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Explore the Nematodes Associated with Scarlet Garden Eggplant (*Solanum aethiopicum*) and Implement Soil Amendment for Effective Management

Kırmızı Bahçe Patlıcanı (*Solanum aethiopicum*) İle İlişkili Nematodların İncelenmesi ve Etkili Yönetim için Toprak İlavelerinin Uygulanması

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ABSTRACT

Nematode infections cause severe damage to crops like eggplants. Information on the effects of nematodes on scarlet eggplant is rare. This study investigated the effect of soil amendments on soil nematodes population densities under garden eggplants. The completely randomized block design with replicated treatments was utilized. The trials were conducted in a field infested with four nematode species: *Meloidogyne*, *Hoplolaimus*, *Helicotylenchus,* and *Pratylenchus*. Number of nematodes per plot were extracted, plant height was measured with tape, and number of leaves were counted. Biochar (10 tons ha^{-1} (100%)) excelled in the control of these nematodes, followed by cow dung (100%) and *Bauhinia purpurea* (100%), then cow dung (5 tons ha^{-1} (50%)), and *Bauhinia* sp. (50%). *Hoplolaimus* sp. multiplied or survived most, particularly on biochar (50%) followed by *Pratylenchus* sp. on *Bauhinia* sp. (50%). All treatments had similar nematode populations. At 3 weeks after transplanting (WAT), cow dung 50%, *Bauhinia* sp. 100%, and *Bauhinia* sp. 50% induced the production of taller plants than the control. At 5 WAT, cow dung 50% was the best material for producing taller plants followed by *Bauhinia* sp. 100% and *Bauhinia* sp. 50% then biochar (50 and 100%). At 3 WAT, all organic control agents performed better than control, except for biochar. At 4 WAT, all the organic control agents except biochar 50% performed better than control. Finally, at 5 WAT best control material was cow dung 100% followed by *Bauhinia* sp. (100%), *Bauhinia* sp. (50%), biochar (100%), and cow dung (50%). These amendments are all recommended.

Keywords: African eggplant, Botanicals, Compost, Disease control, Host-parasite interaction

ÖZ

Nematod enfeksiyonları, patlıcan gibi ürünlere ciddi zararlar vermektedir. Nematodların kırmızı patlıcan (scarlet eggplant) üzerindeki etkilerine dair bilgiler sınırlıdır. Bu çalışma, bahçe patlıcanlarında toprak ilavelerinin toprak nematodlarının popülasyon yoğunlukları üzerindeki etkisini araştırmıştır. Çalışmada tekrarlanan uygulamalarla tamamen rastgele blok deneme deseni kullanılmıştır. Denemeler, *Meloidogyne, Hoplolaimus, Helicotylenchus* ve *Pratylenchus* olmak üzere dört nematod türü ile bulaşık bir tarlada yürütülmüştür. Parsel başına nematod sayıları çıkarılmış, bitki boyu şerit metre ile ölçülmüş ve yaprak sayısı sayılmıştır. Biochar (10 ton ha^{-1} (%100)), bu nematodların kontrolünde en etkili olan uygulama olmuştur. Bunu %100 oranında inek gübresi ve *Bauhinia purpurea*, ardından %50 oranında (5 ton ha-1) inek gübresi ve %50 *Bauhinia* sp. takip etmiştir. *Hoplolaimus* sp. en çok çoğalan veya en çok hayatta kalan tür olmuş, özellikle de %50 biochar üzerinde; bunu %50 *Bauhinia* sp. üzerinde *Pratylenchus* sp. izlemiştir. Tüm uygulamalarda benzer nematod popülasyonları gözlenmiştir. Dikimden 3 hafta sonra (WAT), %50 inek gübresi, %100 *Bauhinia* sp. ve %50 *Bauhinia* sp. kontrol grubuna kıyasla daha uzun bitkiler üretmiştir. Dikimden 5 hafta sonra, en uzun bitkileri %50 inek gübresi sağlamış, bunu sırasıyla %100 *Bauhinia* sp., %50 *Bauhinia* sp., ardından %50 ve %100 biochar izlemiştir. Dikimden 3 hafta sonra, biochar hariç tüm organik kontrol ajanları kontrolden daha iyi performans göstermiştir. Dikimden 4 hafta sonra, %50 biochar hariç tüm organik kontrol ajanları kontrol grubundan daha iyi performans göstermiştir. Son olarak, dikimden 5 hafta sonra en iyi kontrol materyali %100 inek gübresi olmuş, bunu %100 *Bauhinia* sp., %50 *Bauhinia* sp., %100 biochar ve %50 inek gübresi izlemiştir. Bu toprak ilavelerinin tamamı önerilmektedir.

Anahtar Kelimeler: Afrika patlıcanı, Botanik, Kompost, Hastalık kontrolü, Konukçu-parazit etkileşimi

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Introduction

Eggplant is termed the 'king of vegetables' in India, South Africa, Malaysia, and Singapore but derided as a 'poor man's vegetable' in some climes (Akin-Osanaiye et al., 2024; Bhaskar & Ramesh, 2015). Eggplant, mostly *Solanum aethiopicum* L. 1756, *Solanum melongena* L. 1753, and *Solanum macrocarpon* L. 1771), ranks third amongst the Solanaceae Juss., 1789 after potato and tomato and it is among the top ten global vegetables (FAOSTAT, 2015, 2022; World Population Review, 2025; Wikipedia, 2025). It is rich in fibre, folates, ascorbic acid, vitamins (especially carotene/vitamin B1), pantothenic acid, potassium, nasunin, carbohydrates, protein, iron, and calcium (Aida et al., 2021; Akin-Osanaiye et al., 2024; Sulaiman et al., 2019).

Eggplants are consumed as salad, roasted as a snack, or eaten as a sauce at home or on social/religious occasions (Ndifon et al., 2022). This consumption is attributed to its unique taste, culinary, and health benefits (Bhaskar & Ramesh, 2015). Accordingly, eggplant can improve nutrition, food security, rural development, and sustainable food production, especially in Sub-Saharan Africa (Abolusoro et al., 2013).

The global eggplant yield amounted to 59,312,600 metric tons in 2021-2022. Eggplant production is mostly carried out in five nations including China, India, Egypt, Turkey and Indonesia. These five countries produce about 90% of total global production of eggplant followed by Pakistan, Japan, and Brazil (FAOSTAT, 2012, 2022; Jalal et al., 2017; Uddin et al.; 2023; World population review, 2025; Wikipedia, 2025).

Eggplant production is constrained by biotic and abiotic stresses amongst which are plant-parasitic nematodes (Coyne et al., 2018). Nematodes cause 42-54% and 30-60% yield losses in vegetables and eggplant respectively (Aida et al., 2021). The following nematode genera in order of diminishing frequency: *Meloidogyne* Göldi 1887, *Pratylenchus* Filipjev 1936, *Helicotylenchus* Steiner 1945, *Scutellonema* Steiner and Lehew 1933, *Radopholus* Cobb, 1893, Thorne 1949, and *Tylenchus* Bastian 1865 were associated with eggplant in fields, while the minor nematodes encountered were *Aphelenchoides* Fischer 1894, *Trichodorus* Cobb 1913, *Aphelenchus* Bastian 1865, and *Xiphinema* Cobb 1913 species), *Scutellonema,* and *Tylenchulus* species (Tanimola and Godwin-Egein, 2011).

In Damascus, the presence of *Meloidogyne* species (43.1%) and other nematodes like *Tylenchorhynchus* Cobb 1913, *Pratylenchus, Paratylenchus* Micoletzky 1922, *Helicotylenchus, Ditylenchus* Filipjev 1936, *Rotylenchus* Filipjev 1934, *Longidorus* Micoletzky 1922, *Xiphenema, Aphelenchus, Aphelenchoides,* and *Tylenchus* was reported in eggplant fields (Haider et al., 2006). Moreover, 18 brinjal eggplant varieties out of 30 were susceptible to *M. incognita* race 1 infestation and only one variety (var. Mahy 80) was resistant to the nematode (Gulwaiez & Tabreiz, 2018).

Root-knot nematodes are a significant pest for eggplants across Africa. Effective management strategies include cultural practices like crop rotation with non-host plants, weed control, and soil solarization. Organic and inorganic amendments have also shown promise in reducing nematode populations and improving eggplant growth (Abd-Elgawad, 2021; Abolusoro et al., 2013; Mukasa & Ramathani, 2013; Touré et al, 2021).

It has been vehemently proven that nematode control is best carried out using chemical nematicides (Abolusoro et al., 2013). Nonetheless, the application of synthetic nematicides is frowned upon nowadays due to their effects on humans, animals, and the environment (Aji, 2024; Gulwaiz & Tabreiz, 2018; Ndifon, 2019; Onkendi et al., 2014). Thus, some banned chemical pesticides like methyl bromide are being replaced with eco-friendly agents in the face of climate change, food insecurity, and increasing global population (Oso, 2020).

Soil amendment prepared using plants in the family Brassicaceae Burnett 1835 release glucosinolate/isothiocyanate compounds that can significantly lower nematode populations in the soil (Tian et al., 2020). Significant nematode mortality was observed due to the application of plant extracts from *Tagetes* L. 1753 species and *Melia azedarach* L. 1753 leaves/shoots (Campos et al., 2022; Fekry et al., 2021).

Sources of soil amendments include composted municipal waste, sludge, and organic manure of plant or animal origin like poultry droppings, cow dung, neem cake, plant extracts, and domestic waste (Abolusoro et al., 2013; Aji, 2024; Noling, 2019; Oso, 2020).

The benefits of using these organic materials include improvement of soil's physical properties like increased water retention, permeability, water infiltration, drainage, aeration, nutrient retention, cation exchange capacity, organic matter content, soil fertility, soil structure, and increased bio-control of nematodes through augmented microbial activity (Noling, 2019; Oso, 2020).

Bio-control of soil pests and pathogens may depend on the type of decomposed material, age of the compost, and biodiversity of the antagonists (Noling, 2019). Moreover, Noling pointed out that in some studies the application of composted municipal wastes up to 120 tons per hectare significantly increased pathogen/nematode population densities as well as plant growth. Both nematode-free and nematode-infested sandy soils lacking organic matter yielded significantly more tomatoes due to the application of soil amendments (Noling, 2019). The stimulatory effect of nematodes on plant growth was observed by Ndifon (2013; 2024).

The findings of Olabiyi et al. (2007) revealed that both decomposed and non-decomposed manure applied as an organic amendment caused a significant reduction in the populations of *Meloidogyne, Helicotylenchus,* and *Xiphinema* species under cowpea resulting in increased growth and yield of the crop. This is a typical finding on soil amendments. The application of amendments is becoming popular amongst many farmers.

Based on the foregoing discourse, this study aimed at thoroughly evaluating the impact of nematodes on garden eggplant (*S. aethiopicum*) and to identify effective soil amendment strategies for their management in the field. Our findings provide valuable insights and solutions for addressing this challenge.

Methods

Site of the study

This rain-fed experiment (with no supplementary irrigation) was carried out at the Faculty of Agriculture and Veterinary Medicine Teaching and Research Farm at the University of Buea, Cameroon. Buea is located at latitude 4°9’10” N and longitude 9°14’28” E. This area has a mean maximum annual temperature of 26.5-28.0°C and the mean relative humidity is 60%. It is situated at 2100 m above sea level on the slopes of one of the highest mountains in Africa.

Isolation of nematodes from experimental units

Soil samples were collected from the experimental plots in a zigzag pattern. Each composite soil sample (600 ml) was poured into a small bucket. Water was added and stirred till the container was filled to ¾ levels. The soil sample was left for 30 seconds while the soil particles settled. Thereafter a 200 µm and 32 µm set of sieves was used for sieving the suspension.

The last liquid component left in the 32 µm sieve was back-washed into a 500 ml beaker. This collected liquid sample was poured into four 45 ml Eppendorf centrifuge tubes, and 3 g of kaolin was added into each centrifuge tube. The kaolin forms a white lathe thus separating the nematodes from the supernatant. The centrifuge was operated at 3000 revolutions per minute (rpm) for 5 minutes.

The Eppendorf tubes were removed from the centrifuge and the supernatant was poured off. Fifteen millimetres of Zinc sulphate ($ZnSO_4.2H_2O$) was added into the clustered sediment in each tube and the sediment was broken with a spatula. The Zinc sulphate helps in suspending the nematodes. The Zinc sulphate used has a density of 1.16-1.18 and facilitates the floating of any nematodes whose density falls in this range.

The tubes were replaced in the centrifuge. The centrifuge was operated again at 3000 rpm for 4 minutes. The supernatant was poured inside a 200 ml container with water to prevent the nematodes from breaking. The supernatant was poured into a 32 µm sieve and back washed till it reached 100 ml in a beaker.

The nematode suspension was dispensed using 1 ml pipettes onto four slides and the nematodes were counted using a nematode counter under the stereomicroscope. Finally, the number of nematodes per 1000 ml of soil was estimated.

Land preparation

A 100 m^2 flat piece of land was cleared, ploughed, and harrowed with a tractor. The topsoil in the plot was scooped up to about 0.2 m depth and mixed together. The nematode-infested field was small enough for uniform mixing of the topsoil in the plot. The average number of mixed nematodes in the soil was estimated by sampling multiple points till similar populations were obtained.

Planting beds were made manually. The plots in form of beds with a dimension of 2 m x 1 m were raised to a height of 0.2 m. The plots were separated by a 0.5 m wide alleyway between beds. The alleyway between blocks was 1 m wide. The sampling was carried out again when the plots were ready for transplanting to ensure that the nematode populations were similar within plots.

Preparation of the organic manure

The organic manures that were used during the experiment included *Bauhinia purpurea* L. 1953 leaves, cow dung, and corn-stalk biochar. Fresh leaves of *Bauhinia purpurea* were harvested, chopped, and put in a bag for 3 weeks. Water was sprinkled on the leaves to facilitate their decomposition.

The biochar was made from corn stalks using the partial combustion method whereby the stalks were poured into a ground basin and soil lightly poured on the corn stalks. This induced a reduced oxygen level causing pyrolysis to ensue during the combustion process. The cow dung was decomposed for a month by pouring water into the plastic container and stirring the contents for aeration weekly.

Experimental layout

The treatments were laid out using the completely randomized block design and each treatment was replicated thrice. The treatment set included; control, biochar 100%, biochar 50%, *Bauhinia* 100%, *Bauhinia* 50%, cow dung 100%, and cow dung 50%. Each 100% rate received 10 tons ha^{-1} and the 50% rates received 5 tons ha^{-1} of the specific compost. The composts were applied and mixed into the soil to about 0.20 m depth at the time/point of setting up the trial. Fifteen 4 week old eggplant seedlings were transplanted per plot immediately when the plots were ready. The 4 weeks old seedlings were raised on heat steamed soil.

Data collection and analysis

Data collection commenced 21 days after transplanting. Data were collected on the number of nematodes per plot, plant height, and number of leaves. The number of nematodes in the soil was counted five weeks after transplanting (WAT) that is nine weeks after sowing (WAS). The eggplant variety utilized can last 11-13 weeks in the field. Plant height was recorded from four plants in each plot using a flexible tape. The number of leaves was counted weekly.

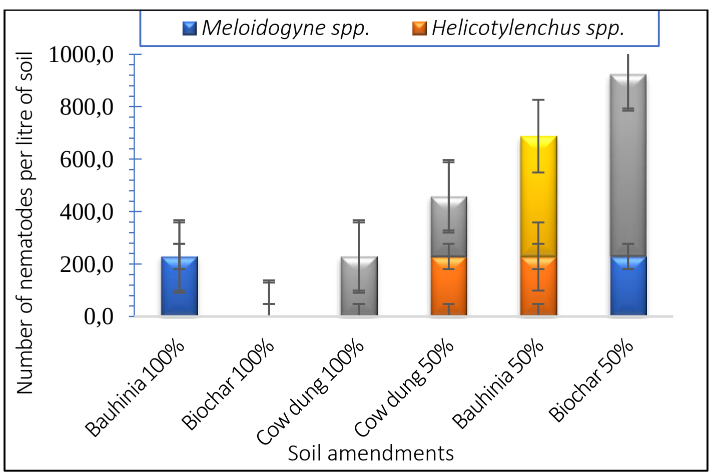
The data were subjected to analysis using the MINITAB statistical package (version 17) and IBM Statistical Package for Social Sciences (IBM SPSS Corp., Armonk, NY, USA) version 25 was used to improve the charts.

Results and Discussion

The effect of soil amendments on the final nematode population densities in the soil at 5 WAT is presented in Figure 1. The results revealed that biochar 100% excelled in the control of the nematodes, followed by cow dung 100% and *Bauhinia* 100%, then cow dung 50%, and *Bauhinia* 50%. *Hoplolaimus* multiplied or survived most on biochar 50%, followed by *Pratylenchus* on *Bauhinia* 50%. All the other treatments had similar nematode populations.

Figure 1.

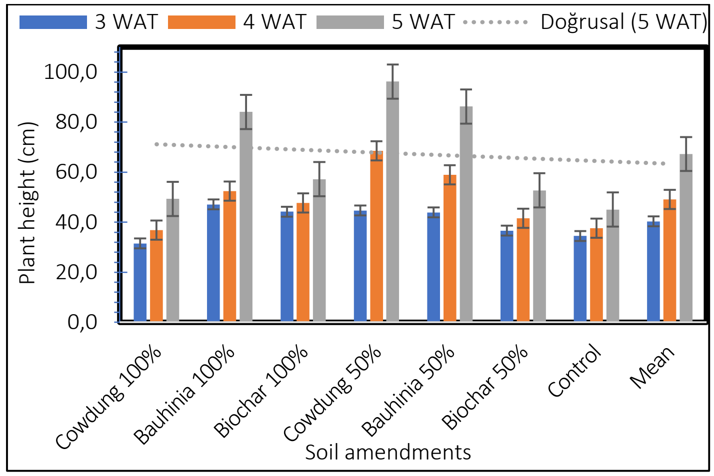
Effects of soil amendments on final nematode population densities in the soil at 5 weeks after transplanting eggplants.



During the early growth stage (3 WAT), cow dung 50%, *Bauhinia sp*. 100%, and *Bauhinia* sp. 50% induced the production of taller plants than the control (Figure 2). Finally, at 5 WAT, cow dung 50% was the best material for producing taller plants followed by *Bauhinia* sp. 100% and *Bauhinia* sp. 50% then biochar (50% and 100%), and so on.

Figure 2.

Effects of soil amendments on plant height at 3, 4, and 5 weeks after transplanting eggplants

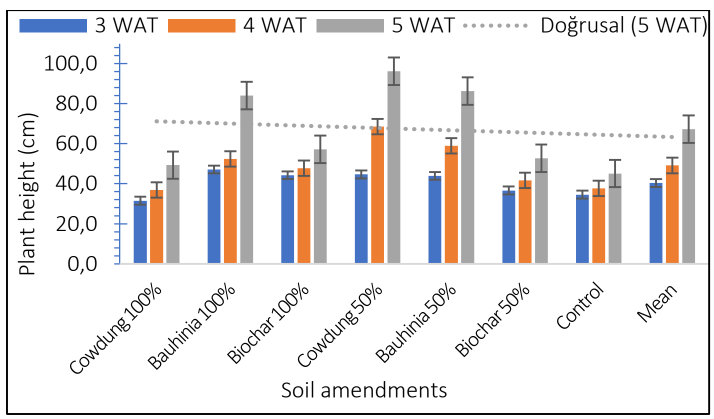


*WAT = weeks after transplanting

Likewise, during early growth (at 3 WAT), all the organic control agents performed better than the control, except for biochar rates (Figure 3). At 4 WAT, all the organic control agents except biochar 50% performed better than the control. Finally, at 5 WAT the best control material was cow dung 100% followed by *Bauhinia* 100%, *Bauhinia* 50%, biochar 100%, and then cow dung 50%.

Figure 3.

Effects of soil amendments on number of leaves at 3, 4, and 5 weeks after transplanting eggplants.



*WAT = weeks after transplanting

At or above 500 *M. incognita* eggs and/or juveniles, a reduction of the shoot height, fruit number, fruit weight, stem girth, flowering, fresh/dry shoot and root weights results which usually climaxes in eggplant yield loss (Sulaiman et al., 2019). Also at or above 500 *Meloidogyne* eggs and/or juveniles, a significant reduction in grapevine growth parameters occurs (Ndifon, 2024).

Chitinous amendments, nitrogenous inorganic fertilizers, manure from animal sources (like poultry droppings/litter), and cover crops constitute excellent soil amendments for improving soil quality and boosting bio-control by microbial antagonists (Noling, 2019). Noling argued that the research findings seem to indicate that the soil amendments are mainly useful as sources of plant nutrients and water availability. This view is not universally acknowledged.

The reproduction factor of *M. incognita* was reduced by 'Nemakey'™ and 'Charge'™ organic soil amendments which culminated in the reduction of the second-stage juveniles by 100% and 81.9% respectively (Jalal et al., 2017). These researchers reported an increase in the quantity of plant growth parameters. Poultry, cow dung, domestic waste, and NPK fertilizer effectively controlled *M. incognita* in the soil (Abolusoro et al., 2013). These findings corroborated the findings of this study.

A significant reduction in the populations of *M. incognita*, *Rotylenchulus reniformis* Linford and Oliveira 1940, *Tylenchorhynchus brassicae Cobb 1913*, and *Helicotylenchus* species were recorded, while plant weight, percent pollen fertility, pod numbers, root nodulation, nitrate reductase activity, and chlorophyll content in leaves increased significantly (Rizvi et al., 2012). The results of this current study were in agreement with the findings by Rizvi.

In tomato fields, marigold and basil plant extracts successfully reduced *M. incognita* populations and increased plant height, plant leaf and fruit yields (Olabiyi, 2008). These typical results confirmed the findings of this present study. To prevent nematode and disease infection 12 tons ha^{-1} organic manure should be applied. Also, live cover-crops and intercropped coniferous crops like mustards - *Brassica juncea (L) Czernajew 1859* kill nematodes (Mukasa and Ramathani, 2018).

Extracts of *Ageratum L* 1753 species severely inhibited *Meloidogyne javanica* in vitro and in vivo. *Ageratum* extract also increased all growth and yield parameters (Mamman, 2023). Some weeds can be effective biopesticides (Fontem et al., 2014) which corroborates the findings of this study herein.

The potential of *Trichoderma harzianum* Rifai 1969 as a biocontrol agent against *M. incognita was assessed on eggplant* (Uddin et al., 2023). Another avenue of nematode control was pointed out by Gaku et al. (2022) whereby *S. melongena* was grafted on *Solanum palinacanthum Dunal 1852* rootstock leading to significant suppression of the reproduction of *M. incognita* even though the yield remained the same. Unfortunately resistance to most nematodes is scarse and can be easily breached. Plant extracts from *Argemone mexicana L. 1753*, *Calotropis procera (Aiton) W.T. Aiton 1811*, *Solanum xanthocarpum Schrad. & Wendl. 1795*, and *Eichhornia echinulata Kunth 1842*) inhibited nematodes and fungi infections in chickpea (*Cicer arietinum L. 1753*) (Rizvi et al., 2012). These plants can be used for preparing soil amendments.

Conclusion

This research examined the nematodes associated with garden eggplant (*Solanum aethiopicum*) and employed soil amendments for the successful management of the nematodes in the field. The efficacy of soil organic amendments including cow dung, *Bauhinia* species, and corn-stalk biochar was demonstrated against four nematodes including *Meloidogyne, Helicotylenchus, Hoplolaimus,* and *Pratylenchus* species. These organic manures were especially effective at the 10-ton ha^{-1} level. The application of organic soil amendments increased the number of plant leaves and shoot height per plant. The crop was subjected to destructive sampling so no yield was recorded but the increase in growth parameters has been positively correlated to increased yield by researchers. The plants remaining in the treated plots after destructive sampling of the inner row plants produced many healthy fruits. These were not scored since the plants were not utilized for data collection from the onset. Finally, corn biochar (100% level) caused a 100% reduction in the population of the nematodes and should be researched more. However, biochar was the least effective agent in indorsing plant growth with time. All the organic materials are recommended for the management of nematodes associated with eggplants, while research on their use continues.

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