. Isa A., Channya K.F, Zakawa N.N., Adbu H.I. and Usman I.K. (2020). Control of Fungal Post Harvest Rot Agents of Groundnut (Arachis hypogea L.) Using Leaf Extracts of Moringa oleifera, IDOSR Journal of Biology, Chemistry and Pharmacy 5(1)57-68, 2020
17. Khan, A. R., Ijaz, M., Haq, I. U., Farzand, A., and Tariqjaved, M. (2014). Management of Cercospora leaf spot of groundnut (Cercospora arachidicola & Cercosporidium personatum) through the use of systemic fungicides, Cercetari Agronomice in Moldova, 47(2): 97-102.
18. Kouamé, C. N., Koffi, J. A. and Kouassi, A. K. (2017). Identification and isolation of actinobacteria from arachiderhizospheric soils in the department of Bondoukou, Côte d'Ivoire. European Journal of Experimental Biology, **7**(3), 46-55.
19. Kozlov, V. V., Mordkovich, V. G.and Azeez, A. O. (2017). Induction of resistance in groundnut (Arachis hypogaea L.) against leaf spot caused by Cercosporidium personatum by treatment with chemical inducers. Bulgarian Journal of Agricultural Science, **23**(5), 734-742.
20. Kumar, R., Kumar, R., Jha, P. N., and Sharma, S. K. (2021). Evaluation of pre- and post-emergence herbicides for weed control in groundnut (Arachis hypogaea L.) under rainfed conditions. Journal of Pharmacognosy and Phytochemistry, **10**(6), 49-54.
21. Kumar, A., Srivastava, A., Roy, N., Verma, A., & Saini, H. K. (2019). Studies on Cercospora leaf spots disease of groundnut under Bundelkhand region. IJCS, 7(4), 2709-2714.
22. Kumatia, E. K., Zoiku, F. K., Baffour, P. K., Anokye-Kumatia, A. B., & Asase, A. (2024). Phytochemical Analysis, Cytotoxicity, and Antitrypanosomal, Antioxidant, and Anti-Inflammatory Activities of Clausena anisata Fruit, Azadirachta indica Leaf, and Stem Bark Extracts. Journal of Parasitology Research, 2024(1), 7509588.
23. Mwai, R., Sila, D. N. and Mburu, M. W. (2016). Assessment of aflatoxin contamination in groundnut (Arachis hypogaea L.) seeds and effect of sample preparation methods on aflatoxin determination. International Journal of Agricultural Science, Research and Technology in Extension and Education

Systems, **6**(2), 1-9.

24. Naab, J. B., Boote, K. J. Prasad, P. V. V. Seini, S. S., and Jones, J. W. (2009). Influence of fungicide and sowing density on the growth and yield of two groundnut cultivars, Journal of Agricultural Science, 47(2) 179-191.
25. Nigam, S. N., Shasidhar, Y. and Aruna, R. (2019). Seed quality: Importance, challenges, and possible strategies for improvement. In S. N. Nigam, Y. Shasidhar, & R. Aruna (Eds.), Groundnut Seed Production (pp. 1-14). Academic Press.
26. Nutsugah, S. K., Abudulai, M., Oti-Boateng, C., Brandenburg, R. L. and Jordan, D. L. (2007). Management of leaf spot diseases of peanuts with fungicides and local detergents in Ghana. Plant Pathology Journal 6 (3): 248 –
27. Orumwensodia, K. O. and Uadia, P. O. (2024). Nutritional Composition, Antioxidant and Antimalarial Activity of Leaves and Stem bark Extracts of Azadirachta indica: A Comparative Study. In Book of Conference (p. 186). University of Benin.
28. Paul, S., Amin, M. N., Ahmed, F., Ali, M. K. and Hossain, M. A. (2018). Genetic variability, correlation, and path coefficient analysis for yield and yield contributing characters in groundnut (Arachis hypogaea L.). Bangladesh Journal of Botany, **47**(3), 697-702.
29. Pazderka, C., and Emmott, A. (2010). Chatham House Procurement for Development Forum: Groundnuts Case Study. Chatham House, 10.
30. Raja Ratna Reddy, Y., Krishna Kumari, C., Lokanatha, O., Mamatha, S., and Damodar Reddy, C. (2020). Antimicrobial activity of Azadirachta Indica (neem) leaf, bark and seed extracts.
31. Reddy, E. C., Sudhakar, C. and Reddy, N. P. (2011). Aflatoxin contamination in groundnut induced by Aspergillus flavus type fungi: A critical review.
32. Shaheen, H. M. U., Rajput, N. A., Atiq, M., Kachelo, G. A., Ahmad, H., Wahab, M., ... & Hasnain, A. (2024). Antifungal potential of medicinal plant extracts against brown leaf spot (BLS) disease of rice caused by Bipolaris oryzae. Sarhad Journal of Agriculture, 40(2), 603-614.
33. Singh, N., Kumar, R., Gupta, S. K., and Lal, R. K. (2020). Evaluation of moisture content, bulk density, angle of repose, and porosity of groundnut. International Journal of Current Microbiology and Applied Sciences.9 (9): 1119-1126.
34. Singh, P., Mishara, A.K. and Tripathi, N.N. (2012). Assessment of mycoflora associated with post-harvest losses of papaya fruits. Journal of Agricultural Technology. 8(3) 961-968.
35. Thakur, S. B., Ghimire, S. K., Chaudhary, N. K., Shrestha, S. M., and Mishra, B. (2013). Variability in groundnut (Arachis hypogaea L.) to Cercospora leaf spot disease tolerance, International Journal of Life Sciences Biotechnology and Pharma Research, 2 (1):254-262.
36. Ugarte, A. (2024). All things PanchitX: Peanuts, biopolitics, and the global south. Cultural Dynamics, 36(1-2), 108-124.
37. Utenga, A., & Lusekelo, A. (2025). Lexicalisation of crop names in Bena, Hehe, and Sangu societies of Tanzania. Cogent Arts & Humanities, 12(1), 2454115.
38. Varshney, R. K., Pandey, M. K., Roorkiwal, M., Singh, V. K. and Ramsay, L. (2016). Legume biology: The basis for crop improvement. Springer.
39. Yakubu, N. B., Yakubu, A., Aliero, B. L. and Bala, S. U. (2019). Analysis of factors affecting the adoption of improved groundnut production technologies among farmers in Kano State, Nigeria. International Journal of Agricultural Sciences, 11(2), 27-33.
40. Yamada, Y., Yamaguchi, M. and Fujiwara, M. (2020). Peanut allergen Ara h 1 stimulates the gut microbiota and induces metabolic endotoxemia, contributing to food allergy. Allergology International, 69(2), 250-258.
41. Zakawa, N. N., Yusuf, C. S., Adamu, M., Timon, D., Tizhe, T. D., & Gazama, A. S. Isolation and Control of Post-Harvest Apple Rot Pathogens Using Ginger (Zingiber officinale Roscoe.) Extracts in Mubi, Nigeria.
42. Zakawa, N. N., Yusuf, C. S., Oyebanji, E. O., Timon, D., Isa, A., Bala, U. and William, N. (2021). Anti-Microbial Activities and Phytochemical Screening of Aqueous Fruit Pulp Extracts of Azanza garckeana (F.Hoffm.). Nigerian Journal of Botany, 34(1): 83-92.
43. Zhang, L., Li, Z., Hu, W., and Yao, Y. (2019). Association mapping of simple sequence repeats markers linked to rust resistance genes in cultivated peanut (Arachis hypogaea L.). Journal of Integrative Agriculture, 18(3), 605- 614.