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Abstract

Evaluation of different concentrations of plant extracts for the control of damping-off disease on maize (*Zea mays*) in Kano state was conducted at Kadawa Research Station of the Institute of Agricultural Research, Ahmadu Bello University, Zaria and the Research Farm of Federal College of Education (Technical) Bichi, Kano in greenhouse in 2023 and 2024. Different concentrations (10, 5, 3.3, 2.5 and 2%) of plant extracts were used which were applied as seeds treatments to test against damping –off pathogens. Disease incidence, seedling emergence and vigour were assessed. Data were analyzed using SAS software to determine treatment effects. The findings revealed that plant extracts significantly reduced damping-off disease incidence on seed germination compared to the untreated control. Neem, henna and garlic extracts were the most effective, particularly at higher concentrations (10%, 5% and 3.3%) reducing disease incidence while enhancing seedling vigour. The study demonstrated the potential of plant-based treatments as eco-friendly alternatives for managing damping-off disease in maize. It is recommended that farmers in Kano State, Nigeria, should consider using the promising concentrations of each extracts as in neem (3.3-5%), garlic (2.5-5%), ginger (3.3-10%), onion (3.3-10%) and henna (2.5-10%) as bio-fungicides for seed treatment to reduce damping-off disease on seed germination in maize.

Keywords: Concentration, Damping-off, Extracts, Germination

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Introduction

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, 2023).

Damping-off Disease in Maize

Damping-off in maize (*Zea mays* L.) is caused by a complex of soil-borne fungal and fungus-like pathogens that attack seeds and young seedlings. These organisms survive in the soil and crop residues, and under favorable conditions such as high soil moisture, poor drainage and cool temperatures they infect germinating seeds and emerging seedlings, leading to significant stand loss and reduced crop yield. Causal Organisms: Damping-off in maize is caused by several soil-borne pathogens, including: *Pythium spp., Fusarium spp., Rhizoctonia solani* and *Phytophthora spp.* These pathogens persist in soil and plant debris and can survive for long periods, making disease control difficult (Rojas *et al.,* 2019).

Pythium species – These are fungus like organisms (*oomycetes*) commonly found in soil and water. They are major contributors to both pre-emergence and post-emergence damping-off, causing seed rot, root infection and seedling collapse. *Pythium spp.* such as *Pythium ultimum, P. aphanidermatum,* and *P. irregulare* have been associated with damping-off in a wide range of crops, including maize (Bayer Crop Science, 2024). *Rhizoctonia solani* – A true fungus frequently involved in damping-off. It infects seeds and the stem base, causing reddish brown lesions, soft decay and girdling of the hypocotyl, which results in seedling collapse. It is active under a range of soil moisture conditions and can survive in soil as resilient structures. *Fusarium species* – These fungi may act alone or in disease complexes, especially under warmer and drier soil conditions. *Fusarium spp.* contributes to pre- and post-emergence damping off and can also lead to root and crown rot in affected seedlings. Other associated organisms – While less commonly reported in maize, related soil fungi such as *Phytophthora spp., Sclerotium spp.,* and *Alternaria spp.* have been implicated in damping off or similar seedling diseases in other crops. Under certain conditions, these organisms may contribute to complex disease interactions (Lamichhane, and Dürr, 2017). Together, these pathogens form a disease complex, meaning that more than one organism may be present and contribute to seed and seedling losses in a field. The severity of disease often depends on environmental conditions that favor the activity and reproduction of these species (*Rhizoctonia solani*).

It occurs in two main forms based on the stage of infection:

Pre-Emergence Damping-Off:

Pre-emergence damping-off occurs when pathogens infect seeds in the soil before they can germinate or emerge. In this form, soil-borne organisms such as *Pythium spp., Rhizoctonia solani* and *Fusarium spp*. invade the seed during imbibitions or early germination, causing seed rot or failure to emerge (Lamichhane and Dürr, 2017). Environmental factors like excess soil moisture, cool temperatures and poor drainage increase the risk, because these conditions favor pathogen activity and delay seed germination (Lamichhane *et al.,* 2017). Symptoms include rotting seeds in the soil, poor or uneven germination, and reduced stand density. Impact: Pre-emergence damping-off directly reduces plant population by killing seeds or seedlings before emergence, leading to gaps that lower overall yield potential.

Post-Emergence Damping-Off:

Post-emergence damping-off occurs after seedlings have emerged from the soil. In this stage, the pathogen infects the stem base or root collar, leading to water-soaked lesions, soft rot and sudden collapse of the seedling (Lamichhane and Dürr, 2017; Rojas *et al.*, 2019). Seedlings may appear healthy early in infection but rapidly wilt and die as the disease girdles the stem. Symptoms include**:** Water-soaked, darkened areas at the soil line, constriction or girdling of the stem and sudden seedling collapse. Post-emergence damping-off causes stand loss and weak plants that cannot compete for space and resources, resulting in poor crop development. The major fungi associated with both types of damping-off include: *Pythium spp*. common in wet soils and responsible for rapid seed rot (Rojas *et al.,* 2019). *Rhizoctonia solani* attacks roots and stem bases, especially under moderate moisture (Lamichhane and Dürr, 2017). *Fusarium spp.* often occurs in disease complexes, exacerbating seedling blight (Rojas *et al.,* 2019).

Materials and Methods

Experimental Sites

The experiments were carried out at Kadawa Irrigation Research Station of the Institute of Agricultural Research, Ahmadu Bello University Zaria (11˚ 65' N, 8˚ 45' E) situated in the Sudan Savanna Ecological Zone of Nigeria, during 2023 and 2024 rainy seasons. The Meteorological data of the area for rain fall, temperature, relative humidity and wind speed were collected from International Institute for Tropical Agriculture (IITA), Kano substation.

Treatment and Experimental Design

Screen house experiment was conducted using a maize variety (*SAMMAZ 27*). The experiment 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 experiment as shown in Table 2.

Soil Analysis

Soil samples were collected from Bichi and Kadawa 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 *et al.,* 2024). The results were prepared in Table 1.

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. Parts of plant used for the experiment is shown in Table 2a. 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 with100, 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 2hours.The treated seeds were 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 and Analysis

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 (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.

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 $P \leq 0.05$.

Results and Discussion

Result in Table 2 showed that in 2023 screen house, highest seed germination (94–95%) were obtained on seed treated with AGRE, AOBE and AGCE. Result also showed that in 2024, ANLE (94.44%) gave the highest germination, with lowest PREEM (5.56%) and good growth.

Result also showed that lowest damping-off were obtained on seed treated with AGCE (PREEM =5.28%, POSTEM = 11.39%). AGRE (86.67%) and AOBE (87.22%) performed poorly with high PREEM (13%). This indicates that AGCE is the most effective extract. ANLE and AHLE had slightly lower germination (91–92%) and higher POSTEM (17–18%).

It also showed that the effects of concentration level in 2023, at 10% and 5% gave the highest germination (99%) and lowest damping off (PREEM = 1–1.3%, POSTEM = 2–5%). At control (0%) performed worst with germination (81%), pre emergence damping off = 18.7%, post emergence damping off = 34%. In 2024, at 10% concentration 99% germination, PREEM = 1%, POSTEM = 2.3%. At control (0%), lowest germination (78%), highest damping-off (PREEM =22%, POSTEM = 34.7%) were observed. This shows that concentration was the most decisive factor: higher levels (≥5%) consistently reduced damping-off incidences.

Statistically, AGCE consistently emerged as the most effective extract (best at reducing disease). ANLE was also very effective, especially in 2024, giving strong germination and survival. AHLE moderate, while AOBE and AGRE less effective, particularly at lower concentrations. Concentration response was highly significant at 10% and 5% concentrations performed best, while untreated control consistently gave the worst results. ANLE and AGCE are best; higher concentrations are most effective. The statistical analysis of Table 2 shows that both plant extracts and concentration significantly influenced maize germination and disease suppression under screen house conditions in Kadawa (2023–2024). While extract type mattered (AGCE and ANLE being superior), concentration was the most decisive factor, with ≥5% providing strong protection against damping-off. The lack of PE× CO interaction suggests that all extracts follow the same trend of increasing effectiveness with higher concentrations.

Seed Germination in the Screen House Experiment

Seed germination at seven days after sowing (7 DAS) is a critical indicator of maize establishment, influencing stand density, seedling vigor and eventual yield. In this study conducted at Kadawa and Bichi during the 2023 and 2024 rainy seasons, results showed that germination percentages were significantly influenced by treatment type, concentration of plant extracts, and environmental conditions. Generally, higher concentrations (5–10%) of neem and garlic extracts promoted superior germination rates compared to untreated controls, while lower concentrations and control plots recorded poor germination. Screen house conditions consistently produced higher germination percentages than the field, reflecting the reduced pathogen pressure and more uniform growth environment. The observed differences between screen house and field germination are attributable to pathogen ecology and environmental variability. Pre-emergence damping-off, primarily caused by *Pythium spp*., is a major constraint in field conditions, especially under cool and moist soil, leading to poor germination (Matthiesen *et al.,* 2016). In contrast, screen house soils typically harbor lower inoculum and provide more stable conditions, explaining the higher germination percentages. Field variability across Kadawa and Bichi and between years, was linked to differences in soil type, organic matter, drainage and rainfall distribution, all of which modulate pathogen pressure and seed metabolic responses (Lamichhane *et al.,* 2017).

The improved germination with neem and garlic extracts aligns with their reported antifungal and antimicrobial properties. Neem contains *azadirachtin* and related *limonoids* that suppress soil-borne pathogens, while garlic produces allicin, a sulfur compound with broad-spectrum antimicrobial activity (Meena *et al.,* 2017). When applied as seed dressings or priming agents, these extracts not only reduced infection but also enhanced physiological seed vigor. Priming accelerates enzyme activation, reserve mobilization and repair processes, leading to faster and more uniform emergence, which was evident in the higher 7-day germination recorded (Paparella *et al.,* 2015).These findings are in agreement with previous reports demonstrating that seed priming and botanical extracts enhance early establishment and reduce pre-emergence losses in cereals (Kumar *et al*., 2020). Practically, the results suggest that neem and garlic seed treatments at ≥5% concentration are effective, eco-friendly options to improve maize germination in pathogen-prone environments. However, the variability across sites and seasons highlights the need for larger on-farm validations and standardization of extract formulations for consistent farmer adoption. Several studies have confirmed the role of plant extracts in promoting seed germination by mitigating pathogen-induced stress.

Ramezani (2009) and Yusuf, *et al.* (2014) observed increased seedling vigor and reduced disease incidence following botanical seed treatments. Similar outcomes were reported by Abass, *et al.* (2013), Adekunle, *et al.* (2015), and Lengai, *et al*. (2021), who documented enhanced germination and early seedling growth in maize and other crops. Percent seed priming is a pre-sowing treatment that enhances seedling vigour and resistance to pathogens (Farooq *et al.,* 2019). Studies suggest that priming maize seeds with plant extracts improves germination rates, seedling health, and resistance to damping-off disease (Khan, *et al*., 2022). Therefore, Plant extract treatments, especially at moderate concentrations, significantly improved maize seed germination at early stages in both screen house and field environments. This highlights the potential of eco-friendly seed treatments in improving crop establishment under varying environmental conditions.

Pre- and Post-emergence Damping-off Disease

Damping-off disease, caused by soil-borne pathogens such as *Pythium, Rhizoctonia,* and *Fusarium* species, remains one of the most destructive constraints to maize establishment. It manifests either as pre-emergence damping-off, where seeds rot before emerging, or post-emergence damping-off, where seedlings collapse soon after emergence due to stem girdling. Both stages result in poor stand establishment, reduced plant vigor and significant yield losses (Lamichhane *et al*., 2017).

In the screen house, damping-off incidence was consistently lower than in the field across both years and sites. This is attributed to reduced inoculum load, controlled soil conditions and less environmental stress. Conversely, in the field trials at Kadawa and Bichi, higher and more variable incidence was observed, linked to soil heterogeneity, fluctuating moisture, and pathogen diversity. Such findings align with reports that disease severity is strongly influenced by soil type, temperature and rainfall patterns (Kumar *et al*., 2020).

Plant extract treatments significantly reduced damping-off incidence. Neem and garlic extracts were most effective, showing a strong dose-dependent suppression of both pre- and post-emergence damping-off. Their effectiveness is attributed to the present of active compounds *azadirachtin* in neem and allicin in garlic that inhibit fungal growth and protect seedlings during early development (Bowers and Locke, 2004; Shukla and Naik, 2020).

Henna, onionand ginger also showed suppressive effects but were less consistent. The positive effect of higher concentrations (5–10%) further supports earlier findings that sufficient bioactive compound levels are necessary for reliable protection. Differences between pre- and post-emergence control were also noted. While neem and garlic reduced both stages, PRE damping-off was more sensitive to treatment, suggesting that *Pythium* and similar pathogens were more easily suppressed than *Rhizoctonia or Fusarium* that dominate post emergence infection. This agrees with earlier studies documenting species-specific variability in susceptibility to botanicals (Lamichhane *et al.,* 2017). Overall, the results reinforce the value of botanical extracts as eco-friendly alternatives to synthetic fungicides. However, field variability indicates the need for integrated approaches combining botanicals with cultural practices (well-drained seedbeds, optimal planting time) and biological agents like *Trichoderma spp*. to achieve consistent protection.

Researches by Ramezani (2009) and Yusuf, *et al.* (2014) confirmed that plant extracts can effectively reduce soil-borne pathogen activity. Studies by Abass, *et al*. (2013) and Adekunle, *et al.* (2015) have showed that seed treatments using botanicals enhance germination and reduced seedling diseases. Lengai, *et al*. (2021) further supported the antimicrobial potential of these extracts in controlling damping-off pathogens. Pre-emergence damping-off can be effectively managed through the use of plant-derived seed treatments. The experiment conducted at Kadawa during the 2023 and 2024 rainy seasons confirmed the efficacy of neem, garlic and henna extracts in reducing early seedling loss, thereby enhancing maize stand establishment. Treatments with plant extracts (neem, garlic, ginger, onion and henna) showed lower post-emergence damping-off incidences compared to the control. Garlic and neem extracts were particularly effective in reducing damping-off, likely due to their antimicrobial properties (Zaker, 2016).

Differences in soil texture and drainage between the two locations may have also influenced pathogen activity and disease severity. Garlic and neem at 2.5% and 2% concentrations consistently recorded the lowest post-emergence damping-off rates. This is consistent with findings by Adebanjo and Shopeju (2002), who reported that aqueous extracts of garlic significantly reduced seedling diseases caused by soil borne pathogens. According to Raaijmakers *et al.* (2009), natural plant extracts rich in antimicrobial compounds can suppress soil-borne pathogens by direct toxicity and induction of plant defense responses.

Kumar, *et al*. (2021) showed that neem seed kernel extract had a significant fungitoxic effect on Rhizoctonia solani. It was confirmed that bio-based treatments offer sustainable alternatives for managing damping-off, especially under organic or low-input systems. Conclusively, pre- and post-emergence damping-off significantly constrained maize establishment at Kadawa and Bichi. Neem and garlic extracts consistently reduced disease incidence in both the screen house and field, especially at higher concentrations. These findings confirm the potential of botanicals as low-cost, sustainable seed treatments, but also highlight the importance of integrating them with biological and cultural measures for stable field performance across seasons.

Summary

This study evaluated the efficacy of different concentrations (0%, 2%, 2.5%, 3.3%, 5% and 10%) of selected plant extracts: neem (*Azadirachta indica),* henna *(Lawsonia inermis),* garlic *(Allium sativum),* onion *(Allium cepa)* and ginger *(Zingiber officinale)* on seed emergence and incidence of damping-off disease in the screen house in maize (*Zea mays* L.) at Kadawa in 2023 and 2024 rainy seasons, 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 incidences compared to untreated controls, with ANLE, AHLE and AGCE extracts showing the highest efficacy. Application of plant extracts significantly improved seed germination percentage compared to the control. Higher concentrations (3.3–10%) generally resulted in better germination, indicating reduced seed rot caused by pathogens. Both pre-emergence and post-emergence damping-off were significantly reduced in treated plots.

Soil analysis from Kadawa showed sandy loam texture with low organic matter and nitrogen, which may favor disease development. However, the use of plant extracts helped mitigate these effects. The study confirmed that the effectiveness of plant extracts is concentration-dependent, with moderate to high concentrations providing better disease control without noticeable phytotoxic effects.

Conclusion and Recommendations

The results showed that certain extracts (e.g., ANLE, AHLE and AGCE) 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.

Based on the results obtained, the following recommendations were made:

i. Farmers in Kano State, Nigeria, should consider using ANLE, AHLE and AGCE extracts as bio-fungicides for seed treatment to reduce damping-off disease in maize.
ii. Farmers should consider the promising concentrations of each extracts as in neem (3.3-5%), garlic (2.5-5%), ginger (3.3-10%), onion (3.3-10%) and henna (2.5-10%).
iii. Proper concentration levels (10%, 5% and 3.3%) should be applied to balance disease control and seedling safety.
iv. Training should be organized to educate farmers on the preparation and application of plant-based treatments.
v. Further experiments should be conducted to assess the long-term effectiveness of plant extracts under real farming conditions.
vi. Additional studies should focus on the mechanisms by which these extracts suppress damping-off pathogens.

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Tables

Table 1: Physical and Chemical Properties of Soils of Experimental Field at Kadawa and Bichi

Soil Characteristics	
Physical Composition (%)	**Kadawa**
Sand	64.1
Silt	19.9
Clay	16.0
Textural Class	Sandy Loam
Chemical Properties	
Nitrogen	0.37
Phosphorus	3.01
Potassium	0.14
Sodium	0.54
Calcium	4.03
Organic Carbon	0.56
Magnesium	2.51
Cation Exchange Capacity	7.31
P^H ratio in 1:2:5 in H_2O	7.25
P^H ratio in 1:2:5 in $MCaCl_2$	6.56

Source: International Institute for Tropical Agriculture, Kano Substation

Table 2: Effect of Plant Extracts at Different Concentrations on Seed Germination and Damping-off Incidences in the Screen House at Kadawa, Kano State in 2023 and 2024 Rainy Seasons

Treatment	**Screen House Experiment**					
	Percent SGERM (%)	Percent PREM (%)	Percent POSTE (%)	Percent SGERM (%)	Percent PREEM (%)	Percent POSTE (%)
Plant Extract (PE)		**2023**			**2024**	
ANLE	92.22b	7.78a	17.22a	94.44a	5.56c	15.28
AHLE	91.39b	8.89a	17.78a	92.22b	7.78b	15.83
AGRE	94.44a	5.56b	14.44ab	86.67c	13.33a	14.44
AOBE	94.44a	5.56b	17.78a	87.22c	12.78a	17.22
AGCE	94.72a	5.28b	11.39b	93.33ab	6.67bc	14.44
LSD (5%)	1.92	1.89	4.86	1.65	1.65	4.89
Concentration (CO)						
10%	98.67a	1.33e	2.67e	99.00a	1.00f	2.33e
5%	99.00a	1.33e	5.00e	96.67b	3.33e	4.00e
3.3%	96.33b	3.67d	11.67d	94.33c	5.67d	10.00d
2.5%	94.00c	6.00c	17.00c	90.67d	9.33c	17.67c
2%	91.33d	8.67b	24.00b	86.00e	14.00b	24.00b
0%	81.33e	18.67a	34.00a	78.00f	22.00a	34.67a
LSD (5%)	2.11	2.07	5.32	1.81	1.81	5.36
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.*

Table 2a: 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