

Efficiency of Bio-Extracts on Bacterial Fruit Blotch of *Watermelon* Varieties as Affected by Climatic Changes, Growth, and Yield Parameters at Ardo Kola in 2020 and 2021

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Abstract

Bacterial fruit blotch (BFB), caused by *Acidovorax citrulli*, is a highly destructive disease that significantly reduces watermelon yield and quality under favorable environmental conditions. This study assessed the effectiveness of selected bio-extracts (Neem oil, Garlic oil, Jatropha oil, and their combinations) and varietal responses in managing BFB incidence, growth performance, and yield of watermelon in Ardo Kola, Taraba State, during the 2020 and 2021 cropping seasons. Field trials were conducted using a randomized complete block design with three replications. Data were collected on disease incidence, number of leaves, and fruit yield. Results showed that Neem oil and Streptomycin treatments significantly reduced BFB incidence compared to the untreated control. Among the tested varieties, Kaolack consistently recorded the highest yield, outperforming Local and Sweet Sangariax varieties. Year-to-year climatic variations influenced both disease severity and yield outcomes; notably, 2021 experienced lower disease incidence and higher yields due to more favorable rainfall distribution and lower humidity. The study concludes that integrating

bio-extract applications with strategic varietal selection offers an eco-friendly and effective approach for managing BFB in watermelon production, particularly under variable climatic conditions.

Keywords: Bacterial Fruit Blotch; Watermelon; Bio-Extracts; Neem Oil; Varietal Response; Climate Variability; Sustainable Disease Management

INTRODUCTION

Watermelon (*Citrullus lanatus*) is among the major cucurbit crops in Nigeria, contributing both to food security and farmers' income. However, its production is constrained by bacterial fruit blotch (BFB), caused by *Acidovorax citrulli*, which can lead to serious losses when conditions are favorable (Burdman & Walcott, 2012; screening studies of resistant cultivars, 2024) (see recent screening protocols in "Screening Method to Identify Watermelon Cultivars Resistant to *A. citrulli*"). Zheng *et al.*, (2024).

Chemical controls such as streptomycin are often used but have drawbacks, including resistance development and environmental concerns. There is growing interest in plant bio-extracts (e.g., neem, garlic, jatropha) for disease control, particularly since recent reviews underscore the antibacterial potential of medicinal plant extracts and their mechanisms (e.g., reduced MIC values, multiple modes of action) Xu *et al.*, (2024).

Varietal tolerance or partial resistance is another avenue. QTL mapping in *Citrullus amarus* identified several loci associated with BFB resistance, though environmental influence is strong and heritability moderate to low Weng *et al.*, (2020). Also, recent advances in use of molecular markers and screening protocols have helped differentiate cultivar responses under challenging environmental conditions Zheng *et al.*, (2024).

Climatic factors — particularly rainfall distribution, relative humidity, and temperature — are known to modulate disease pressure. Moreover, innovations such as plasma-activated water treatment of seeds have been shown to reduce BFB in melon seedlings in recent work, which highlights the importance of integrating climate management and seed health in disease control strategies. Zhang *et al.*, (2025).

This study therefore seeks to evaluate the efficiency of selected bio-extracts on BFB suppression in watermelon varieties across two seasons (2020 and 2021) at Ardo Kola, with emphasis on how varietal responses and climatic variation affect disease, growth, and yield.

MATERIALS AND METHODS

Study Site

Field trials were conducted at the College of Agriculture experimental farm, Ardo Kola, Taraba State, Nigeria, during 2020 and 2021 rainy seasons. The site lies in the Guinea Savanna zone with mean annual rainfall 1,200–1,500 mm, mean temperature 26–32°C, and relative humidity 60–85%.

Experimental Design and Treatments

The experiment used a factorial RCBD with three replications. Factor A (Bio-extracts) consisted of 8 treatments (Garlic, Neem, Jatropha, Garlic–Neem, Garlic–Jatropha, Jatropha–Neem, Streptomycin, Control), while Factor B (Varieties): Kaolack, Sweet Sangariax, Local.

Preparation of Bio-extracts

Collection and Preparation of Plant Materials

Fresh, healthy leaves, seeds, or cloves of neem (*Azadirachta indica*), garlic (*Allium sativum*), and jatropha (*Jatropha curcas*) were collected, washed with tap water, and shade-dried for 5–7 days until constant weight was obtained. The dried samples were ground into fine powder using a laboratory blender and stored in airtight containers at room temperature until extraction, as described by Edward *et al.* (2017).

Extraction of Single Plant Bioextracts

For each plant material, aqueous and ethanolic extracts were prepared following standard maceration methods. In the aqueous method, 100 g of powdered material was macerated in 1000 mL of distilled water (1:10 w/v) for 24–48 h at room temperature with occasional stirring. For the ethanolic method, 50 g of powdered material was soaked in 250 mL of 70% ethanol (1:5 w/v) for 72 h with intermittent agitation, as outlined by Kristianto *et al.* (2023). The mixtures were filtered through double-layered muslin cloth followed by Whatman No. 1 filter paper. Filtrates were concentrated under reduced pressure in a rotary evaporator at 40 °C to obtain crude extracts, which were preserved in amber bottles at 4 °C until use (Donkor *et al.*, 2023)

Preparation of Combined Extracts

Two methods were adopted for combination: (i) co-extraction, where equal proportions of two or more plant powders (e.g., neem + garlic, neem + jatropha, garlic + jatropha) were extracted together using the aqueous and ethanolic procedures described above; and (ii) post-extraction mixing, where equal volumes of individually prepared crude extracts were mixed at ratios of 1:1 (v/v) or 2:1 (v/v), depending on treatment requirements. This approach has been widely used to evaluate synergistic and additive effects of combined plant bioextracts (Jeong *et al.*, 2023; Donkor *et al.*, 2023). To ensure homogeneity, mixtures were vortexed for 2–3 min and checked for phase stability.

Emulsion Preparation for Application

Oil-based extracts (e.g., neem oil and jatropha oil) were emulsified prior to application. A stock solution was prepared by mixing 10 mL of crude oil extract with 0.5 mL liquid soap as an emulsifier. This was gradually diluted with distilled water to 1000 mL to obtain a 1% (v/v) working emulsion. Combined emulsions (e.g., neem + garlic oil, neem + jatropha oil) were prepared by mixing equal volumes of the respective oil emulsions before dilution, as described by Kristianto *et al.* (2023). Storage and Handling All extracts and emulsions were stored in amber bottles at 4 °C and prepared fresh every 7 days to minimize microbial contamination and degradation of active constituents. Control treatments included distilled water and 70% ethanol (solvent control), while a commercial antibiotic (streptomycin) served as the positive control (Edward *et al.*, 2017).

Application

Seeds were sown at 1 m × 1 m spacing. Extracts were applied as foliar sprays beginning 2 weeks after germination, repeated at 10-day intervals for 6 weeks. Streptomycin (200 ppm) served as check.

Data Collection

Climatic data: Daily rainfall, temperature, humidity recorded.

Disease incidence (%) = (Infected plants ÷ Total plants) × 100.

Growth parameters: Vine length, number of leaves.

Yield parameters: Fruit number, fruit weight, total and marketable yield.

Data Analysis

Data were subjected to ANOVA using SAS 9.4. Significant means were separated by LSD at 5% probability.

RESULTS

Table 1. Effect of Bio-extracts on BFB Incidence (%) in 2020 and 2021

Treatment	2020 (%)	2021 (%)	Mean (%)
Streptomycin	6.1 ^d	4.8 ^d	5.5 ^d
Neem	9.3 ^c	7.5 ^c	8.4 ^c
Garlic–Neem	14.7 ^b	12.1 ^b	13.4 ^b
Jatropha–Neem	16.9 ^b	13.8 ^b	15.4 ^b
Garlic	18.5 ^b	15.7 ^b	17.1 ^b
Jatropha	21.2 ^b	17.6 ^b	19.4 ^b
Garlic–Jatropha	23.5 ^b	19.8 ^b	21.6 ^b
Control	67.2 ^a	55.3 ^a	61.3 ^a

Means with same letter not significantly different at $P \leq 0.05$ (LSD = 3.8).

Table 2. Varietal Response to BFB Incidence (%) in 2020 and 2021

Variety	2020 (%)	2021 (%)	Mean (%)
Kaolack	12.4 ^c	9.6 ^c	11.0 ^c
Sweet Sangariax	25.6 ^b	20.3 ^b	23.0 ^b
Local	46.7 ^a	39.2 ^a	43.0 ^a

LSD=4.1

Table 3. Growth & Yield (Mean of 2020–2021 with Treatments × Varieties)

Treatment × Variety	Vine length (cm)	Leaves per plant	Mean Yield (t/ha)
Streptomycin × Kaolack	225 ^a	47 ^a	25.3 ^a
Neem × Kaolack	220 ^a	45 ^a	23.9 ^a
Garlic × Kaolack	200 ^b	41 ^b	20.7 ^b
Jatropha × Kaolack	18.2 ^b	39 ^b	19.1 ^b
Neem × Sangariax	15.7 ^c	39 ^c	16.9 ^c
Neem × Local	9.2 ^d	32 ^c	10.3 ^d
Control × Local	7.1 ^c	25 ^d	7.8 ^c

LSD for Vine length = 12.3; Leaves = 3.7; Yield = 1.9.

DISCUSSION

The findings that neem extract and streptomycin suppress BFB aligns with recent empirical studies in Taraba State showing neem oil treatments produced low disease incidence (~7%) compared to high incidence (>80%) in untreated plots (2021) Aji *et al.*, (2024)

Recent literature (e.g., comprehensive review on medicinal plant extracts as antibacterial agents) shows that extraction solvent, plant part used, and phytochemical content critically affect efficacy, which helps explain why combination treatments (garlic-neem, etc.) had intermediate suppression levels. Xu *et al.*, (2024).

Varietal responses mirror findings in recent screening studies where certain watermelon accessions show partial resistance, QTL mapping in *C. amarus* indicates several loci with small to moderate effect, but environmental interaction is strong Weng *et al.*, (2020)

Novel approaches like plasma-activated water (PAW) seed treatment (recently published in 2025) have shown promise for reducing BFB in melon seedlings, pointing to seed health and pre-treatment as possible components of integrated control Zhang *et al.*, (2025)

CONCLUSION

Neem oil is a highly promising bio-extract for managing BFB in watermelon under field conditions. Kaolack variety demonstrated strong performance under disease pressure. Climatic variation between seasons (2020 and. 2021) significantly influenced disease severity and yield outcomes.

Recommendations:

Promote neem-based bio-extracts among farmers in BFB-affected regions.

Use tolerant or partially resistant varieties (e.g., Kaolack or those identified in recent screening studies).

Incorporate seed treatment (e.g., PAW) and climate monitoring into integrated disease management programs.

Further research to refine dosage, explore new bio-extracts, and evaluate varietal responses under varying environmental conditions.

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