IJAFLS
e-ISSN: 2602-4381
International Journal of Agriculture, Forestry and Life Sciences
Original Article Open access Int J Agric For Life Sci (2023) 7(2): 33-35

An Eco-Friendly Approach for The Management of Root-Knot Nematodes in Tomato

Shraddha Timsina[1]*

[1]G.P. Koirala college of Agriculture and Research Centre(GPCAR),Gothgaun,Morang,Nepal.
***Correspondence:** shraddhatimsina999@gmail.com

Citation
Timsina, S. (2023). An Eco-Friendly Approach for The Management of Root-Knot Nematodes in Tomato. Int J Agric For Life Sci (2023) 7(2): 33-35.
Received :12 June 2023
Accepted :26 September 2023
Published Online :22 December 2023
Year: :2023
Volume :7
Issue :2 (December)
Pages :33-35

International Journal of Agriculture, Forestry and Life Sciences; Edit Publishing, Eskişehir, Türkiye.

Available online https://dergipark.org.tr/ijafls

Abstract
Root-knot nematodes (RKNs) are microscopic soil-borne pests that pose a significant threat by attacking the roots of numerous plant species. This causes a lot of damage and can reduce the amount of crops produced. RKNs have a unique ability to survive in the soil for extended periods, even in the absence of a host plant which has increased its threat by making it more devastating. An experiment was done on a tomato field at the Lamjung campus that had the root-knot nematode problem to see how well different treatments worked on these nematodes in tomato plants. Treatments like Neem cake, chicken manure, Lantana camara, Trichoderma, and Fosthiozate, were arranged in Randomized Complete Block Design and replicated four times. The disease parameter i.e., the root-knot index was recorded along with the growth parameter yield at the time of harvest. Chicken manure worked the best in reducing the root-knot problem, with a score of (0.87), and it helped produce the highest yield (12.38 t/ha). Neem cake and Lantana camara also did well. Also, the more root-knot issues there were, the fewer tomatoes were produced. This connection was very strong and significant

Key words
Root-knot nematodes, Tomato, Meloidogyne incognita, botanicals, management.

Introduction
The tomato (Lycopersicon esculentum Mill.) belongs to the family Solanaceae and is a widely cultivated, nutritious fruit (Haque et al., 1999). It originated from the highlands of South America where it was originally called "tomato". It is globally recognized that tomato holds a prominent position in vegetable production and consumption, closely following potatoes and sweet potatoes (Hossain et al., 2010). Tomatoes are good for health as they provide minerals, essential amino acids, sugars, dietary fibers, and vitamins (Sesso et al., 2003). Tomato cultivation is experiencing increasing popularity in Nepal, with districts such as Kavre, Dhankuta, Sarlahi, Dhading, Dang, Kathmandu, Rupandehi, etc (K. Singh et al., 2015). On a global scale, the leading countries in tomato production include the United States, China, India, and subsequently Turkey (Villanueva Gutierrez et al., 2018). The tomato alone covers 22,566 hectares of land with an average productivity of 18.01 mt/ha (MoALD, 2018/2019). In the Lamjung district, tomatoes are among the major vegetables, following cauliflower and cabbage, occupying an area of 177 hectares with average productivity of 14.4 mt/ha (MoALD, 2018/2019).
Root-knot, caused by Meloidogyne spp., stands out as one of the most widespread and devastating biotic stresses that tomatoes face throughout their growing season (Hunt et al., 2009). Meloidogyne incognita is extensively prevalent and is regarded as a highly significant pest in terms of economic impact (Hussain et al., 2011). Among cultivated vegetables, tomatoes, eggplants, okra, peppers, gourds, and melons are highly susceptible to root-knot nematodes. With a host range encompassing 44 plant families, this disease is prevalent across tropical, subtropical, and some warm temperate regions worldwide (Hayward, 1991; Ji et al., 2005). The typical symptoms of infestation include the formation of galls of various sizes on the roots of plants. Since RKNs extract nutrients and minerals from the plants, symptoms such as stunting, chlorosis (yellowing), premature wilting, malformed fruits, and reduced plant growth become evident (Williamson, 1998). Plant growth and productivity can be negatively impacted by reduced nutrient and water uptake due to the presence of M. incognita infection, which leads to the deformation of roots (Kepenekci et al., 2016; McCarter, 2008). Nematode control is primarily achieved through various methods, including plant resistance, crop rotation (Chitwood, 2002), and the use of biocontrol agents (Mukhtar et al., 2003; Rahoo et al., 2011). Due to the economic and hazardous consequences associated with chemical nematicides, researchers have shifted their focus towards implementing biological methods to control Meloidogyne spp (Randhawa et al., 2001). Bio-control presents a viable and environmentally friendly alternative for safeguarding plants, offering significant potential for advancing sustainable agriculture. The effectiveness of bio-control is contingent upon factors such as the specific nematode species, the host plant, the root exudates it produces, and the other crops involved in the rotation (S. Singh et al., 2010). Root-knot nematode infestation leads to an average loss of 20.6% in tomato yield (Sasser, 1989).
Once a field becomes infested with RKN nematodes, complete eradication becomes a challenging task for farmers. However, it is possible to manage their population below the threshold level. In the study area, there has been limited assessment and research conducted on the spread and eco-friendly management of root-knot diseases. Hence, this research aimed to explore alternative management strategies and sustainable approaches by utilizing various biological agents and plant extracts to mitigate the impact of these diseases.

Materials And Methods
The experiment was done at IAAS Lamjung Campus in Nepal between March and July 2022. This place is 700 masl and known to have a worm problem affecting plants. The test was done on a tomato variety called Srijana. The experiment followed a Complete Randomized Block Design (RCBD) using six different treatments like Neem cake, Chicken Manure, Lantana camara, Trichoderma, and Fosthiozate each replicated four times. Each plot measured 3m*2m with 16 plants, spaced at 50 cm*50 cm apart, with rows set 75 cm*75cm apart. There was a 1-meter gap between each trial and 50 cm between plots. A 20-ton FYM was used as the base, and the advised fertilizer mix of N: P: K @ 200:120:100 kg/ha was added. Other agronomical practices such as irrigation, weeding, pruning, staking, and plant protection were carried out as required.

Table 1. Treatment Details

S.N	Treatments	Application dose	Application time
T1	Neem Cake	3t/ha of water	2 weeks before transplanting
T2	Chicken Manure	10t/ha	2 weeks before transplanting
T3	Lantana Camara	0.5%(W/w) or 10t/ha	2 weeks before transplanting
T4	Trichoderma	200 gram/6kg of manure	7 days before transplanting
T5	Fosthiozate	2ml/l of water	7 days before transplanting
T6	Control	Use of recommended dose of fertilizers only	

Root-Knot index

The root-knot index, a disease parameter, was recorded, along with growth parameter yield at the time of harvesting of tomato The tagged plant was carefully uprooted after 90 days of transplanting and the roots were washed gently with tap water and root-knot was observed. The degree of root-knot nematode infection was recorded according to the rating degree given by (Thies et al., 1997) as under:

Yield

The fruits harvested from the selected plants were taken and weighed an average yield was calculated

Statistical Analysis

The data of the experiments were statistically analyzed, using RStudio for analysis of variances. All the values were presented as the mean which was compared according to Critical Difference (C.D.) at P = 0.05 level. Duncan's Multiple Range Test was employed to test for significant differences between the treatments.

Results

Root-Knot index

Six treatments were tested to see how well they tackled the Root-knot Nematodes problem in tomato plants using environmentally friendly methods. The results in (Figure 1) show all the treatments helped reduce the Gall index compared to the group that wasn't treated. Each one worked in different ways against the worms. The data showed clear differences ($p \leq 0.001$) in how effective they were. Chicken manure exhibited the highest reduction in the root-knot index with a score of (0.87), which stood out from the others. Neem cake was next best with (2.62), then came Lantana camara (2.91), Trichoderma (3.31), Fosthiozate (3.5), and the group that wasn't treated was last with (4.75). It is important to highlight that the control group displayed the highest root-knot index, indicating its ineffectiveness in managing the nematodes. In the end, the data showed chicken manure worked the best, followed by neem cake, Lantana camara, and Fosthiozate. The group that wasn't treated did the worst against the root-knot nematodes.

Table 2. Gall Index value to score Root-knot nematodes on tomato

S. N	Score	Index value
1	1	No galls or egg mass present
2	2	1-3% roots galled or covered with egg mass
3	3	4-10% roots galled
4	4	11-25% roots galled
5	5	26-35% roots galled
6	6	36-50% roots galled
7	7	51-65% roots galled
8	8	66-80% roots galled
9	9	>80% roots galled

Table2: Effects of different treatments on Gall index and Yield of tomato

Treatment	Shoot Length	Root Length	Shoot diameter	Root weight	Yield (t/ha)	Gall index
Neem Cake	141.32	24.32	4.27	38.18	9.59^{a}	2.9100^{b}
Chicken Manure	143.81	25.12	4.28	37.81	12.38^{b}	0.8750^{c}
Lantana Camara	143.31	28	4.72	42.50	9.33^{b}	2.6250^{b}
Trichoderma	138.31	26.87	4.61	44.18	8.13^{b}	3.3125^{b}
Fosthiozate	134.06	29.18	4.19	38.18	5.66^{c}	3.5000^{ab}
Control	136.44	27	4.46	39.46	4.59^{c}	4.7500^{a}
LSD(0.05)	18.89	6.43	0.57	9.50	1.87	1.29
SEM(+-)	2.55	0.88	0.078	1.286	0.39	0.35
F-Proab	ns	ns	ns	ns	***	***
CV%	8.98	15.95	8.67	15.73	15.03	28.625
Grand Mean	139.54	26.75	4.425	40.057	8.28	2.99

*Note: SEM±, Standard Error of mean; C.V, Coefficient of variation; LSD, Least significant difference. Means in the column with same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; '***' Significant at 0.001 level of Significance; '**' Significant at 0.01 level of Significance; '*' Significant at 0.05 level of Significance. Value in parenthesis indicates the original mean value.*

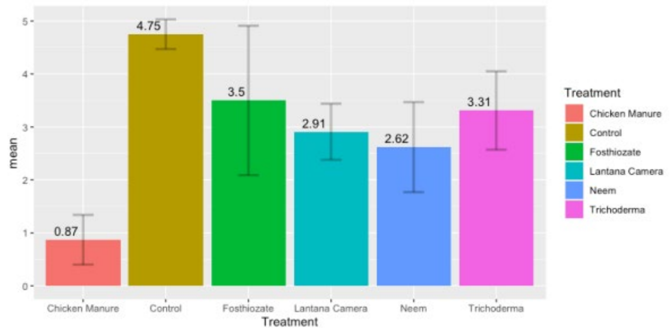

Figure 1: Effects of different treatments on the Gall index of Tomato

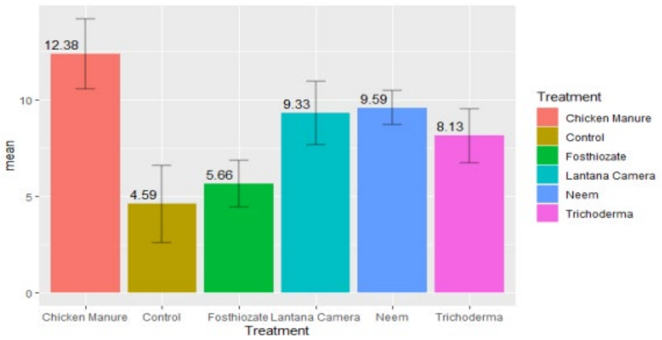

Figure 2: Effects of different treatments on Yield of tomato

Yield

Six treatments were tested to see how they could safely help tomato plants grow more and deal with the Root-knot Nematodes issue. The results in (Figure 2) showed that every treatment helped the plants produce more than the group that wasn't treated. Each method had different impacts on the plant's growth and health. The data showed clear differences ($p \leq 0.001$) in how much each group produced. Chicken manure made plants grow the most, giving (12.38 t/ha), which was notably more than the rest. Neem cake came next with (9.59 t/ha), then Lantana camara with (9.33 t/ha), and Trichoderma with (8.13 t/ha). The group that wasn't treated grew the least, with (4.59 t/ha). Summing up, chicken manure worked the best for growth, followed by neem cake, Lantana camara, and Fosthiozate. The group that got no treatment grew the least.

Correlation between Yield and Root Knot index

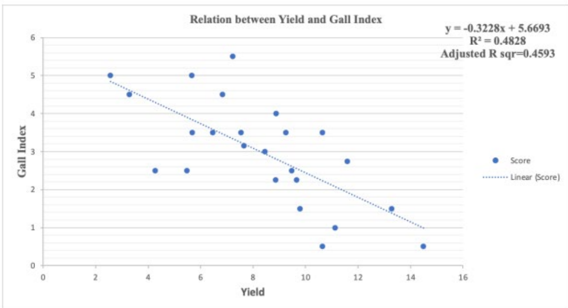

Figure 3: Correlation between Yield and Gall index

The presented graph illustrates a significant negative correlation between the Yield and Gall index, with a significance level of 0.001%. This indicates that as the severity of the disease increases, there is a corresponding decrease in crop yield, resulting in significant losses. The adjusted R-square value of 0.45 implies that 45% of the changes in the dependent variable can be attributed to the factors included in this model.

Discussion

This finding aligns with the research conducted by (Abdel-Dayem et al., 2012) which also highlighted the nematicidal and fertilizing properties of chicken manure. The elevated levels of Nitrogen and Phosphorous present in chicken manure have positively impacted plant growth, resulting in increased resistance against nematode attacks. It is because of the addition of nutrients to the soil as a result of organic matter decomposition, the direct killing or inhibiting effects of decomposed materials on nematodes, and the root`s capacity to absorb water and nutrients required for photosynthesis. Similar results were also documented by (Pérez et al., 2005) who observed that chicken manure exhibited effectiveness in reducing the gall index, particularly under elevated temperatures. Specifically, at a temperature of 30°C, the efficacy of chicken manure against the gall index was notably high. This result was supported by (Chindo et al., 1990) who reported an increase in yield attributed to various factors. This can be attributed to several factors, including enhanced nutrient availability for the plants, improved soil conditions leading to increased root growth, and subsequently, better utilization of soil nutrients. These factors collectively minimize nematode damage. Additionally, the application of poultry manure brings about changes in both the biotic and abiotic environment surrounding the plants, ultimately altering the relationships between hosts and parasites.

(Sumbul et al., 2015) also reported that oil-cakes serve as a highly suitable and readily accessible substrate for promoting the robust growth of beneficial microorganisms, thereby benefiting plants in numerous ways. It has been observed that these microorganisms play a crucial role in accelerating the decomposition of oil-cakes. Consequently, this decomposition process aids in reducing the nematode population, offering a valuable benefit to the plants. (Bhattacharya et al., 1987) also reported similar findings regarding the decomposition of the Neem cake. They discovered that among the various chemical constituents found in neem kernels, the nematotoxic properties are solely attributed to a group of compounds called limonoids, which belong to B-furano-triterpenoids. Neem cake is rich in nitrogen content, making it a valuable source of organic manure in agricultural fields, leading to an increase in crop yield. Furthermore, the roots of plants grown in soil amended with neem cake undergo physiological changes that make them unsuitable for nematode penetration and development. This contributes to a certain level of resistance in plants against nematode infections.

(Ghimire et al., 2015) also reported a similar finding of larvicidal activity of lantana camara due to the presence of camaric acid and olenolic acids. (Qamar et al., 2005) also found similar findings which explain the different metabolites like lantanoides acid, camaric acid, and oleanolic acid possessing nematicidal activity. A similar finding was found by (Sahebani et al., 2008) who explore the different defense enzymes leading to systematic resistance in plants. The presence of *Trichoderma harzianum* in the roots resulted in an increase in the activity of defense-related plant enzymes, such as peroxidase, chitinase, B-1,3-glucanases, lipoxigenase, and phenylalanine ammonia-lyase. Since nematode eggshells contain proteins and chitin, which are targets for *T. harzianum* and other nematophagous fungi, these fungi produce extracellular chitinase, protease, and other lytic enzymes that aid in egg penetration. In the untreated control group, the crop yield was significantly lower due to the severe infestation of disease and the development of root-knot, which hampers the efficient uptake of nutrients.

Conclusion

The treatments showed noticeable differences in both disease parameters and yield. The results showed chicken manure worked the best at fighting the root-knot nematode disease and increasing tomato yield, with neem cake and Lantana camara coming next. Different organic amendments have diverse effects on nematode suppression, which depend on various factors such as the types of compounds released, dosage, soil characteristics, and nematode population levels. So, it's recommended to keep using eco-friendly treatments that are available and affordable for the best long-term results. This method can be an alternative to chemical solutions and can help keep the environment clean. It's best to use this technique to prevent issues and be a part of global efforts to keep soil good for growing in the future.

Acknowledgement

We extend our sincere gratitude and heartfelt appreciation to IAAS, Lamjung, for providing us with the opportunity to conduct this research. We are deeply grateful to Mr. Rajan Paudel and Mr. Sanjay Mahato, Assistant Professors, for their invaluable guidance and support throughout the study period. We would also like to thank all the people directly or indirectly involved in the study process wholeheartedly.

Statement of Conflict of Interest

The author(s) declare no conflict of interest for this study.

Author's Contributions

The contribution of the authors is equal

References:

Abdel-Dayem, E., Erriquens, F., Verrastro, V., Sasanelli, N., Mondelli, D., Cocozza, C. J. H. (2012). Nematicidal and fertilizing effects of chicken manure, fresh and composted olive mill wastes on organic melon. 49, 259-269.

Bhattacharya, D., Goswami, B. K. J. R. N. (1987). Comparative efficacy of neem and groundnut oil-cakes with aldicarb against MeZuidugyne incognita in tomato. 10(4), 467-470.

Chindo, P., Khan, F. J. I. J. o. P. M. (1990). Control of root-knot nematodes, Meloidogyne spp., on tomato, Lycopersicon esculentum Mill., with poultry manure. 36(4), 332-335.

Chitwood, D. J. J. A. r. o. p. (2002). Phytochemical based strategies for nematode control. 40(1), 221-249.

Ghimire, G., Gupta, R., Keshari, A. K. J. N. J. o. Z. (2015). Nematicidal activity of Lantana camara L. for control of Root-knot nematodes. 3(1), 1-5.

Haque, M., Islam, M., Rahman, M. J. B. J. A. S. (1999). Studies on the presentation of semi-concentrated tomato juice. 26(1), 37-43.

Hayward, A. J. A. r. o. p. (1991). Biology and epidemiology of bacterial wilt caused by Pseudomonas solanacearum. 29(1), 65-87.

Hossain, M. E., Alam, M. J., Hakim, M., Amanullah, A., Ahsanullah, A. J. B. R. P. J. (2010). An assessment of physicochemical properties of some tomato genotypes and varieties grown at Rangpur. 4(3), 135-243.

Hunt, D. J., Handoo, Z. A. (2009). Taxonomy, identification and principal species. In Root-knot nematodes (pp. 55-97): CABI Wallingford UK.

Hussain, M., Mukhtar, T., Kayani, M. J. J., Journal of Animal, & Sciences, P. (2011). Assessment of the damage caused by Meloidogyne incognita on okra (Abelmoschus esculentus). 21(4), 857-861.

Ji, P., Momol, M., Olson, S., Pradhanang, P., Jones, J. J. P. d. (2005). Evaluation of thymol as biofumigant for control of bacterial wilt of tomato under field conditions. 89(5), 497-500.

Kepenekci, I., Hazir, S., Lewis, E. E. J. P. m. s. (2016). Evaluation of entomopathogenic nematodes and the supernatants of the in vitro culture medium of their mutualistic bacteria for the control of the root-knot nematodes Meloidogyne incognita and M. arenaria. 72(2), 327-334.

McCarter, J. P. J. N. b. (2008). Nematology: terra incognita no more. 26(8), 882-884.

MoALD. (2018/2019). Statistical Information of Nepalese Agriculture. Kathmandu, Nepal: Agri-Business Promotion and Statistics, Ministry of Agriculture and Livestock Development (MoALD).

Mukhtar, T., Pervaz, I. J. I. J. o. A., Biology. (2003). In vitro evaluation of ovicidal and larvicidal effects of culture filtrate of Verticillium chlamydosporium against Meloidogyne javanica. 5(4), 576-579.

Pérez, P. E. Z., López, C. C., Zárate, P. M. J. A. e. d. a. (2005). El español Antonio Romera y la historiografía artística chilena: una propuesta de organización fundacional. 78(310), 133-144.

Qamar, F., Begum, S., Raza, S., Wahab, A., Siddiqui, B. J. N. p. r. (2005). Nematicidal natural products from the aerial parts of Lantana camara Linn. 19(6), 609-613.

Rahoo, A. M., Mukhtar, T., Gowen, S. R., Pembroke, B. J. P. J. o. Z. (2011). Virulence of entomopathogenic bacteria Xenorhabdus bovienii and Photorhabdus luminescens against Galleria mellonella larvae. 43(3), 543-548.

Randhawa, N., Sakhuja, P., Singh, I. J. P. D. R.-L.-. (2001). Management of root knot nematode Meloidogyne incognita in tomato with organic amendments. 16(2), 274-276.

Sahebani, N., Hadavi, N. J. S. (2008). Biological control of the root-knot nematode Meloidogyne javanica by Trichoderma harzianum. 40(8), 2016-2020.

Sasser, J. N. J. P.-p. n. t. f. s. h. e. (1989). Plant-parasitic nematodes: the farmer's hidden enemy.

Sesso, H. D., Liu, S., Gaziano, J. M., Buring, J. E. J. T. J. o. n. (2003). Dietary lycopene, tomato-based food products and cardiovascular disease in women. 133(7), 2336-2341.

Singh, K., Bhandari, R. J. S. P., Kathmandu. (2015). Vegetable crops production technology. 103-107.

Singh, S., Mathur, N. J. B. S., & Technology. (2010). In vitro studies of antagonistic fungi against the root-knot nematode, Meloidogyne incognita. 20(3), 275-282.

Sumbul, A., Rizvi, R., Mahmood, I., Ansari, R. A. J. A. J. P. P. (2015). Oil-cake amendments: Useful tools for the management of phytonematodes. 9(3), 91-111.

Thies, J., Mueller, J., Fery, R. J. J. o. t. A. S. f. H. S. (1997). Effectiveness of Resistance to Southern Root-knot Nematode in Carolina Cayenne 'Pepper in Greenhouse, Microplot, and Field Tests. 122(2), 200-204.

Villanueva Gutierrez, E. E. J. I. P. a. t. F. o. L. A., Horticulture, & Science, C. P. (2018). An overview of recent studies of tomato (*Solanum lycopersicum spp*) from a social, biochemical and genetic perspective on quality parameters. (2018: 3).

Williamson, V. M. J. A. R. o. P. (1998). Root-knot nematode resistance genes in tomato and their potential for future use. 36(1), 277-293.