The Pharma Innovation Journal 2023; 12(9): 1014-1017

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(9): 1014-1017

www.thepharmajournal.com
Received: 25-07-2023
Accepted: 30-08-2023

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Screening and assessment of *Meloidogyne enterolobii* infestation in different varieties of guava (*Psidium guajava* L.)

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Abstract
Guava (*Psidium guajava* L.), globally renowned for its nutritional and flavorful attributes, confronts challenges due to root-knot nematodes. The *Meloidogyne* genus, especially *M. enterolobii*, poses significant threats to agriculture. This study addresses the urgent need to manage *M. enterolobii* infestations in guava by investigating screening and detection methodologies. Nine well-recognized guava varieties *viz*., L-49, Lalit, Hisar Safeda, Sweta, Allahabad Barfkhan, Pant Prabhat, Hisar Surkha, Red Flesh and Dhawal were subjected to controlled pot experiments, revealing their responses to *M. enterolobii* infestations. The results demonstrated susceptibility across all tested varieties, without any highly resistant genotypes. During this experiment 179.33 galls/5 g of roots were recorded in Sweta followed by 141.33 galls/5 g of roots were recorded in Red Flesh. Whereas, minimum 56 galls/5 g of roots were recorded in Hisar Surkh variety of guava. The absence of strong resistance underscore the gravity of *M. enterolobii* infestations in guava cultivation, necessitating integrated pest management strategies. Such strategies could include soil management, crop rotation, and the development of nematode-resistant cultivars.

Keywords: Guava, *Meloidogyne enterolobii*, root-knot nematodes, susceptibility, resistance, screening

Introduction
Globally, guava (*Psidium guajava* L.) stands as one of the most economically significant fruit crops, cherished for its nutritional value, pleasant flavor, and versatility in culinary applications (Kamle *et al*., 2017) [9]. However, the production of guava is frequently hampered by various biotic and abiotic stresses, with plant-parasitic nematodes being a notable concern (Sikandar *et al*., 2023) [15]. Among these nematodes, the genus *Meloidogyne* holds a prominent position due to its destructive impact on numerous agricultural crops, including guava. (Martinset *et al*., 2013) [11]. *Meloidogyne spp*. commonly known as root-knot nematodes, are responsible for inducing complex anatomical and physiological changes in plant roots, leading to reduced nutrient uptake, stunted growth, and compromised yield (Jones *et al*., 2013, da Silva and Krasuski, 2012; Martinset *et al*., 2013) [8, 5, 11].

One particular species, *Meloidogyne enterolobii*, has garnered attention in recent years for its aggressive nature and wide host range (Philbrick *et al*., 2020) [12]. Originally identified as a distinct species from the closely related *Meloidogyne incognita* (Sellers *et al*., 2021) [14]. *M. enterolobii* has earned notoriety for its ability to overcome resistance mechanisms in various crop plants, leading to significant losses in agriculture (Castagnone-Sereno and Danchin 2014). In the case of guava, the invasion of *M. enterolobii* presents a substantial challenge to sustainable production, as it can substantially diminish yield and quality (Brito *et al*., 2004) [2].

The need to develop effective strategies to manage *M. enterolobii* infestations in guava plantations has become increasingly urgent (Sikandar *et al*., 2023) [15]. Early detection and precise identification of the nematode species are crucial steps in devising targeted management approaches (Bogale *et al*., 2020) [1]. This has led to the development and application of various molecular and diagnostic techniques for the accurate identification of *M. enterolobii* (Chen *et al*., 2022) [4]. Such screening methods not only aid in early intervention but also provide insights into the distribution and prevalence of this nematode species, enabling the formulation of region-specific management strategies (Venette *et al*., 2021) [13].

In this context, this study aims to investigate and present methodologies for the screening and detection of *Meloidogyne enterolobii* in guava.

By elucidating the molecular and diagnostic techniques employed in the identification of this nematode species, this research contributes to a deeper understanding of the challenges posed by *M. enterolobii* infestations in guava cultivation. Furthermore, the insights gained from this study have the potential to inform the development of integrated pest management strategies that can mitigate the impact of this destructive nematode on guava production systems.

Materials and Methods

During this experiment, nine famous guava varieties- L-49, Lalit, Hisar Safeda, Sweta, Allahabad Barfkhan, Pant Prabhat, Hisar Surkha, Red Flesh and Dhawal were collected from Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut. Varieties were screened for their reaction against *M. enterolobii*. A pot experiment was conducted to check the level of resistance or susceptibility of the varieties against root-knot nematode. Three replications were maintained for each root stock of different guava varieties. The pots were filled with 5 kg of sterilized soil and the root stocks were planted in each one of them. 20 days after transplanting, 500 juveniles were inoculated in each pot near the root zone and afterwards each pot was filled with water. Root-knot index was recorded at six months after planting. Five gram of roots was collected from each pot of each variety of Guava. The observations were recorded on the number of galls/5 g of roots and the susceptible or resistant levels of cultivars were determined on the basis of the root knot index on 1-5 scale.

Table 1: Root-knot index 1 to 5 scales for *Meloidogyne enterolobii* (Hartman and Sasser, 1985) [7]

Number of root galls/plant	Root knot index scale	Reaction
0	1	Highly resistant (HR)
1-10	2	Resistant (R)
11-30	3	Moderately resistant (MR)
31-100	4	Susceptible (S)
>100	5	Highly susceptible (HS)

Assessment of Susceptibility and Resistance

Six months after plantation, the evaluation of the guava varieties for susceptibility or resistance reaction against *Meloidogyne enterolobii* was undertaken. For this assessment, 5 gram of roots was extracted from each guava variety. The roots were thoroughly washed to ensure clear visibility of the galls formed. Then counting of galls was carried out, focusing on the number of galls present on the 5 gram of roots. Moreover, Root Gall Index (RGI) was determined for each guava variety. The RGI employed a scale ranging from 1 to 5, where 1 indicated minimum galling and 5 indicated maximum galling. This index facilitated the quantification of the susceptibility or resistance levels exhibited by the different guava cultivars in response to the nematode infestation. This experimental approach aimed to discern the varying reactions of the selected guava varieties to *Meloidogyne enterolobii* infestations. The assessment criteria included galls count, root-knot index, and observations made on the galls presence and distribution on the guava roots. This investigation contributes valuable insights into the potential resistance mechanisms of these guava varieties against the destructive impact of *M. enterolobii*, aiding in the development of effective nematode management strategies.

Results and Discussion

In this study, we conducted a comprehensive screening of nine prominent guava varieties, including L-49, Lalit, Hisar Safeda, Sweta, Allahabad Barfkhan, Pant Prabhat, Hisar Surkha, Red Flesh, and Dhawal, to evaluate their reactions against the root-knot nematode *Meloidogyne enterolobii.* The screening was carried out under pot conditions to ascertain the response of these varieties to the nematode infestation. Observations were made on average galls per 5 gram of roots (galls/5 g of roots) and the Root Gall Index (RGI) after six months of guava plantation. The results indicated that all the guava varieties supported the development and multiplication of the nematode to varying extents and no resistant reactions were observed in any tested varieties. Among the varieties, the highest average galls per 5 gram of roots (179.33 galls/5g) were observed in the Sweta variety, followed by Red Flesh (141.33 galls/5g), L-49 (155 galls/5g), and Pant Prabhat (137.33 galls/5g). Hisar Surkha variety exhibited the lowest average galls per 5 gram of roots (56 galls/5g) among all the tested varieties. Based on the Root Gall Index (RGI) assessment, three varieties - Hisar Surkha, Allahabad Barfkhan, and Lalit-were categorized as susceptible to the nematode infestation. The remaining varieties, including Sweta, Red Flesh, L-49, Pant Prabhat, Hisar Safeda, and Dhawal, showed a highly susceptible reaction against *Meloidogyne enterolobii.* No variety demonstrated high resistance, resistance, or moderate resistance against the nematode. The results findings from previous studies, conducted by Kumar *et al*. (2019) [10] and Freitas *et al*. (2014) [6], which underscore that the widespread susceptibility of guava genotypes against *Meloidogyne enterolobii.* These studies demonstrated that various guava cultivars and species exhibited susceptibility or varying degrees of resistance against the guava root knot nematode. The absence of highly resistant genotypes emphasizes the challenges posed by *Meloidogyne enterolobii* infestations in guava cultivation. As demonstrated in this study and supported by earlier research, the nematode's ability to establish and reproduce on all tested genotypes highlights the urgent need for integrated pest management strategies. These strategies should encompass practices such as soil management, the use of resistant rootstocks to mitigate the impact of this destructive nematode on guava cultivation. Our screening of different guava genotypes against *Meloidogyne enterolobii* sheds light on the susceptibility profile of these varieties. The findings underscore the importance of continued research and collaborative efforts to develop nematode-resistant cultivars and effective management practices to safeguard guava production.

Table 2: Screening of different guava varieties against guava root-knot nematode

S. No	Name of Variety	No. of Galls/5gm of Roots	Galling Index	Reaction
1	L-49	155.00	5	Highly susceptible
2	Lalit	90.66	4	Susceptible
3	Hisar safeda	129.00	5	Highly susceptible
4	Allahabad burfkhan	65.66	4	Susceptible
5	Pant prabhat	137.33	5	Highly susceptible
6	Hisar surkha	56.00	4	Susceptible
7	Sweta	179.33	5	Highly susceptible
8	Red flesh	141.33	5	Highly susceptible
9	Dhawal	119.33	5	Highly susceptible

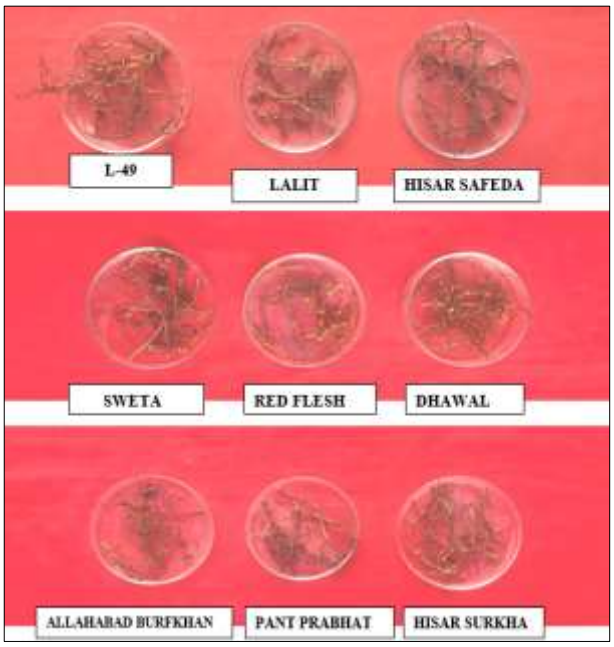

Fig 1: Galls formation on roots of different guava varieties

Fig 2: Field View

Conclusion

The screening of nine prominent guava varieties, including L-49, Lalit, Hisar Safeda, Sweta, Allahabad Barfkhan, Pant Prabhat, Hisar Surkha, Red Flesh, and Dhawal, against *Meloidogyne enterolobii* revealed valuable insights into their responses to root-knot nematode infestations. The experimental assessment, conducted under pot conditions, illuminated the susceptibility profile of each variety, providing essential information for guava cultivation and nematode management strategies. The results highlighted that all tested guava genotypes supported the development and multiplication of *M. enterolobii* to varying extents. Notably, no variety exhibited high resistance, resistance, or even moderate resistance against the guava root knot nematode. Instead, the majority of the varieties displayed high susceptibility, with variations in the severity of galling observed. The absence of highly resistant genotypes underscores the challenges posed by *M. enterolobii* infestations in guava production systems. This emphasizes the need for comprehensive integrated pest management strategies to mitigate the nematode's impact. Such strategies may encompass soil management and the development of nematode-resistant cultivars. This study enhances our understanding of the interactions between guava genotypes and *Meloidogyne enterolobii.* Future research endeavors should focus on identifying potential resistance mechanisms and harnessing this knowledge to enhance guava resilience against root-knot nematodes.

Acknowledgement

The author wish thank to HOD of Department of Plant Pathology, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, for providing the research facilities.

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