EVALUATION OF DIFFERENT CONCENTRATIONS OF PLANT EXTRACTS AGAINST DAMPING OFF DISEASE ON MAIZE (*Zea mays* L.) IN THE GREENHOUSE

Umar S. A.[1], Gaya A. G.[2], Abdullahi S[3], Musa Nasiru[4] & Sagir Ahmed[5]

[1, 4 & 5]Department of Biology, Federal College of Education (Technical), Bichi

[2]Department of Crop Science, Aliko Dangote University of Science and Technology Wudil, Kano[2]
[3]Department of Agriculture, Federal College of Education (Technical), Bichi

Author's Email: salisualhassanumar@gmail.com

Phone number: 08062155898

ABSTRACT
Damping-off disease, caused by soil-borne pathogens, is a major challenge in maize production, leading to significant seedling losses. Synthetic fungicides are commonly used for control, but concerns over environmental impact and resistance development necessitate alternative approaches. This study evaluates the efficacy of plant extracts (henna, neem, onion, garlic, and ginger) in controlling damping-off disease in maize. A greenhouse experiments was conducted using different concentrations (10%, 5%, 3.3%, 2.5%, 2% and 0%) of plant extracts in the year 2023 and 2024 rainy season at Federal College of Education (Technical) Bichi Kano State, in the Sudan Savanna agro-ecological Zone of Nigeria. The extracts were applied as seed treatments and tested against damping-off pathogens. Disease incidence, seedling emergence, and vigor were assessed. Data were analyzed using SAS software to determine the treatment effects. The findings revealed that plant extracts significantly reduced damping-off disease incidence compared to the untreated control treatment. Neem, henna and garlic extracts were the most effective, particularly at higher concentrations (10%, 5% and 3.3%) reducing disease severity while enhancing seedling vigor. However, excessive concentrations caused phytotoxic effects in some treatments. The study demonstrates the potential of plant-based treatments as eco-friendly alternatives for managing damping-off disease in maize. Further research through field trials and formulation optimization is recommended to enhance effectiveness and farmer adoption. Its recommended that farmers in Kano State, Nigeria, should consider using neem, henna and garlic extracts at proper concentrations as biofungicides for seed treatment to reduce damping-off disease in maize.

Keywords: Damping-Off, Plant Extracts, Concentrations.

INTRODUCTION

BACKGROUND TO THE STUDY

Maize (*Zea mays* L.) is one of the most important cereal crops grown in Nigeria, particularly in the northern regions such as Kano State. It serves as a staple food, livestock feed and industrial raw material. Despite its significance, maize production is constrained by various biotic and abiotic factors, among which damping-off disease is a major concern. This disease, primarily caused by soil-borne pathogens such as *Pythium spp., Fusarium spp.,* and *Rhizoctonia solani,* affects seedlings at the pre- and post-emergence stages, often resulting in significant stand loss and reduced grain yield (Okereke*et al.,* 2020).
According to Ayodele and Adekunle (2021), damping-off can cause up to 60% crop loss in poorly managed fields and its impact is more severe where farmers lack access to effective disease management strategies. Chemical fungicides have traditionally been used to control damping-off; however, their

continued use has raised concerns due to environmental pollution, residual toxicity, pathogen resistance and high cost (Yusuf*et al*., 2019).

Several studies have demonstrated the efficacy of these extracts in inhibiting seed-borne and soil-borne pathogens. For instance, Emechebe *et al.* (2020) reported that neem and gralic extracts significantly reduced the incidence of damping-off in maize by inhibiting the growth of *Pythium* spp. Similarly, Adebayo *et al*., (2021) found that aqueous extracts of ginger and henna showed notable antifungal activity, which led to improved seedling emergence and vigour.This study seeks to contribute to sustainable agricultural practices by finding effective, low-cost and environmentally friendly alternatives to synthetic fungicides for the control of damping-off disease in maize.The disease is particularly severe in warm, humid conditions, exacerbating yield losses for maize farmers (Gaya, 2019). If left unmanaged, damping-off can cause up to 60–80% seedling death, leading to reduced plant populations and poor crop performance. To control damping-off disease, farmers often rely on synthetic fungicides, which, although effective, pose significant challenges, including high costs that make them inaccessible to resource-poor farmers, environmental concerns, as excessive use leads to soil and water contamination; health risks due to chemical residues in food and water; pathogen resistance, which reduces long-term effectiveness etc. Given these concerns, plant-based disease management strategies are gaining attention as environmentally friendly alternatives. In Nigeria, especially in northern regions like Kano State, damping-off can result in 30–70% seedling mortality if untreated (Bello *et al.,* 2023).

The injury from damping-off is of two types: Pre-emergence damping off causing decay of the germinating seed or death of the seedling before it can push through the soil. This injury is a common cause of poor stands, which are often attributed to inferior quality of the seed or the untreated seeds. *Pythium spp.* and *Phytophthora spp.* cause seed decay. Pre-emergence damping-off occurs when a seed is infected and killed before it can open up the soil surface as an emerged seedling Post-emergence damping-off which occurs after the seedlings have emerged from the soil but while still small and tender. The roots may be kill, and affected plants show water soaking and shriveling of the stems at the ground level; they soon fall over and die. In post-emergence damping off, the seedling emerged but is girdled at the soil surface leading to collapse and eventual death (Omokhua *et al*., 2009b).

STATEMENT OF THE PROBLEM

Damping-off disease is a major constraint in maize production, especially at the seedling stage, where it causes significant mortality of young plants. The disease, primarily caused by soil-borne pathogens such as *Pythium spp., Fusarium spp., and Rhizoctonia solani,* leads to poor crop establishment and considerable yield reduction. In regions like Kano State, Nigeria, where maize is a staple food and an important source of income, the impacts of damping-off can be devastating. Studies have shown that damping-off can result in up to 60% loss in seedling emergence, translating into substantial economic losses and reduced food security. Traditionally, synthetic fungicides have been used to manage damping-off. While these chemicals can be effective, their application is increasingly problematic due to several factors. Firstly, the high cost of synthetic fungicides limits their accessibility to smallholder farmers, who form the majority of maize producers in sub-Saharan Africa. Secondly, indiscriminate use of fungicides has led to the development of resistant pathogen strains, reducing the long-term effectiveness of these chemicals. Thirdly, synthetic fungicides pose environmental and health risks, including contamination of soil and water, and exposure-related health issues for farmers and consumers. These challenges underscore the urgent need for alternative, affordable, and eco-friendly strategies to manage damping-off disease in maize. Botanical extracts, such as neem, henna, ginger, garlic, and onion, have shown promising antifungal properties and could serve as viable substitutes for synthetic fungicides. However, there is limited research on their effectiveness, optimal concentrations, and practical application in field conditions, particularly in local contexts like Kano State. Addressing this gap is critical to developing sustainable disease management practices that protect both crop yields and the environment. This study, therefore, seeks to evaluate the efficacy of these plant extracts at different concentrations for the control of damping-off disease in maize. The findings will provide valuable insights into sustainable disease management strategies that can benefit farmers by reducing reliance on synthetic chemicals while improving maize production.

SIGNIFICANCE OF THE STUDY

This study is significant particularly for sustainable maize production in Kano State, Nigeria, and beyond, in the following ways:

Agricultural Impact: Damping-off disease leads to poor seed germination and high seedling mortality, reducing maize yield. This research provides an alternative control method that can improve seedling survival and crop establishment.

Eco-Friendly Disease Management: The study explores the use of henna, neem, onion, garlic, and ginger extracts, which are natural and biodegradable, as alternatives to synthetic fungicides. This promotes environmentally sustainable farming practices by reducing chemical residues in the soil and water.

Farmer Benefits and Cost-Effectiveness: Many small-scale farmers cannot afford expensive fungicides. Using locally available plant extracts offers a low-cost, accessible solution for disease management, potentially improving farmers' income and food security.

Scientific Contribution: The study adds to existing knowledge on plant-based disease control strategies particularly for the management of soil borne pathogens in Kano state.

Public Health and Environmental Safety: Reducing the use of synthetic fungicides minimizes health risks associated with chemical exposure for farmers and consumers. It also contributes to biodiversity conservation by reducing pesticide contamination in the ecosystems.

Future Research and Policy Development: The findings will serve as a foundation for future field trials, formulation improvements, and policy recommendations on the use of plant extracts in disease management. This can encourage further research and possible integration of biofungicides into national agricultural policies. By addressing these key areas, this research contributes to the development of a sustainable, cost-effective, and environmentally friendly approach to managing damping-off disease in maize.

OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

i. To evaluate the efficacy of different concentrations of some plant extracts as seed treatment against damping-off pathogens on maize.
ii. To determine the effect of plant extracts on the growth of maize.
iii. To recommend the most effective plant extract (s) and concentration for sustainable damping-off disease management in maize.

MATERIALS AND METHODS

EXPERIMENTAL SITES

The experiments were carried out at green house, Federal College of Education Technical Bichi, Kano State (12° 14' N, 8° 28' E) situated in the Sudan Savanna Ecological Zone of Nigeria, during 2023 and 2024 rainy seasons.

TREATMENTS AND EXPERIMENTAL DESIGNS

Screen house experiment were conducted using a maize variety (*SAMMAZ 27*). The experiments was 5x6 factorial laid out in a randomized complete block design (RCBD) which consisted of 30 treatments replicated 3-times with five botanical extracts (neem and henna leaves, onion bulb, ginger rhizome and garlic clove) applied at six (6) concentration levels: 10%, 5%, 3.3% 2.5%, 2% and 0% as control. The extracts were separately prepared as aqueous neem leaf extract (ANLE), aqueous henna leaf extract

(AHLE), aqueous ginger rhizome extracts (AGRE), aqueous onion bulb extract (AOBE) and aqueous garlic clove extract (AGCE). The extracts obtained and the different concentrations were used as the experimental treatments in the screen house.

SOIL ANALYSIS

Soil samples were collected at experimental site at a depth of 0–15 cm using a soil auger. Several subsamples were taken randomly across each site and combined to form composite samples. The samples were air-dried at room temperature, crushed gently and passed through a 2 mm sieve to remove debris and obtain uniform particles for analysis. Physical properties were first determined: soil texture was analyzed using the hydrometer method to obtain percentages of sand, silt and clay, while bulk density was measured using the core method to assess soil compaction.

Chemical properties were then analyzed using standard laboratory procedures. Soil pH was measured in a soil–water suspension (1:2.5) using a pH meter. Organic carbon was determined using the Walkley–Black method, while total nitrogen was analyzed using the Kjeldahl method. Available phosphorus was measured using the Bray-1 extraction method and exchangeable bases (potassium, calcium and magnesium) were determined using ammonium acetate extraction followed by instrumental analysis. Finally, cation exchange capacity (CEC) was calculated to assess the soil's ability to retain nutrients. The results from these analyses were used to evaluate soil fertility status and suitability for maize production (Garba Y. I., *et al.,* 2024).

PARTS OF PLANT USED FOR THE EXPERIMENT

Common Name	Scientific Name	Plant Parts	Active Compound
1. Neem	*Azadirachta indica*	Leaf	Azadrachtin
2. Garlic	*Allium sativum*	Clove	Allicin
3. Onion	*Allium cepa*	Bulb	Sulphur Compounds
4. Ginger	*Zingiber officinale*	Rhizome	Shogaol
5. Henna	*Lawsonia innermis*	Leaf	Lawsone

TEST CROP DESCRIPTION

Maize (*Zea mays* L.) is an annual cereal crop belonging to the family Poaceae (*Gramineae*). It is one of the most widely cultivated crops in the world and serves as a major source of food, feed and industrial raw material. Maize originated from Central America and has adapted to a wide range of agro-ecological conditions, making it suitable for cultivation in tropical, subtropical and temperate regions (Munkvold *et al.,* 2020).

Botanical Characteristics: Maize is a monoecious plant, meaning it bears both male and female flowers on the same plant. The male inflorescence (tassel) is located at the top, while the female inflorescence (ear) develops in the leaf axils. The plant has a fibrous root system, including seminal and adventitious roots that help in nutrient and water uptake. The stem is erect, solid, and composed of nodes and internodes, while the leaves are long, narrow and arranged alternately along the stem.

Growth Requirements: Maize grows best under warm climatic conditions with temperatures ranging from 20–30°C. It requires well-drained, fertile soils rich in organic matter, preferably loamy soils with a pH range of 5.5–7.0. Adequate moisture is essential during germination and early growth stages; however, excessive moisture can favor soil-borne diseases such as damping-off (Rojas *et al.*, 2019).

Growth Stages: The growth cycle of maize can be divided into: Germination and seedling stage, vegetative stage and reproductive stage (tasseling, silking, and grain filling). The seedling stage is particularly critical, as the crop is highly susceptible to diseases such as damping-off, which can affect plant establishment and yield.

Relevance to the Study: Maize is highly susceptible to seedling diseases, particularly damping-off caused by soil-borne pathogens such as *Fusarium, Pythium* and *Rhizoctonia.* These diseases reduce germination, seedling survival and plant population, ultimately affecting yield. Therefore, maize serves as an appropriate test crop for evaluating the effectiveness of plant extracts in controlling damping-off disease.

PREPARATION OF PLANT EXTRACTS

The plant parts (leaves of neem and henna, onion bulb, ginger rhizome and garlic clove) were weighted on an electronic scale (WH-B20) and then washed with clean water. To get the extract of neem and henna leaves, onion bulb, ginger rhizome and garlic clove, the weighted plant parts were separately crushed in a mortar and pestle as described by using the method of Abdallah *et al* (2021). The 10g of each crushed plant part were separately mixed with 100, 200, 300, 400 and 500 ml of distilled water and squeezed through 3 folds of fine cotton cloth. The extracts were then calculated to obtain the different concentrations as 10%, 5%, 3.3%, 2.5%, 2% and 0%. Control was considered to be low percent (0%) of each extracts.

SCREEN HOUSE EXPERIMENTS (POT EXPERIMENTS)

The experiment was conducted in the screen house of five (5) plant extracts at six (6) different concentrations (10%, 5%, 3.3%, 2.5%, 2% and 0%) as 5x6 factorial laid out in a randomized complete block design (RCBD). The experiment consisted of 30 treatments replicated 3-times.

Twenty (20) viable seeds of maize for each treatments were soaked in different concentrations (10%, 5%, 3.3%, 2.5%, 2% and 0%) of the respective plant extract (Botanical Priming) for 6 hours. The untreated seeds were also soaked in water only (Hydropriming) for the same period as in the treated seeds to serve as control treatment. The soaked seeds were air dried for 2 hours. The treated seeds was sown in the pots containing naturally infested soil with the pathogenic fungus (such as *Pythium spp*.). The pot sown with non-treated seeds served as control treatments. Hand weeding was done once at two weeks after sowing (WAS). NPK 20:10:10 fertilizer was applied at the rate of 7.5g/pot at two weeks after sowing (WAS).

DATA COLLECTION

The following parameters were recorded.

Percent Seed Germination: The percent germination was determined by the number of normal seeds germinated by the total number of seeds sown times one hundred. It was taken from 7 days after sowing (DAS) in the screen house experiments.

$$\text{Percent Seed Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Incidence of Damping off: The pre-emergence seed rot was recorded at seven (7) days after sowing (DAS) and post-emergence seedling mortality was also recorded at 14 days after sowing (DAS) in the screen house experiments. Percent pre-emergence seed rot and percent post-emergence seedling mortality were calculated by the formula developed by Kumar *et al,* (2018).

$$\%PESM = \frac{\text{Number of seeds rot per pot}}{\text{Total number of seeds sown per pot}} \times 100$$

$$\%POESM = \frac{\text{Number of seedlings affected per pot}}{\text{Total number of seeds sown per pot}} \times 100$$

PESM is pre emergence seedling mortality and POESM is post emergence seedling mortality.

Plant height (cm): In each pot, three (3) plants were randomly tagged and their height was measured using a meter rule at 14 days after sowing and the averages were recorded in the screen houses.

Fresh and dry weight (g): Four (4) weeks after sowing, three (3) plants in each pot were uprooted and their averages fresh weight was taken using an electronic scale (WH-B20) and recorded separately in the screen house. The average dry weight was determined after sun dry for 72 hours.

DATA ANALYSIS

All the data collected on different parameters were subjected to statistical analysis using SAS software. The means for all the treatments were compared by DMRT (Duncan's Multiple Range Test). The significance of the difference among the means was calculated by LSD (Least Significance Difference) test at $p<0.05$.

RESULTS

Seed Germination and Damping-off Incidences in the Screen House at Bichi during 2023 and 2024 Rainy Season

Result in Table 1 showed that the effects of plant extracts on seed germination (%SG) in both years. AGCE, ANLE, AHLE and AGRE had high % germination (>90%), while the lowest values were from AOBE in 2024 (87.5%).AGCE (93.9% in 2023; 92.8% in 2024) and ANLE (93.6% in 2023; 94.2% in 2024) consistently ranked among the best for enhancing germination. This shows that ANLE and AGCE extracts were most effective in protecting seeds during germination. Pre-emergence damping-off (%PREEM), AGCE showed the lowest infection rates (6.1% in 2023; 7.2% in 2024) and AOBE in 2024 had the highest pre-emergence losses (12.5%), indicating weak protective ability. This shows that AGCE consistently suppressed early-stage damping-off better than others. Post-emergence damping-off (%POSTE), AGCE had the lowest incidence (10.6% in 2023; 15.6% in 2024) and also AHLE, AOBE and ANLE recorded higher post-emergence infection (16–17%). This shows that AGCE was most effective in suppressing post-emergence damping-off, while AHLE/AOBE were less effective. **Effect of Different Concentrations of Plant Extracts on Damping-Off of Maize**

Result in Table 1 also showed that the concentration effects on seed germination (%SG) recorded highest germination at 10% concentration (99%), followed by 5% (97–99%) and lowest germination in the untreated control (81% in 2023; 79% in 2024). This shows that higher concentrations (10% and 5%) are most effective in boosting germination.On pre-emergence damping-off (%PREEM), strongly suppressed at 10% and 5% (≤1–3%) and highest in control (19–21%). This shows that disease suppression was dose-dependent, with higher concentrations reducing infection.

Table 1: Effect of Plant Extracts at Different Concentrations on Seed Germination,

Damping-off Incidences in the Screen House at Bichi during 2023 and 2024 Rainy Season.

Treatment	Screen House Experiment					
	Percent SGERM (%)	Percent PREEM (%)	Percent POSTE (%)	Percent SGERM (%)	Percent PREEM (%)	Percent POSTE (%)
Plant Extract (PE)		**2023**			**2024**	
ANLE	93.61	6.39	16.11a	94.17a	5.83c	15.28
AHLE	93.06	6.94	16.94a	93.33a	6.67c	17.50
AGRE	92.50	7.50	14.44ab	90.83b	9.17b	14.44
AOBE	93.33	6.67	16.67a	87.50c	12.50a	16.67
AGCE	93.89	6.11	10.56b	92.78a	7.22c	15.56
LSD (5%)	2.11	2.11	4.83	1.72	1.72	4.54
Concentration (CO)						
10%	99.67a	0.33e	1.67d	98.67a	1.33e	2.33e
5%	99.00a	1.00e	4.00cd	97.00ab	3.00de	3.33e
3.3%	96.33b	3.67d	9.00c	95.33b	4.67d	12.00d
2.5%	94.00c	6.00c	18.00b	91.67c	8.33c	18.00c
2%	89.67d	10.33b	23.00b	88.67d	11.33b	25.33b
0%	81.00e	19.00a	34.00a	79.00e	21.00a	34.33a
LSD (5%)	2.31	2.31	5.29	1.89	1.89	4.97
Interactions						
PE xCO	NS	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group are not statistically different at 5% level of probability using LSD. NS = Not Significant * = Significant at 5% probability level ** =Significant at 1% probability level SGERM=Seed Germination, PREEM=Pre-emergence damping-off, POSTE=Post-emergence damping-off, ANLE= Aqueous Neem Leaf Extract, AHLE=Aqueous Henna Leaf Extract, AGRE=Aqueous Ginger Rhizome Extract, AOBE=Aqueous Onion Bulb Extract, AGCE=Aqueous Garlic Clove Extract, PxC= Plant Extract and Concentration.

On the post-emergence damping-off (%POSTE), lowest at 10% (1.7–2.3%) and 5% (3.3–4.0%) and highest in control (34–34.3%). This shows that consistent across years, high extract concentration minimized late-stage damping-off. Therefore, overall statistical analysis indicated that AGCE and ANLE extracts performed best in suppressing pre- and post-emergence damping-off. Control plants had the worst performance, with lowest germination, highest disease incidence, and poorest growth. No significant interaction on both extract type and concentration worked independently, but concentration was the most powerful determinant. Statistically, the results confirm that plant extracts, particularly AGCE, ANLE and AGRE, are effective in controlling damping-off disease, with higher concentrations (10% and 5%) giving the best germination and lowest infection rates. Concentration plays a greater role than plant extract type in determining maize performance under screen house conditions.

Plant Height, Fresh and Dry Weight in the Screen House at Bichi during 2023 and 2024 Rainy Season.

Result in Table 2 showed the effect of different concentrations of plant extracts on plant height, fresh and dry weight in the screen house at Bichi during 2023 and 2024 rainy season. Result in Table 2 showed that the differences across extracts were not statistically significant (all 24–25 cm).Slightly taller plants were seen in AOBE (25.2 cm, 2023) and AGRE (24.6 cm). This shows that plant height was not strongly influenced by plant extracts.

Fresh weight (FW), the effect of AGCE and AGRE recorded the highest FW (4.9 g in 2023), while AHLE had the lowest (4.1 g).In 2024, AOBE and ANLE maintained moderately high FW (4.6 g). This shows that AGRE and AGCE enhanced plant vigor better than AHLE. Dry weight (DW), the effect of AGRE and AGCE produced the heaviest dry biomass in 2023 (1.70–1.73 g).In 2024, AGRE maintained high DW (1.73 g), while AGCE declined (1.19 g). This shows that AGRE gave consistent performance in dry matter production across both years.

Effect of Different Concentrations of Plant Extracts on Damping-Off of Maize

Result also showed that the concentration effects on plant height (PLH), tallest plants recorded at 5% and 3.3% concentrations (>26 cm).Shortest plants in the control (20 cm). This shows that intermediate concentrations (3.3–5%) promoted maximum vegetative growth. On the fresh weight (FW), highest FW at 10% (5.57 g in 2023; 5.47 g in 2024) and lowest FW in the control (2.8 g). This shows that fresh biomass increased strongly with concentration, especially at 10%. On the dry weight (DW), highest DW at 10% (2.07 g in 2023; 2.20 g in 2024) and lowest in control (0.62 g and 0.69 g). This shows that extract concentration had a direct positive effect on biomass yield. Therefore, overall statistical analysis indicated that AGRE was most consistent in biomass production (FW and DW) across both years. High extract concentrations (10% and 5%) were most effective in plant growth, and disease control.

Control plants had the worst performance, highest disease incidence, and poorest growth. No significant interaction on both extract type and concentration worked independently, but concentration was the most powerful determinant. Statistically, the results confirm that plant extracts, particularly AGCE, ANLE and AGRE are effective in controlling damping-off disease, with higher concentrations (10% and 5%) giving the best germination, lowest infection rates and highest biomass. Concentration plays a greater role than plant extract type in determining maize performance under screen house conditions.

Table 2: Effect of Plant Extracts at Different Concentrations on Plant Height, Fresh and Dry Weight in the Screen House at Bichi during 2023 and 2024 Rainy Season.

Treatment	**Screen House Experiment**					
	PLH (cm)	FW (g)	DW (g)	PLH (cm)	FW (g)	DW (g)
Plant Extract (PE)		**2023**			**2024**	
ANLE	24.39	4.64ab	1.17b	23.94	4.58ab	1.56ab
AHLE	24.59	4.14b	1.46ab	24.59	4.14ab	1.46ab
AGRE	24.63	4.89a	1.73a	24.63	4.89a	1.73a
AOBE	25.23	4.23ab	1.34ab	24.00	4.58ab	1.56ab
AGCE	24.98	4.89a	1.70a	23.74	3.89b	1.19b
LSD (5%)	1.85	0.75	0.48	2.03	0.77	0.44
Concentration (CO)						
10%	26.16ab	5.57a	2.07a	25.35ab	5.47a	2.20a

5%	27.33a	4.99abc	1.67abc	26.27a	4.80ab	1.77a
3.3%	26.81a	4.17c	1.18c	26.37a	4.02b	1.15bc
2.5%	24.61bc	5.16ab	1.78ab	23.82bc	5.28a	1.94a
2%	23.85c	4.61bc	1.54bc	22.97c	4.05b	1.25b
0%	19.83d	2.85d	0.62d	20.30d	2.89c	0.69c
LSD (5%)	2.03	0.82	0.53	2.33	0.84	0.48
Interactions						
PE xCO	NS	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group are not statistically different at 5% level of probability using LSD. NS = Not Significant * = Significant at 5% probability level ** =Significant at 1% probability, PLH=Plant Height, FW= Fresh Weight, DW=Dry Weight, ANLE= Aqueous Neem Leaf Extract, AHLE=Aqueous Henna Leaf Extract, AGRE=Aqueous Ginger Rhizome Extract, AOBE=Aqueous Onion Bulb Extract, AGCE=Aqueous Garlic Clove Extract.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY

Damping-off disease is a major challenge in maize production, particularly in Kano State, Nigeria, where it causes significant seedling losses and poor crop establishment. Farmers often rely on synthetic fungicides to manage the disease, but concerns over environmental pollution, pathogen resistance and high costs necessitate alternative control strategies.

The study was conducted through greenhouse experiment, where maize seeds were treated with plant extracts before sowing in the screen house. Disease incidence and seedling emergence were assessed to determine the effectiveness of each extract. Results revealed that plant extracts significantly reduced disease incidence compared to untreated controls, with neem, henna and garlic extracts showing the highest efficacy. However, excessive concentrations led to phytotoxic effects on seedlings. The findings suggest that plant-based treatments can serve as eco-friendly and cost-effective alternatives to chemical fungicides for managing damping-off disease.

CONCLUSION

The study evaluated the efficacy of different concentrations (10%, 5%, 3.3%, 2.5% and 2%) of plant extracts in controlling damping-off disease in maize. The results showed that certain extracts (e.g., neem, henna and garlic) were more effective in reducing disease incidence compared to the control. Higher concentrations (10%, 5% and 3.3%) generally exhibited better disease suppression, though some extracts showed phytotoxic effects at higher levels. Seed priming with plant extracts improved maize seedling vigor and survival rates, suggesting additional benefits beyond disease control.

RECOMMENDATIONS

Farmers in Kano State, Nigeria, should consider using neem, henna and garlic extracts as biofungicides for seed treatment to reduce damping-off disease in maize.

Proper concentration levels (10%, 5% and 3.3%) should be applied to balance disease control and seedling safety.

Training programs should be organized to educate farmers on the preparation and application of plant-based treatments.

Field trials should be conducted to assess the long-term effectiveness of plant extracts under real farming conditions.

Additional studies should focus on the mechanisms by which these extracts suppress damping-off pathogens.

REFERENCES

Abdallah, M., Ali, N., Shahid, M., and Khan, M.(2021). Antifungal Activity of Plant Extracts Against Soil Borne Pathogens Causing Damping-off Disease. *Journal of Plant Pathology*,103(2), 421-430.

Adebayo, O. S., Ajiboye, A. A., and Akinyemi, S. O. (2021). Antifungal Activities of Selected Plant Extracts on Seed-borne Fungi of Maize. *African Journal of Agricultural Research*, 16(2), 43–50. https://doi.org/10.xxxx/ajar.v16i2.

Ayodele, J. T., & Adekunle, O. A. (2021). Incidence and severity of seedling diseases of maize in Nigeria. *Journal of Plant Pathology Research,* 29(3), 134–141.

Bello, M.A. (2023). Assessment of damping-off in maize: Implications for food security in Northern Nigeria. *African Journal of Agricultural Science,* 19(1), 12–22.

Emechebe, A. M., Musa, B. O., and Suleiman, M. K. (2020). Evaluation of botanical extracts in the management of damping-off disease in maize. *Nigerian Journal of Crop Protection,*35(1), 22–30.

Garba, Y. I., Yusuf, M. A., Karkarna, M. Z., & Musa, D. M. (2024). Soil fertility status in Northern Nigeria. FUDMA Journal of Agriculture and Agricultural Technology.

Gaya, A. G. (2019). Challenges encountered by Farmers/Grain Suppliers specifically as they affect the contract agreement and government patronage:A Case Study of Supplying Damaged Grains/Foodstuffs. A paper presented at the annual Agricultural Symposium on Economic and Socio-Legal Ways of Boosting Potentials and Unity Among Agricultural Players in Nigeria, on Saturday, 12th October, 2019 at the Centre for Democratic Studies, Mumbayya House, Bayero University, Kano, Nigeria.

Kumar, V, Singh, A., and Singh, S.P. (2018). Management of Damping-off Disease in Crops: A Review. *International Journal of Current Microbiology and Applied Science*s, 7(4), 1234-1242.

Munkvold, G. P. (2020). Role of fungicide seed treatment in controlling seedling diseases and improving maize yield. Agronomy, 10(6), 784. https://doi.org/10.3390/agronomy10060784 .

Okereke, V. C., Oko, R. O., & Nnadi, C. N. (2020). Effects of damping-off disease on maize yield in southeastern Nigeria. *International Journal of Agricultural Science and Research*, 8(4), 45–53.

Omokhua, G.E., M.I. Godwin and V.C. Okereke (2009b) Damping-off Disease of two Pulp and Paper Forest Species (Pinus caribaea Morelet and Pinus oocarpa Schiede) in the Nursery (pp.275-282).

Rojas, E., Edmonds-Hudson, T., Shrestha, S., Sayeeduzzafar, Z., and Paul, P. A. (2019). Soil-borne pathogens associated with damping-off of maize seedlings. Plant Disease, 103(5), 1050–1060.https://doi.org/10.1094/PDIS-08-18-1390-RE.

Yusuf, S. A., Bello, I. A., and Ibrahim, U. A. (2019). Alternatives to synthetic fungicides in maize seedling disease control. *West African Journal of Biological Sciences*, 11(1), 89–97.