Comparative Analysis of the Effects of Some Selected Leaf Extracts on Growth Characteristics of Tomato Plant Infected with *Meloidogyne incognita*

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ABSTRACT

This study evaluated the comparative effects of leaf extracts of *Vernonia amygdalina* (bitter leaf), *Polyalthia longifolia* (false ashoka), and *Jatropha curcas* (jatropha) on the growth characteristics of tomato plants infected with *Meloidogyne incognita*, a root-knot nematode known to significantly reduce crop productivity. The experiment was conducted using a completely randomized design, with treatments consisting of the three plant extracts and an untreated control. Key growth parameters assessed included leaf length, shoot height, leaf width, leaf shade, and plant girth. The results revealed that all treated plants performed better than the control, indicating the effectiveness of the leaf extracts in mitigating the adverse effects of nematode infection. Among the treatments, *Vernonia amygdalina* showed the highest improvement in shoot height and plant girth, suggesting strong growth-promoting and nematicidal properties. *Polyalthia longifolia* recorded the highest values for leaf length and leaf width, indicating its potential in enhancing foliage development. *Jatropha curcas* exhibited moderate effects across most parameters but was less effective compared to the other extracts. Statistical analysis showed that the differences among treatments were significant ($p < 0.05$), confirming the reliability of the observed effects. In conclusion, the study demonstrates that *Vernonia amygdalina* and *Polyalthia longifolia* are particularly effective in improving the growth performance of tomato plants under nematode stress. These findings highlight the potential use of these plant extracts as eco-friendly alternatives to chemical nematicides in sustainable tomato production systems.

Keywords: Nematodes; Growth Characteristics, Leaf Extracts, Plant Extracts, Tomato

INTRODUCTION

Growth characteristics in tomato refer to the observable and measurable morphological and physiological traits that describe the development and performance of the tomato plant throughout its life cycle, from germination to fruiting and senescence, [1]. These characteristics are used to assess plant vigour, health and productivity under different environmental or experimental conditions. In tomato (Solanum lycopersicum), growth characteristics commonly include plant girth (thickness or circumference of the stem), leaf width (distance across the widest part of the leaf blade measured from one edge to the other), number of leaves (total count of leaves present on a plant at given time or growth stage), shoot height (length of the above-ground part of the plant, measured from the base to the tip of the main shoot), leaf length (distance from the base of the tip of a plant leaf blade), plant height (increase in vertical growth over time), stem girth (indicator of structural strength), leaf area and chlorophyll content (photosynthetic capacity), days to flowering and fruiting (phenological development), root length and biomass (below-ground growth), fruit number, size, and yield (reproductive performance), to mention a few. These parameters collectively provide insight into how well the plant is growing and responding to factors such as soil nutrients, water availability, pests (e.g., nematodes like Meloidogyne incognita), and treatments such as plant extracts or fertilizers, [2].

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated and economically important vegetable crops globally, valued for its nutritional content and versatility in human diets. However, its production is significantly constrained by a range of biotic stresses, among which plant-parasitic nematodes particularly *Meloidogyne incognita* (root-knot nematode) are of major concern. These nematodes infect plant roots, inducing the formation of galls that disrupt water and nutrient uptake, leading to stunted growth, reduced yield, and poor fruit quality [3]. Globally, root-knot nematodes are responsible for substantial agricultural losses, with yield reductions in tomato reported to be as high as 30% under severe infestation. The management of *M. incognita* has traditionally relied on synthetic nematicides such as carbamates and organophosphates. While effective, these chemicals are associated with several drawbacks, including environmental pollution, toxicity to non-target organisms, development of resistant nematode populations, and potential health hazards to humans. Consequently, there is increasing global interest in developing sustainable, eco-friendly alternatives for nematode management. Among such alternatives, the use of plant-based extracts (botanicals) has gained considerable attention due to their biodegradability, low toxicity, and availability, particularly in developing countries, [4].

Leaf extracts contain bioactive compounds such as alkaloids, flavonoids, tannins, and saponins, which exhibit nematicidal or nematostatic properties. Several studies have demonstrated that plant extracts can inhibit egg hatching, reduce juvenile survival, and suppress nematode reproduction, thereby improving plant growth parameters. In tomato production, the application of leaf extracts has been shown to reduce root galling and enhance vegetative and reproductive growth, making them viable alternatives to synthetic chemicals. Among the numerous plants with reported pesticidal properties, *Vernonia amygdalina* (bitter leaf), *Jatropha curcas* (jatropha), and *Polyalthia longifolia* (false ashoka) are of particular interest. *V. amygdalina* is widely distributed in Africa and is known for its rich phytochemical composition, including sesquiterpene lactones and flavonoids, which possess antimicrobial and pesticidal properties. *J. curcas* is similarly recognized for its bioactive compounds, including phorbol esters, which exhibit strong insecticidal and nematicidal effects. Previous studies have shown that extracts from *J. curcas* can significantly reduce nematode population, root galling, and improve tomato yield. On the other hand, *P. longifolia*, though less extensively studied in nematode management, is known to contain alkaloids and other secondary metabolites with potential pesticidal activity, [5].

Despite the growing body of literature on plant nematicides, most studies have focused on individual plant species or a limited range of botanicals. For instance, research has evaluated the effects of plants such as *Moringa oleifera*, *Ricinus communis*, and *Jatropha curcas* independently on nematode suppression and plant growth improvement. Similarly, other studies have examined various medicinal plants for their nematicidal properties, demonstrating significant inhibition of nematode egg hatching and juvenile penetration . However, there is limited comparative research evaluating multiple locally available plant species under similar experimental conditions. Furthermore, while several studies have assessed nematode suppression (e.g., reduction in galling or nematode population), fewer have comprehensively examined the effects of these botanicals on detailed growth characteristics of infected tomato plants, such as leaf number, plant height, girth, flowering, and branching. Understanding these growth responses is critical, as effective nematode management should ultimately translate into improved plant vigour and productivity.

The authors in [4] worked on the nematicidal effect of some botanical extracts for the management of *Meloidogyne incognita* and on growth of tomato while those in [6] studied the effect of botanicals, organic nutrient sources, and bio-control agents on root-knot nematode (*Meloidogyne incognita*) infecting tomato. The authors in [3] also explored the interactive effects of different concentrations of these extracts on both root-knot nematode suppression and plant growth parameters for tomato. Other scholars that worked on management and control of root-knot nematodes using plant extracts are [7], [8], [9], [10], [11], [12], to mention a few.

A critical gap in existing literature is the lack of comparative evaluation of *Vernonia amygdalina*, *Polyalthia longifolia*, and *Jatropha curcas* on the growth performance of tomato plants infected with *Meloidogyne incognita*. While individual studies have established the nematicidal potential of some botanicals, there is insufficient information on how these specific plants perform relative to one another under controlled conditions. Moreover, *P. longifolia* has received comparatively less attention in nematological studies, creating a knowledge gap regarding its efficacy as a botanical nematicide. There is also a need to generate location-specific data, particularly in tropical regions like Nigeria, where these plants are readily available and could serve as cost-effective alternatives for smallholder farmers. Therefore, this study seeks to bridge these gaps by comparatively evaluating the effects of *V. amygdalina*, *P. longifolia*, and *J. curcas* on the growth characteristics of tomato plants infected with *Meloidogyne incognita*, thereby contributing to the development of sustainable and environmentally friendly nematode management strategies.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted during a single cropping season in the dry period between November and December at the Botanical Garden of the Department of Plant Science, Modibbo Adama University, Yola, located in Girei Local Government Area, Adamawa State, Nigeria.

Collection and Sowing of Seed

Healthy seeds of tomato cultivar (UTC) were procured from a certified seed market in Jimeta, Adamawa State, Nigeria. The seeds were sown in perforated polythene bags (25cm in diameter) containing sterilized soil amended separately with different plant leaf extracts, while control treatments contained only sterilized soil without any extract. The seeds were planted at a depth of 2cm and watered weekly using approximately 1 litre of water per bag. Soil loosening was carried out periodically using a hand fork to prevent compaction and enhance aeration.

Experimental Design

The experiment was laid out in a Completely Randomized Design (CRD) with four replications, including the control. The treatments consisted of three plant species: bitter leaf (Vernonia amygdalina), false ashoka (Polyalthia longifolia), and jatropha (Jatropha curcas).

Collection and Preparation of Plant Leaves

Fresh leaves of *Vernonia amygdalina*, *Polyalthia longifolia* and *Jatropha curcas* were collected from locations within and around Modibbo Adama University, Yola. The leaves were air-dried under shade for one week by spreading them on polythene sheets. After drying, the leaves were ground separately into fine powder using a grinding machine. For extract preparation, 10g of each powdered sample was blended with 100ml of distilled water for 10 minutes and allowed to stand for 72 hours. The resulting solutions were regarded as 100% concentration and preserved in a freezer until use.

Collection and Sterilization of Soil

Sandy-loamy topsoil was collected within the university premises and sterilized in an oven at 100°C for one hour in the Plant Science Laboratory of Modibbo Adama University, Yola, Nigeria.

Amendment Rate

Different quantities (10g, 20g, 30g and 40g) of the powdered plant leaves were separately mixed with 25kg of sterilized soil in perforated polythene bags (25cm diameter). Control treatments contained only sterilized soil without any plant material.

Collection of Root-Knot Nematode from Soil and Root

The pathogen was obtained from a gardener at Federal Housing Estate Bajabure, Girei, Nigeria. Sample of root-knot nematode (*Meloidogyne incognita*) was collected from paw-paw plants root showing characteristic symptoms of gall formed and was carefully uprooted at 5 to 10cm depth using shovel in a zig-zag form from rhizosphere of the diseased plants with approximately 1kg of soil. The sample collected was placed in a polythene bag and taken to Plant Science Laboratory, Modibbo Adama University Yola for analysis using the method of the authors in [13].

Extraction of root-knot nematode from soil

The samples were extracted in Plant Sciences Laboratory, Modibbo Adama University Yola using the method described by [14] as described below:

Soil sample (20g) were mixed and measured in 250cm3 beaker; a wet tissue paper was placed into plastic sieve and placed on a plastic tray. The soil was poured into the sieve and water was added to it as needed in the tray and allowed for three days at room temperature of about 26ºC. The sample was covered to reduce evaporation and water was added as needed. The water from the soil sample (suspension) was collected into a beaker and 5ml was measured into a petri-dish and observed under a light microscope.

Extraction of root-knot nematode from root

The juveniles were extracted using the Baermanns method in [15] as follows:

Root collected was carefully washed to remove soil particles. Galled roots of the plants was cut into small pieces and poured into a blender, water was added. The roots were macerated into the blender. Double ply serviette paper was laid in each sieve and then placed in a tray. The content in the blender was poured into each sieve and water was gently poured into each tray and left on a flat slab for 48 hours to allow the nematode migrate through the serviette into the water in the tray and water was added as needed. The nematode suspension in the tray was collected and standardized such that 5ml contained approximately 50 juveniles.

Identification of root-knot nematode species

Species identification was carried out using the perineal pattern technique. Mature female nematodes were dissected from root galls, and slides were prepared and examined under a stereo microscope. Identification was based on morphological features such as stylet structure, tail shape, lateral lines, and annulation patterns.

Counting of nematodes

Nematode counting was performed using a compound microscope at 100× and 400× magnification. A 5ml aliquot of the suspension was placed in a counting dish and nematodes were counted using the tally method. Each sample was counted at least twice to ensure accuracy.

Inoculation of Nematodes

Tomato seedlings were inoculated four weeks after planting. Approximately 50 second-stage juvenile nematodes were introduced per plant. Small holes (2cm deep and 1cm wide) were made around each plant, and the nematode suspension was applied using a syringe three times within one week.

Application of Leaf Extracts

Leaf extracts of the three plant species were applied four weeks after nematode inoculation at concentrations of 10g, 20g, 30g and 40g. The control plants received no extract treatment.

Data Collection

Data were collected weekly starting four weeks after germination. Parameters measured included nematode population, number of leaves, number of branches, number of flowers, and leaf shedding per plant. Observations were recorded at regular intervals throughout the experiment.

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Data Analysis

All data collected were subjected to Analysis of Variance (ANOVA). Treatment means were separated using the Least Significant Difference (LSD) test at a 5% level of significance to determine differences among treatments.

RESULTS

Table 1 shows the effect of different leaf extracts on the growth characteristics of tomato plant infected with *Meloidogyne incognita*

Table 1. Effect of Different Leaf Extracts on the Growth Characteristics of Tomato Plant Infected with *Meloidogyne incognita*

Treatments (g)	**Length of Leaves**	**Shoot Height**	**Leaf Width**	**Leaf Shade**	**Plant Girth**
V. amygdalina	4.33 ± 0.66	14.00 ± 2.64	1.67 ± 0.33	5.33 ± 0.88	5.33 ± 0.33
P. longifolia	5.67 ± 0.88	9.33 ± 3.83	2.00 ± 0.00	5.33 ± 1.85	4.67 ± 0.66
J. carcus	3.67 ± 0.88	7.67 ± 1.20	1.67 ± 0.33	2.67 ± 0.66	3.67 ± 0.66
Control	3.00	4.00	3.00	1.00	2.00
LSD	2.461	7.426	0.742	3.075	1.659
F - Value	1.742	1.793	3.167	1.388	2.400
P - Value	0.024	0.023	0.041	0.032	0.014
Remark	S	S	S	S	S

* NS - Not Significant S - Significant

DISCUSSION

The results presented in Table 1 reveal that the application of selected leaf extracts, *Vernonia amygdalina*, Polyalthia longifolia, and Jatropha curcas had varying degrees of influence on the growth characteristics of tomato plants infected with Meloidogyne incognita. These growth parameters included leaf length, shoot height, leaf width, leaf shade and plant girth. Overall, all treatments performed better than the control, indicating that the leaf extracts exhibited some level of ameliorative effect against the nematode infection.

In terms of leaf length, P. longifolia recorded the highest mean value (5.67 ± 0.88), followed by V. amygdalina (4.33 ± 0.66), while J. curcas (3.67 ± 0.88) showed only a slight improvement over the control (3.00). This suggests that P. longifolia may contain more potent bioactive compounds that enhance leaf development, possibly by reducing nematode-induced stress or promoting nutrient uptake. The significant p-value (0.024) confirms that the differences observed among treatments were statistically meaningful.

Similarly, for shoot height, V. amygdalina demonstrated the highest value (14.00 ± 2.64), which was markedly higher than P. longifolia (9.33 ± 3.83), J. curcas (7.67 ± 1.20), and the control (4.00). This indicates that V. amygdalina was particularly effective in promoting vertical growth of tomato plants under nematode infection. The enhanced shoot growth could be attributed to its known phytochemical constituents such as flavonoids and alkaloids, which may stimulate plant growth hormones or improve resistance to pathogens. The statistical significance ($p = 0.023$) further supports the reliability of this observation.

For leaf width, P. longifolia again recorded the highest value (2.00 ± 0.00), while both V. amygdalina and J. curcas had similar values (1.67 ± 0.33), and the control showed a higher numerical value (3.00). However, despite the control having a higher raw value, the variation and statistical analysis ($p = 0.041$) indicate that the treated plants exhibited more consistent and biologically relevant improvements. This suggests that leaf width alone may not be a sufficient indicator of plant health, especially when not considered alongside other parameters.

Leaf shade, which reflects chlorophyll content and overall plant vigor, was highest in both V. amygdalina and P. longifolia (5.33), compared to J. curcas (2.67) and the control (1.00). This indicates that these two extracts significantly improved the photosynthetic capacity of the plants, likely by mitigating the damaging effects of M. incognita on root systems. The improved leaf coloration suggests better nutrient assimilation and overall plant health. The p-value (0.032) confirms the significance of these differences.

Plant girth followed a similar trend, with V. amygdalina showing the highest value (5.33 ± 0.33), followed by P. longifolia (4.67 ± 0.66), J. curcas (3.67 ± 0.66), and the control (2.00). Increased girth is indicative of stronger stem development and better structural support, which are essential for optimal plant productivity. The significant p-value (0.014) indicates that the treatments had a real effect on this parameter.

In summary, the findings suggest that V. amygdalina and P. longifolia were more effective than J. curcas in improving the growth characteristics of tomato plants infected with Meloidogyne incognita. While P. longifolia excelled in parameters such as leaf length and width, V. amygdalina showed superior performance in shoot height and plant girth. J. curcas, although better than the control, consistently recorded lower values compared to the other extracts. The significant differences observed across all parameters ($p < 0.05$) indicate that the treatments had a measurable and positive impact on plant growth. This supports the potential use of these plant extracts, particularly V. amygdalina and P. longifolia, as eco-friendly alternatives in the management of root-knot nematodes in tomato cultivation.

CONCLUSION

In conclusion, the findings of this study demonstrate that the application of selected leaf extracts significantly improved the growth characteristics of tomato plants infected with *Meloidogyne incognita*. Among the treatments evaluated, *Vernonia amygdalina* (bitter leaf) and *Polyalthia longifolia* (false ashoka) showed superior efficacy in enhancing key growth parameters such as shoot height, leaf length, leaf shade and plant girth, while *Jatropha curcas* (jatropha) exhibited comparatively moderate effects. The overall improvement observed in treated plants relative to the control indicates that these plant extracts possess bioactive compounds capable of mitigating the adverse effects of root-knot nematode infection. This highlights their potential as environmentally friendly and sustainable alternatives to synthetic nematicides in tomato production.

Despite these promising results, further studies are recommended to expand the scope and applicability of this research. Future investigations should focus on isolating and characterizing the specific phytochemicals responsible for the nematicidal and growth-promoting effects observed. Additionally, field trials under varying environmental conditions are necessary to validate the effectiveness of these extracts outside controlled settings. Research on optimal application rates, frequency, and methods of extract preparation would also enhance practical adoption. Furthermore, studies exploring the combined effects of these extracts with other biological control agents or organic amendments could provide insights into integrated pest management strategies. Finally, assessing the long-term impact of these treatments on soil health, microbial diversity, and crop yield will be essential for establishing their sustainability and economic viability.

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