Entomology

# Application method of local plant material for effective management of Nematode (Nematoda) infestation in tomato (*Lycopersicum esculentus*) production

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**Abstract**

Tomato (*Lycopersicum esculentus*) is an important global vegetable crop that contributes to nutrient security. Production of this crop is constrained by many factors of which nematode infestation is observed to be quite threatening. The study aimed to determine appropriate method of application of identified local plant materials for effective management of nematode infestation. This was achieved by conducting field trials at Lower Nursery, Njala campus through establishment of experimental plots of tomato host plant in a factorially Randomized Complete Block Design (RCBD) with three replicates in each treatment, repeated twice in the year. The plot size was 18.8 m ×12m with 12 experimental units. The size of each treatment unit was 3m x 4m with 0.6m path between plots and 1 m between replicates. Each plot consisted of 4 rows with 6 plants stands per row. The experimental design consisted of one level of tomato variety (Mongal) and one local plant material which is Siam weed (*Chromolaena odorata*). Three methods (Pocketing, Ring, and Broadcasting) of identified local plant material were used to determine the appropriate method of application. Data were collected on percentage survival rate, morphological parameters, phenology and yield parameters of tomato host plant respectively. The Data collected were analyzed using Statistical Analysis System (SAS). Differences between mean values of the various parameters were determined by one-way ANOVA analysis while significantly different means were separated using the Student-Newman-Keuls (SNK) test at $p \leq 0.05$ level of significance. The Ring method of *Chromolaena odorata* application yielded the most favorable results. These values were the highest among all methods, indicating superior growth and effective management of nematodes.

**Keywords:** tomato variety, nematode, botanical, pocketing, broadcasting, ring

## Introduction

Tomato (*Lycompersicum esculentus*) belongs to the Solanaceae family, and it is one of the most commonly cultivated vegetable crops worldwide [1]. Tomato is a rich source of micronutrients, such as minerals, vitamins, and antioxidants that are essential for the human diet. They also contain high levels of lycopene, an antioxidant that reduces the risks associated with many cancers and neurological diseases. Tomato is consumed as fresh fruit, salads, soup, stew and other dishes. Virtually, tomato is grown in all regions of Sierra Leone with high production concentrated in the Western and Northern areas. Like other Africa countries, yield of tomato in Sierra Leone continue to be low barely exceeding 6 t ha-1. The low yield of tomato could be ascribed to the poor soil fertility, unavailability of improved planting material (seed) and the incidence of pest and diseases. Despite the significant nutritional, socio-economic and environmental roles of tomato, the right kind and quantity of tomato are not grown in Sierra Leone. This is as a result of unavailability of improved varieties that growers continue to cultivate local cultivars. Many pests and diseases affect both the quantity and quality of tomato production. Plant parasitic nematodes are one of them [2]. Root-knot nematodes (*Meloidogyne incognita*.) are economically important worldwide pathogens causing considerable damage to many crops, including cucumbers, tomato, rice, pepper, okra, watermelon, cantaloupe, onion, pumpkin, squash, sweet potato, sweet corn, carrot, eggplant, bean, pea and even cotton [3]. Although chemical nematicides have been widely used in commercial agriculture to control nematodes, they are both highly toxic and very expensive. Nematicides are not suitable for home garden use. Control of root-knot nematodes in gardens involves a combination of growing resistant varieties where available, good cultural practices, and encouraging natural biological control. Scientists fined that the use of nematicides is an effective way of controlling plant-parasitic nematodes. However, the long-term use of traditional organophosphorus and carbamate chemical nematicides can lead to increased nematode resistance [4]. Root-knot nematode in tomatoes is reported to cause yield reduction in a considerable amount worldwide widely including symptoms ranging from stunted growth, galled roots, chlorosis, wilting, and eventually death of the host [5]. A range of strategies are used to control root knot nematodes, and these include the use of nematicides, organic manure amendment and resistant cultivars. In Sierra Leone, most farmers use synthetic chemicals indiscriminately to control nematodes and associated infections to tomato. However, chemical nematicides have disadvantages in being expensive and

extremely toxic to man and animals when not applied at the right time, in the right way and in the right dosage. Many farmers are using locally available plant materials to control nematodes in tomato cultivation but the appropriate method of application of the identified local plant materials are yet to be investigated in the study area. The objective of this research was to determine the method of application of the identified local plant materials for effective management of nematode infestation in tomato production. Determining the appropriate method of application of the identified local plant materials for effective management of nematode infestation in tomato production would boost vegetable production in the study area and possibly beyond. This approach was expected to improve the environmental sustainability, field horticulture operations, tomato productivity and, at the same time, reduce cost of nematode management on poor resource farmers.

## Materials and methods

The experiment was conducted at the Lower Nursery, Njala University, southern region, Sierra Leone during the second cropping seasons of 2023. Annual rainfall in the trial area ranges from 1500-2000 mm with average temperature of 26ºC. Cowpea was earlier cultivated and harvested on the experimental site before the growth trial was established. The soil type on the study area is loamy clay (Orthoxic Plehumult soil) with pH of 5.6 [6]. The experimental plot was ploughed using hand hoe. Soil samples were collected at different spots in the experimental site at a depth of (15, 20 and 30) cm respectively after ploughing using a garden trowel and placed in suitable labeled plastic sample bags. The soil sample was later taken to the laboratory for analysis. After the analysis, it was confirmed from the result that nematodes (especially root knot nematode) were present in the experimental site. The soil extraction procedure for the field experiments was adopted from [7]. The area was lined, pegged and seedbeds were constructed. The plot size was 18.8m×12m with 12 experimental units. The size of each treatment unit was 3m x 4m with 0.6m path between plots and 1 m between replicates. Each plot consisted of 4 rows with 6 plants stands per row. The experiment was factorially arranged in Randomize Complete Block Design (RCBD) with 3 replicates each consisted of 4 treatments. The experimental design consisted of one level of tomato variety (Mongal) and one local plant material which was Siam weed (*Chromolaena odorata*). Three methods (Pocketing, Ring, and Broadcasting) of identified local plant material were used to determine the appropriate method of application. The local material which was identified with the help of the Njala University Herbarium was collected at the required quantity and taken to the experimental site at the Njala University Lower Nursery, Njala Campus. The identified plant material was sorted out to avoid admixture of unwanted plants, ground using a grinding machine and weighed. 7 tons/ha of ground material was placed in planting holes one week before planting of seedlings for each treatment unit. One variety of tomato (*Lycopersicum esculentus*) was used in the experiment. The tomato seeds were purchased from Seed-Tech International, Freetown, Sierra Leone (a general supplier of imported and local horticultural seeds and materials). Seeds were nursed for three (3) weeks before transplanting to the field. One seedling was planted per stand at a planting space of 60 cm x 75 cm (0.6 m x 0.75 m) to give a plant population of 22,222 plants/ha. Three hand weeding were carried out at 3, 6, and 8 weeks after planting. Other normal routine field management practices such as pest and disease management were carried out as recommended by the ministry of Agriculture and food security (MAFS) in Sierra Leone. Eight plants were randomly selected per treatment for measuring of morphological characteristics. Hence, the number of leaves, leaf area, total height and stem girth of the plants were measured on a weekly basis effective the second week after transplanting until flowering. Leaf area index was determined at mid-flowering stage using a portable leaf area meter model LI- 3000 A with base scanner serial No PAM 1684.The number and weight of the fresh tomato fruits were evaluated at economic maturity stage. Phenological data such as days to 50% flowering and fruit setting were recorded. The Data collected were analyzed using Statistical Analysis System (SAS). Differences between mean values of the various parameters were determined by a one-way ANOVA analysis while significantly different means were separated using the Student-Newman-Keuls (SNK) test at $p \leq 0.05$ level of significance.

## Results

### Percentage survival rates of Mongal tomato

Three application methods namely pocketing, broadcasting and ring methods were investigated on the percentage survivorship for the mongal tomato variety and results are presented in (Table 1). The ring method indicated the highest percentage with a value of 93.66% followed by the pocketing method 93.98% and broadcasting method 87.96%. The pocketing and ring method showed no significance difference in percentage of tomato that survived at ($p$=0.05) and the percentage survivorship for the control was 65.25% (Table 1).

### Morphological parameters of Mongal tomato

The Ring method of Siam weed application (Table 1), recorded the highest mean plant height 31.09cm and leaf number 78.11, largest mean stem girth 0.49cm and leaf area 11.64cm², followed by Pocketing method. The least mean in all the growth parameters was recorded from the control 24.09cm plant heights, 0.38cm stem girth, 43.55 leaf number and 11.64cm² leaf area. There was significance difference between Pocketing and Ring method, Broadcasting and control method in plant height at ($p$=0.05). No significance difference occurred between Pocketing and Broadcasting in plant height. There was no significance difference between Pocketing and Ring in stem girth. Significance difference occurred between Broadcasting and control in stem girth at ($p$=0.05). Significance difference also occurred between Pocketing and Ring, Broadcasting and control in leaf number at ($p$=0.05). There was no significance difference between Pocketing and Ring, Broadcasting and control in leaf area as indicated in Table 1.

### Phenological parameters of Mongal tomato

The ring method of Siam weed application (Table 2) in Mongal tomato recorded the least period to reach 50% flowering and fruit setting (48-53.66 days), followed by pocketing method. The highest days to reach 50% flowering and fruit setting were recorded from the control (53-62 days). There was no significance difference between pocketing and ring method, broadcasting and control method in flowering (Table 2).

Significance difference occurred between Broadcasting and Pocketing, Ring and control method in flowering. No significance difference occurred between Pocketing and Ring method at ($p$=0.05) in fruit setting. Significance difference occurred between Broadcasting and control in fruit setting at ($p$=0.05).

**Fruit number and weight of Mongal tomato**

The Ring method of Siam weed application (Table 2) in Mongal tomato recorded the highest fruit number 36.66 and weight 1.82kg followed by pocketing method 23.53 fruit number and 1.40kg weight. The least number of fruits of average value of 17.77 of fruit number and weight 0.98kg were recorded from the control treatment. There was significance difference between pocketing and ring method in both fruit number and weight at ($p$=0.05) (Table 2). However, no significance difference was observed between broadcasting and control in fruit number and weight (Table 2).

**Table 1:** Effect of method of application of plant materials on the agronomic parameters of Mongal tomato

| Treatment | Agronomic parameters | | | | |
|---|---|---|---|---|---|
| | Survival (%) | Plant height (cm) | Stem girth (cm) | Leaf number | Leaf area ($cm^2$) |
| Pocketing | 93.98 a | 27.98 b | 0.47 a | 60.36 b | 15.12 a |
| Broadcasting | 87.96 b | 26.22 b | 0.44 b | 53.19 c | 11.64 b |
| Ring | 93.66 a | 31.09 a | 0.49 a | 78.11 a | 15.43 a |
| Control | 56.25 b | 24.09 c | 0.38 c | 43.55 d | 12.40 b |

Means in column with the same letter are no significantly different at $p$>0.05

**Table 2:** Effect of method of application of plant materials on the Phenological and yield parameters of Mongal tomato

| Treatment | Phenological and yield parameters | | | |
|---|---|---|---|---|
| | Days to 50% flowering (Days) | Days to 50% fruit set (Days) | Number of fruits | Weight of fruit (Kg) |
| Pocketing | 49.33 b | 55.00 c | 23.53 b | 1.40 b |
| Broadcasting | 51.67 b | 58.00 b | 18.22 c | 1.04 c |
| Ring | 48.00 b | 53.66 c | 36.66 a | 1.82 a |
| Control | 52.67 a | 62.33 a | 17.77 c | 0.98 c |

Means in column with the same letter are no significantly different at $p$>0.05

## Discussion

**Survival percentage (%), morphological, phenological and fruit number and weight of Mongal tomato**

The methods of application of local plant materials were investigated using three main methods namely ring, pocketing and broadcasting to determine the effectiveness of these methods to suppress nematode population. The pocketing method showed to be quite effective involves creating pockets or holes in the soil and placing Siam weed material in these pockets around the tomato plants. The recorded percentage survival rate of 93.98% suggested that, the pocketing method was quite effective suppressing nematode infestation compared to the other two methods as the tomato plants had a highest survival rate. This means that most of the tomato plants treated with this method remained healthy and nematode-free. The broadcasting method typically involves spreading Siam weed material across the field or around the tomato plants without any specific placement in pockets. The percentage survival rate of 87.96% indicated that, Broadcasting method though effective in suppressing nematode infestation, was however lower than Ring and Pocketing. The percentage survival rate of 93.66% is similar to the pocketing method, suggesting that, the ring method was highly effective in suppressing nematodes infestation in the various most tomato varieties as they survived and remained healthy. In contrary, the control represented a scenario where no Siam weed or other local plant materials were used with a consequent effect of low percentage survival rate of 56.25% indicated that, a significant portion of the tomato plants in the control group succumbed to nematode infestation, showing the importance of nematode management in tomato production. This percentage that survived showed inferior morphological parameters and yields according to the values obtained under control treatment. The findings of this study agreed with those of Sidhu *et al.*, (2017) [8] who reported that application of botanical extracts increases yields and may help manage root-knot nematode populations in infested fields. The plant height measurements in (Table 1) suggested that, the Ring method resulted in the tallest plants 31.09cm, followed by the Pocketing method 27.98cm, the Broadcasting method 26.22 cm, and finally, the Control method 24.09cm. The Ring method appears to have the most significant positive impact on plant height, indicating that it might be the most effective in promoting plant growth. Stem girth measurements show a similar trend as plant height. The Ring method resulted in the thickest stems 0.49cm, followed by the Pocketing method 0.47cm, the Broadcasting method 0.44 cm, and the Control method 0.38cm. The number of leaves on the plants was highest with the Ring method 78.11, followed by the Pocketing method 60.36, the Broadcasting method 53.19, and the Control method 43.55. The Ring method appears to promote the most leaf development. Leaf area measurements also indicate that the Ring method resulted in the largest leaf area 15.43$cm^2$, followed by the Pocketing method 15.12$cm^2$, the Broadcasting method 12.40$cm^2$, and the Control method 11.64$cm^2$. The findings of this research are also in agreement with those of Aiyadurai *et al.*, (2018) [9] who suggested that, plant parasitic nematodes can be controlled by application of botanicals.

The pocketing method (Table 2) resulted in the shorter time to reach both 50% flowering and 50% fruit setting (49-55 days) as compared to Broadcasting. This suggested that, applying Siam weed using the pocketing method was effective in promoting earlier development in the Mongal tomato plants, which can be beneficial for overall crop yield and production. The broadcasting method took slightly more time (52-58 days) compared to the pocketing method, with longer durations to reach both flowering and fruit setting. This method was less

effective at accelerating the developmental stages in the tomato plants compared to the pocketing method. The Ring method resulted in the shortest time to reach 50% flowering and 50% fruit setting (48-54 days) among the tested methods. This method was the most effective at promoting early development in the Mongal tomato plants, even more so than the pocketing method. The control method, which did not involve the application of Siam weed, resulted in the longest duration to reach both 50% flowering and 50% fruit setting. This indicated that, Siam weed application, in general, can accelerate the developmental stages in the tomato plants compared to not using it. These results agreed with Sainju *et al.*, (2003) [10] who reported that insufficient nutrient status increased days to 50% flowering, while excess delayed flowering.

The proximity of the Siam weed to the tomato plants may have contributed to the observed increase in fruit number 23.53 and fruit weight 1.40kg. The broadcasting method suggested that, Siam weed was evenly spread across the tomato field. However, this method might not be as effective as the pocketing method because, the concentration of bioactive compounds released by the Siam weed may have been lower. The nematode management effect might not have been as strong, resulting in a lower fruit number 18.22 and weight 1.04kg compared to the pocketing method. Furthermore, if the Siam weed application was not uniform, some areas of the field might not have received adequate nematode management. The Ring method (Table 2) involves planting Siam weed in a circular pattern around the tomato plants. This method may create a barrier that is more effective at preventing nematodes from reaching the tomato roots. The Siam weed roots in the ring might release a higher concentration of nematode-suppressing compounds in close proximity to the tomato plants, leading to a significant increase in both fruit number 36.66 and fruit weight 1.82kg. The control method suggested that, no Siam weed was used, and this serves as the baseline for comparison. Without Siam weed application, nematodes may have had a more detrimental impact on the tomato plants, leading to reduced fruit number 17.77 and lower fruit weight 0.98kg. This result reinforces the importance of using Siam weed or other nematode-suppressing methods to enhance tomato production. These results (Table 2) suggested that, applying Siam weed using the Ring method led to the highest average fruit number 36.66 and fruit weight 1.82 kg in Mongal tomato plants. On the other hand, the control group (no Siam weed treatment) resulted in the lowest average fruit number 17.77 and fruit weight 0.98 kg. The pocketing method and broadcasting method fell in between in terms of fruit number and fruit weight. These findings indicated that, the Ring method may be the most effective in suppressing nematodes and improving tomato production compared to the other methods. These results agreed with those of Sidhu *et al.*, (2017) [8] who reported that application of botanical extracts increases yields and may help manage root-knot nematode populations in infested fields.

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