MEDIRES
Symbol of Quality Research

Pesticide Science and Pest Control
info@mediresonline.org

ISSN:2833-0943 RESEARCH ARTICLE

# Screening of Some Popular Egyptian Varieties of Some Solanaceous Vegetables Against Root-Knot Nematode, Meloidogyne Javanica

Abdel-Mageed, M. A.[1*], Montasser, S. A.[2], El-Mesalamy, A. F.[1], Mahmoud, N. A.[1] and Desoky A.S.S

[1]Agric. Zool. and Nematol. Dep., Fac. of Agric. Al-Azhar University, Assiut Branch
[1]Agric. Zool. and Nematol. Dep., Fac. of Agric. Al-Azhar University, Cairo.
[3]Plant protection Department (Agricultural Zoology), Faculty of Agriculture, Sohag University, Egypt

***Corresponding Author:** Abdel-Mageed, M. A. Agric. Zool. and Nematol. Dep., Fac. of Agric. Al-Azhar University, Assiut Branch.

**Received:** 15 March 2023; **Accepted:** 12 April 2023; **Published:** 28 April 2023.

**Citation:** Abdel-Mageed, M. A, (2023). Screening of Some Popular Egyptian Varieties of Some Solanaceous Vegetables Against Root-Knot Nematode, Meloidogyne Javanica. Journal of Pesticide Science and Pest Control.2(1). DOI: 10.58489/2833-0943/020

**Copyright:** © 2023. Abdel-Mageed, M. A. This is an open-access article distributed under the terms of The Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited

## Abstract

Sixteen cultivars' varieties of the following solanaceous vegetables; eggplant varieties. (Balady, Classic, long white and Woman bag), pepper varieties. (Balady, Deer horn, Lamashiar, Mexican, Red sweet zoly, Saudi and Top star) and tomato varieties (Al-Basha 1077, Sama, Strain-B, Super Cristal and Tomato 935) were tested for their host response to *Meloidogyne javanica*. According to rating scale based on nematode reproduction, Classic, long white & Woman bag varieties. of eggplant and Top star variety. of pepper were considered as highly susceptible hosts with (Rf) values 18.04, 15.24, 19.82 & 17.30 folds, respectively. While, Balady variety. of eggplant and Strain-B variety. of tomato were classified as moderately susceptible hosts to nematode infection with (Rf) values 5.28 and 5.07 folds. Lamashiar variety. of pepper and tomato varieties. Super Cristal, Al- Basha 1077 &Tomato 935were found less susceptible with (Rf) values ranged between 1.07 and 4.83 folds. On the other hand, *M. javanica* failed to reproduce and multiple on Deer horn variety. of pepper, which was ranked as highly resistant host with (Rf) value 0.59-fold. Whereas, Balady variety. of pepper and Sama variety. of tomato were ranked as resistant hosts. Nematodes could not reproduce, develop, or penetrate the roots of Mexican, Red sweet zoly and Saudi varieties. of pepper, which were ranked as immune hosts to *M. javanica* infection.

***Keywords:*** *Eggplant, tomato, pepper, Meloidogyne javanica, root-knot nematode*

## Introduction

The family Solanaceae is an economically important family of flowering plants. The family ranges from annual and perennial herbs to vines, or either shrub and trees, including a number of important vegetable crops like tomato, pepper, eggplant, white and red potato, and tomatillo. The family also contains several plants that are considered toxic to humans being such as the weeds jimsonweed, nightshade and mandrake. Many members of the family contain potent alkaloids that are having immense value by considering its nutritional value. The Solanaceae consists of approximately 98 genera and about 2,700 species, with a great diversity in their habitats, morphology and ecology. Solanaceous vegetable crops are important source of vitamin C, A, E, thiamine, niacin, pyridoxine, folacin, minerals and dietary fibers which play a significant role in human nutrition and helps to cope with malnutrition (Devi and Nagar 2017)

Nematodes are one of the most diverse phyla in the kingdom of Animalia, probably exceeding all other animal species in sheer abundance (Chitwood & Chitwood 1974). Nematodes are found in almost all terrestrial, aquatic and marine environments. They can be either free-living or parasitic, feeding on plants, fungi, and animals (Decraemer & Hunt 2013). The species, which have adapted a plant-parasitic lifestyle, pose a significant threat to crop production worldwide (Sikora & Fernàndez 2005) and to solanaceous cultivated in soils of the Nile Valley and reclaimed sandy soils in the desert of Egypt (Mokbel et al., 2006; Abd-Elgawad et al., 2012; Abd-Elgawad, 2013 and Montasser et al., 2019). The root-knot nematodes consist of sedentary polyphagic root endoparasites (Sharon et al. 2007) and their species are the most destructive plant-parasitic nematodes causing large economic losses in crop production (Sasser 1980). More than 100 species of root-knot nematode have been reported worldwide (Karssen & Moens 2013). As a result, most solanaceous are invaded by the root-knot nematode Meloidogyne spp. infested. According to Mota et al. (2013) nematodes can also form complexes with other pathogens such as Fusarium oxysporum, Rhizoctonia solani and Thielaviopsis basicola. Nowadays, nematologists around the world are looking for alternative control measures to avoid soil pollution with chemical nematicides and the resulting hazardous effects due to its residues. Farmers use resistant rootstocks to manage the nematodes of genus Meloidogyne in modern agricultural trends. Currently, cultivars resistant to M. incognita or M. javanica are species identified by Pinheiro et al., (2014) as the most important for vegetable crops. However, other species have gained prominence; They have been found to infect materials resistant to the above species (Pinheiro et al., 2014). Other species pose a major threat to vegetable production due to their high harmful potential, wide range of hosts, and lack of resistant commercial material. Genetic resistance has been considered the best alternative to control phytonematodes due to the low efficiency of chemical control and the search for sources of vital resistance in breeding programs (Hussain et al., 2014 and Liu et al., 2015). Therefore, the aim of the present study is to evaluate the genotypes of some solanaceous vegetables in terms of their response to M. javanica infection.

## Materials and Methods

### *Propagation of Meloidogyne javanica in pure culture*

A pure stock culture of the root-knot nematode *M. javanica* was prepared from naturally infected tomato roots collected from an infested field in Assiut province. Individual egg-masse with their mature females removed from root tissue. Each egg-mass placed in a small glass capsule containing fresh water. The females from which egg-masses were taken preserved in 4 % formaldehyde solution in glass capsules for nematode identification. Each egg-mass was transferred to a 25 cm pot filled with-steam sterilized sandy loam soil and grown with a seedling of eggplant variety. Balady. Inoculated pots were placed in a greenhouse and watered when needed. After two months of inoculation, infected roots were then chopped and used as sources of inoculation for other series of clean cv. Strain-B tomato seedling. By repeating this procedure, enough quantities of inoculation from stock cultures were obtained on eggplant variety. Balady.

### *Identification of Meloidogyne species*

Species of *Meloidogyne* were identified on basis of perineal pattern system of mature females. It was achieved by transferring individual mature females on a slide in a drop of hot lacto-phenol solution. The posterior end of each mature female was cut off by using a sharp razor blade and trimmed down to the area showing the pattern. Slides were gently covered with a clean cover slip and sealed with finger nail-polish, (Taylor and Netscher, 1974). All preparations were examined microscopically using an oil immersion lens. Identification of *Meloidogyne* sp. was established after referring to morphological characteristics given by Chitwood (1949); Taylor & Sasser (1978); Sasser & Carter (1982) and Hartman & Sasser (1985).

### *Greenhouse screening tests*

Seeds of the following solanaceous vegetables, four eggplant (*Solanum melongena*) cultivars; (Balady, Classic, long white and Woman bag, seven pepper (*Capsicum annuum* L.) cultivars; Balady, Deer horn, Lamashiar, Mexican, Red sweet zoly, Saudi and Top star), andfive tomato (*Solanum lycopersicum* L.) cultivars; (Al-Basha 1077, Sama, Strain-B, Super Cristal and Tomato 935) were plantedin 30 cm diameter pots containing mixture of clay and sand soil (1:1 v: v) for two weeks. Pots were then inoculated with approximately 3000 newly hatched juveniles (J2) of *M. javanica* per plant by pipetting the nematode suspension in five holes around the root system. Each treatment was replicated three times. Non-inoculated plants served as a control. All pots were arranged in a randomized block design in a greenhouse. All plants were grown during the normal growing seasons at greenhouse temperature of30 ± 5 Co, for 60 days after planting or 30 ± 5 Co, for 45 days after inoculation, all plants were harvested and removed gently, washed in water and the root of each plant was stained in lacto-phenol acid fuchsine **(Goodey 1957).** Number of juveniles in soil per pot, galls, nematode developmental stages on root, egg-masses per root was counted. Eggs of ten randomly selected egg-masses of each root system were also counted by sodium hypochlorite. The rate of nematode reproduction was calculated. Plant growth criteria involving length and fresh weight of both roots and shoots were calculated. The percentages of reduction of such parameters of each plant were also determined. The host category of the tested crop cultivars plants infected with the root-knot nematode, based to the nematode reproduction (Rf = Pf / Pi) was determined according to Montasser *et al*. (2017), as follow: (Pf / Pi = 0.0) I = Immune host, (Pf / Pi < 0 xss=removed xss=removed xss=removed xss=removed> 15.0) HS = Highly susceptible host.

## Result and Discussion

Sixteen local and important solanaceous cultivars belonging to three crop species were tested for their susceptibility and resistance to the infection of the root knot nematode, *M. javanica* infection Table (1). Eggplant cultivars Classic, Long white & Woman bagand Top star cultivar of pepper were highly susceptible as these cultivars gained the highest values of number of galls, adult female, egg-masses per root, eggs per egg-mass and rate of nematode reproduction. No significant differences were found on such nematode criteria on such root cultivars when compared with those of the other tested cultivars. Therefore, the calculated values of rates of nematode reproduction were 18.04, 15.24, 19.82 & 17.30 folds, respectively. On Balady cultivar of eggplant and Strain-B cultivar of tomato supported the moderately values of nematode criteria, however, the calculated numbers of galls per root and values of rates of nematode reproduction (Rf) were 81 & 69 galls and 5.28 & 5.07 folds, respectively. Also, *M. javanica* reproduced and multiplied low on Lamashiar cultivar of pepper and tomato cultivar Super Cristal, Al- Basha 1077 &Tomato 935 with the number of galls per root and rates of nematode reproduction (Rf) values ranged between 20 & 54 galls and 1.07 & 4.83 folds, respectively. cultivar of pepper and Sama cultivar of tomato. The nematode final population per plant was less than its initial population in these plant cultivars. There upon, on such nematode criteria on such root cultivars when compared with those of the other tested cultivars. Therefore, the calculated values of rates of nematode the calculated number of galls and rates of nematode On the other hand, *M. javanica* failed to reproduce and multiply on Balady reproduction (Rf) on such cultivars were 2 & 9 galls and 0.04 & 0.31folds, respectively. In addition, the evaluation revealed Mexican, Red sweet zoly and Saudi cultivars of pepper as immune (non-host) with zero, number of galls per root, nematode juveniles in soil, nematode developmental stages per root, egg-masses per root, eggs per egg-mass, nematode final population and rate of nematode reproduction.

Susceptibility of some eggplant, pepper and tomato cultivars to root-knot nematode, *M. javanica* infection under greenhouse conditions.

Sixteen local and important solanaceous cultivars belonging to three crop species were tested for their susceptibility and resistance to the infection of the root knot nematode, *M. javanica* infection Table (1). Eggplant cultivars Classic, long white & Woman bagand Top star cultivar of pepper were highly susceptible as these cultivars gained the highest values of number of galls, adult female, egg-masses per root, eggs per egg-mass and rate of nematode reproduction. No significant differences were found on such nematode criteria on such root cultivars when compared with those of the other tested cultivars. Therefore, the calculated values of rates of nematode reproduction were 18.04, 15.24, 19.82 & 17.30 folds, respectively. On Balady cultivar of eggplant and Strain-B cultivar of tomato supported the moderately values of nematode criteria, however, the calculated numbers of galls per root and values of rates of nematode reproduction.

The influence of the root-knot nematode, M. javanica on plant growth of fresh weights of shoots and roots of the same cultivars as well as percentage reductions when compared with healthy once were recorded. Plants Fresh weights of Classic, Long white & Woman bag cultivars of eggplant and Top star cultivar of pepper were highly significantly affected by the nematode infection when compared with their controls. The percentage of reductions in plants weights on such cultivars were 44.44, 33.74, 61.85 & 48.29%, respectively. Whereas, the lowest reductions in plants fresh weights were recorded on Mexican, Red sweet zoly and Saudi cultivars of pepper. The collected plant growth parameters (decreased percentage) on such cultivars were 3.25, 1.48 &1.43 %, respectively. hereby, according to rating scale based on nematode reproduction as plant damage, the host category as shown in Table 1.

Generally, these results are in accordance with findings of Oka *et al*., (2004); Gharabadiyan *et al*.

(2012) and Cole *et al*., (2014). Several authors have studied the inheritance of the resistance reactions of *C. annuum* lines to root-knot nematodes. Hare (1956, 1957) demonstrated that a dominant gene (*N*) present in cv. Santaka controlled resistance to three different *Meloidogyne* species, but

***Table 1:*** Susceptibility of some eggplant, pepper and tomato cultivars to root-knot nematode, *M. javanica* infection under greenhouse conditions

| Plants | Cultivars | No. galls / Root | Nematode final population (Pf) | dRate of nematode reprod. (P f / P I) | Plant Fresh weight in (gm.) | | | Host Category |
|---|---|---|---|---|---|---|---|---|
| | | | | | Infected | Non-infected | Decr. % | |
| Eggplant | Balady | 81 b | 15841 | 5.28 | 5.24 | 6.00 | 12.67 | MS |
| | Classic | 165 a | 54125 | 18.04 | 2.50** | 4.50 | 44.44 | HS |
| | Long white | 52 cde | 45721 | 15.24 | 6.56* | 9.90 | 33.74 | HS |
| | Woman bag | 80 b | 59450 | 19.82 | 4.86** | 12.74 | 61.85 | HS |
| Pepper | Balady | 2 g | 126 | 0.04 | 5.37 | 6.93 | 22.51 | HR |
| | Deer horn | 16 fg | 1784 | 0.59 | 5.16 | 6.80 | 24.12 | R |
| | Lamashiar | 44 de | 14496 | 4.83 | 1.65* | 2.32 | 28.88 | LS |
| | Mexican | 0 g | 0 | 0.00 | 8.03 | 8.30 | 3.25 | I |
| | Red sweet zoly | 0 g | 0 | 0.00 | 5.32 | 5.40 | 1.48 | I |
| | Saudi | 0 g | 0 | 0.00 | 3.45 | 3.50 | 1.43 | I |
| | Top star | 82 b | 51894 | 17.30 | 4.99** | 9.65 | 48.29 | HS |
| Tomato | Al-Basha 1077 | 20 fg | 3402 | 1.13 | 27.53* | 34.37 | 19.90 | LS |
| | Sama | 9 g | 940 | 0.31 | 38.16 | 44.16 | 13.59 | HR |
| | Strian-B | 69 bc | 15201 | 5.07 | 14.77** | 32.06 | 53.93 | MS |
| | Super Cristal | 54 cd | 4187 | 1.40 | 19.86* | 39.84 | 50.15 | LS |
| | Tomato 935 | 33 ef | 3203 | 1.07 | 14.48** | 23.84 | 39.26 | LS |

Means in each column followed by the same letters are not significantly different by (p≥0.05) according to Duncan's multiple range test.
* Significant at 0.05 level of probability ** highly significant at 0.01 level of probability.

its efficiency depended upon the nematode isolate and the amount of inoculum (Hare, 1957). Hazarika, (1990); Khan *et al.* (2002); Basappa, (2005); Buena *et al*. (2006) and Devi *et al*. (2015) reported that, if a cultivar is listed as resistant to a species ofroot-knot nematode, this does not necessarily mean that the cultivar is resistant to all races of this species and the response of cultivars in some case, may also, very due to environmental factors. Resistance to one species or one race of root-knot nematodes may be independent of resistance to other species, races or biotypes (Bommalinga *et al*., (2013); Okorley *et al.,* (2018) and Rabelo *et al*., (2018). For example, the genotypes of *Capsicum annuum* L. var. *annuum* are resistant based on the reproduction factor, and highly resistant based on the reproduction index to M. javanica while for the M. incognita race 3, six genotypes are resistant and/or highly resistant. No evaluated C. annuum genotype is resistant to M. enterolobii (Soares et al., 2018).

## References

1. Abd-Elgawad, M. M. M., Kabeil, S. S. A., Fanelli, E., & Molinari, S. (2012). Different Levels Of Anti-Oxidant Enzyme Activities In Tomato Genotypes Susceptible And Resistant To Root-Knot Nematodes [Diferentes Niveles De Actividad Enzimática Anti-Oxidante En Genotipos De Tomate Susceptibles Y Resistentes A Nematodos Agalladores]. Nematropica, 330-336.

2. Abd-Elgawad, M. M. M. (2013). Phytonematode damage, economic threshold and management with special reference to Egypt. Egyptian Journal of Agronematology, 12(1), 159-176.
3. Abd-Elgawad, M. M. M., Kabeil, S. S. A., Fanelli, E., & Molinari, S. (2012). Different Levels Of Anti-Oxidant Enzyme Activities In Tomato Genotypes Susceptible And Resistant To Root-Knot Nematodes [Diferentes Niveles De Actividad Enzimática Anti-Oxidante En Genotipos De Tomate Susceptibles Y Resistentes A Nematodos Agalladores]. Nematropica, 330-336.
4. Basappa, S. S. (2005). Studies on wilt complex of eggplant (solanum melongena l.) and it's management. Master of Science (Agricultural University) Dist. Ratnagiri (Maharashtra State) India.
5. Bommalinga, S., Narasimhamurthy, T. N., Prahalada, G. D., & Reddy, B. M. R. (2013). Screening of bell pepper cultivars against root-knot nematode Meloidogyne incognita [(kofoid and white) Chitwood]. Int J Life Sci Bot Pharm Res, 2(1), 225-228.
6. Chitwood, B. G. (1949). 'Root-knot nematodes'. Part 1. A revision of the genus Meloidogyne Goeldi, 1887. Proceedings of the Helminthological society of Washington, 16(2), 90-114.
7. Chitwood, B. G. (1949). 'Root-knot nematodes'. Part 1. A revision of the genus Meloidogyne Goeldi, 1887. Proceedings of the helminthological Society of Washington, 16(2), 90-114.
8. Chitwood, B. G. and Chitwood, M. B. (1974). Introduction to Nematology. University Park Press, Baltimore, London and Tokyo, 1974.
9. Cole, A. O.; Starr, J. L. and Fawole, B. (2014). Evaluation of tomato varieties for resistance to Meloidogyne spp. in Nigeria. J. Nematol., 46, Pp. 147.
10. Devi, T. S., & Sumita, K. (2015). Screening of brinjal germplasms against root-knot nematode Meloidogyne incognita. World Journal of Pharmacy and Pharmaceutical Sciences, 4(11), 1300-1.
11. Devi, S. and Nagar, A. (2017). Nutritional and Medicinal Properties of Solanaceous Vegetables. Division of vegetable Science, IARI, New Delhi, 110012.
12. Gharabadiyan, F., Jamali, S., Ahmadiyan Yazdi, A., & Eskandari, A. (2012). Source of resistance to root-knot nematode (Meloidogyne javanica) in tomato cultivars. Journal of Agricultural Technology, 8(6), 2011-2021.
13. Goodey, J. B. (1957). Hoplolaimus proporicus n. sp.(Hoplolaiminae: Tylenchida). Nematologica, 2(2), 108-113.
14. Hare, W. W. (1956). Resistance in pepper to Meloidogyne incognita-Acrita. Phytopathology, 46(2), 98-104.
15. Hare, W. W. (1957). Inheritance of resistance to root-knot nematodes in pepper. Phytopathology, 47(8), 455-459.
16. Hartman, K. M. and Sasser, J. N. (1985). Identification of differential host test and perineal pattern morphology. p. 69–77. In: "An Advanced Treatise on Meloidogyne" Vol. II. "Methodology" (K.R. Barker, C.C. Carter, J.N. Sasser, eds.). North Carolina State Univ. Graph. Raleigh, N.C., USA, 223 pp.
17. Hazarika, K. (1990). Pathogenicity and management of Meloidogyne incognita on Brinjal (Solanum melongena) M. Sc. (Agri) Thesis, Assam Agricultural University, Jorhat.
18. Hussain, M. A., Mukhtar, T., & Kayani, M. Z. (2014). Characterization of susceptibility and resistance responses to root-knot nematode (Meloidogyne incognita) infection in okra germplasm. Pakistan Journal of Agricultural Sciences, 51(2).
19. Khan, B., Khan, A. A., & Khan, M. R. (2002). Response of some cultivars of pepper, eggplant and tomato to races of root-knot nematodes, Meloidogyne incognita and M. javanica. Indian Journal of Nematology, 32(2), 147-152.
20. Karssen, G. Moens, M. (2013). Root-knot nematodes. In Perry RN, Moens, M. Plant Nematology, 2nd edition. CAB International, Wallingford, UK.;59-90.
21. Liu, B., Ren, J., Zhang, Y., An, J., Chen, M., Chen, H., ... & Ren, H. (2015). A new grafted rootstock against root-knot nematode for cucumber, melon, and watermelon. Agronomy for sustainable development, 35, 251-259.
22. Mokbel, A. A., Ibrahim, I. K. A., El-Saedy, M. A. M., & Hammad, S. E. (2006). Plant parasitic nematodes associated with some fruit trees and vegetable crops in northern Egypt. Egypt. J.

Phytopathol, 34(2), 43-51.

23. Montasser, S. A., Mahmoud, N. A., El-Mesalamy, A. F., & Abdel-Mageed, M. A. A. (2017). Evaluation of six leguminous crops against the root-knot nematode, Meloidogyne javanica infection. Pakistan Journal of Nematology, 35(1), 79-84.
24. Montasser, S., Anany, A., & Khalifa, A. (2019). Screening of some potato cultivars for root-knot nematode (Meloidogyne javanica) and reniform nematode (Rotylenchulus reniformis) infection under greenhouse conditions. Egyptian Journal of Agronematology, 18(1), 60-69.
25. Mota, F. D. C., Alves, G. C. S., Giband, M., Gomes, A. C. M. M., Sousa, F. R., Mattos, V. S., ... & Carneiro, R. M. D. G. (2013). New sources of resistance to Meloidogyne incognita race 3 in wild cotton accessions and histological characterization of the defence mechanisms. Plant Pathology, 62(5), 1173-1183.
26. Oka, Y., Offenbach, R., & Pivonia, S. (2004). Pepper rootstock graft compatibility and response to Meloidogyne javanica and M. incognita. Journal of nematology, 36(2), 137.
27. Okorley, B. A., Agyeman, C., Amissah, N., & Nyaku, S. T. (2018). Screening selected solanum plants as potential rootstocks for the management of root-knot nematodes (Meloidogyne incognita). International journal of agronomy, 2018.
28. Pinheiro, J. B., Silva, G. O. D., Macêdo, A. G., Biscaia, D., Ragassi, C. F., Ribeiro, C. S., ... & Reifschneider, F. J. B. (2020). New resistance sources to root-knot nematode in Capsicum pepper. Horticultura Brasileira, 38, 33-40.
29. da Silva Rabelo, J., de Almeida Guimarães, M., Santos, C. D. G., Neto, B. P. L., de Araújo Hendges, A. R. A., dos Santos Viana, C., ... & Neto, H. D. S. L. (2018). Prospection and production of Solanaceae species resistant to the root knot nematode. African Journal of Agricultural Research, 13(16), 851-857.
30. Carter, C. C., & Sasser, N. (1999). A guide to the development of a plant nematology program (No. 30391 Caja (306)). North Carolina State University. Department of plant pathology,.
31. Soares, R. S., Silva, E. H. C., Vidal, R. L., Candido, W. D. S., Franco, C. A., Reifschneider, F. J. B., & Braz, L. T. (2018). Response of Capsicum annuum L. var. annuum genotypes to root-knot nematode infection. Chilean journal of agricultural research, 78(1), 78-85.
32. Sasser, J. N. (1980). Root-knot nematodes: a global menace to crop production. Plant disease, 64(1), 36-41.
33. Sasser, J. N., & Carter, C. C. (1982). Root-knot nematodes (Meloidogyne spp.): Identification, morphological and physiological variation, host range, ecology, and control. Nematology in the Southern region of the United States. Southern cooperative series bulletin, 276, 21-32. 258.
34. Sharon, E., Chet, I., Viterbo, A., Bar-Eyal, M., Nagan, H., Samuels, G. J., & Spiegel, Y. (2007). Parasitism of Trichoderma on Meloidogyne javanica and role of the gelatinous matrix. European journal of plant pathology, 118, 247-258.
35. Sikora, R. A., & Fernandez, E. (2005). Nematode parasites of vegetables. In Plant parasitic nematodes in subtropical and tropical agriculture (pp. 319-392). Wallingford UK: CABI publishing.
36. Taylor, A. L., & Sasser, J. N. (1978). Biology, identification and control of root-knot nematodes (Meloidogyne species). Biology, identification and control of root-knot nematodes (Meloidogyne species).
37. Taylor, D. P., & Netscher, C. (1974). An improved technique for preparing perineal patterns of Meloidogyne spp. Nematologica, 20(2), 268-269.