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RESEARCH ARTICLE

Plant parasitic nematodes infecting grape trees, *vitis vinifera* L. at Qena locality, Qena governorate, Egypt

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Abstract

Grape, *Vitis vinifera* L. is considered the most economically important fruit crops in the world. In Egypt, grape comprise the second after citrus for domestic consumption. This study was conducted in the Experimental Horticultural Farm of South Valley University, Qena, to conduct a survey on the most important predominant genera of plant parasitic nematodes (PPNs), associated with the soil rhizosphere and roots of grape trees, *Vitis vinifera* L. cv. Superior Seedless, that causing remarkable economic losses. The obtained results reported that nine genera of PPNs were associated with soil rhizosphere of grape trees namely, *Meloidogyne, Tylenchorhynchus, Longidorus, Pratylenchus, Xiphinema, Trichodorus, Tylenchulus, Helicotylenchus* and *Paratylenchus.* While, only three genera were reported to be in grape root samples viz., *Meloidogyne, Pratylenchus,* and *Tylenchulus.* The results revealed that the population density (PD) of *Meloidogyne* spp. was the most dominant, attacking grape trees with an average of 2550.78 individuals per 200 cm^3 soil, and 1228.89 individuals/1g roots, with 37.99% and 55.36 % frequency of occurrence (FO) in soil and root samples, respectively. Statistical analysis of soil and root results reported that there were significant differences in nematode populations among registered genera LSD 5% = 154.8 and 292.4, respectively. Additionally, the numbers of nematode populations in soil and root samples varied significantly between February, March, and January, with the LSD 5% values being 369.3 and 338.4, respectively.

Keywords: grape, *Vitis vinifera* L., plant parasitic nematodes, frequency of occurrence, phytonematodes

Introduction

Grape, *Vitis vinifera* L. occupied the most important fruit crops all over the world. In Egypt, grape ranks second after citrus in domestic consumption, additionally, it is being exported annually, serving as one of sources for hard currency. Grape plantations extended geographically from Alexandria to Aswan, which, combined with the production of early and late ripening grapes, supports the continued accessibility of grapes along the year months. According to the report of (FAO, 2022), the total cultured area in the world was about 6,730,179 hectares with a total annual production of 74,943 million tons. In Egypt, total cultured areas inhabit about 79,092 ha with a total annual production of approximately 1.572 million ton with an average yield of 19.87 ton/ha. The most popular cultivars viz., Thompson Seedless, Flame Seedless, Superior Seedless, Crimson Seedless and Roomy (Omar and Akingbe, 2020), plus new ones such as Prime Seedless, Early Sweet and Star Light (Ahmed and El-Aziz, 2021).

Plant parasitic nematodes (PPNs) or phyto-nematodes are one of the main pests reported

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from almost all grape yards worldwide representing serious burden for viticulturists and lead to general reduction in vine vigor and fruit production (Zasada *et al.*, 2012). The major PPNs infecting grapes include *Meloidogyne* spp., *Pratylenchus* spp., *Criconemella* spp., *Tylenchulus* spp., *Helicotylenchus* spp. and *Heterodera* spp., (Malik *et al.*, 2022). Seven genera of PPNs namely, *Meloidogyne*, *Rotylenchulus*, *Tylenchulus*, *Pratylenchus*, *Helicotylenchus*, *Tylenchorhynchus* and *Xiphinema* were associated with grape yards in Belbies district, Sharkia Governorate, Egypt, (El-Marzoky *et al.*, 2015). These nematodes are known to have a very wide range of host distribution as they are known to reduce root weight, which translates into significant yield losses, (Korayem *et al.*, 2015). Bibi *et al.* (2024) indicated that six genera of PPNs namely, *Helicotylenchus*, *Filenchus*, *Tylenchorhynchus*, *Xiphinema*, *Tylenchus*, and *Pratylenchus* were found to be associated with grape yards from different locations viz., Manki, Lahor, Anbar, Kunda, Shahmansoor, and Panjpir in District Swabi, Pakistan. Regular surveillance to determine PPNs occurrence, spread and population is the first step toward successful and effective management, (Abraham *et al.*, 2018). The status of PPNs infecting grape yards will provide vital information for extension agents to educate farmers about these yield reducing pests and effective management, (Iliya *et al.*, 2021). There exists a paucity of information on the status of PPNs attacking grape trees in Qena governorate, Egypt. Findings from this study will give an insight on PPNs status that will help in feature management, as well as damage of PPNs in many susceptible grape yards, mainly in temperate areas could be a concern for replanting.

Therefore, this study was conducted to shed a light on the PPNs attacking grape trees in Qena governorate, Egypt for the first time.

2. Materials and Methods

The present study was conducted through two trials; the first was carried out in the Experimental Horticultural Farm of South Valley University, Qena and the other was done in the Pesticides Laboratory of Plant Protection Department, Fac. of Agric., South Valley University, Qena.

2.1. Samples Collection

In a Superior Seedless grape yard, *Vitis vinifera* L. (14 years old), rhizosphere samples from surrounding soil and roots were collected over three months (from January 2022 to March 2022). Experiment layout was randomized complete block design (RCBD) with three replicates. For each replicate, five sub-samples were collected and mixed together to form a composite sample of about 1 kg taken in a zigzag-sampling pattern from the tested orchard. Each sub-sample was collected from the rhizosphere zone of the different trees at a depth of 15-30 cm (most nematodes are found in these layers), including a part of plant roots by garden trowel. The five sub-samples for each replicate were mixed well and kept in a polyethylene bag labeled with the most important related data then sealed and sent directly in a sample box to the laboratory and kept in a refrigerator at 5°C for nematode extraction, enumeration and identification process.

2.2. Extraction of PPNs genera

PPNs were extracted from different samples using the modified Baermann technique. The roots of each sample (replicate) were washed and cut into small pieces (1 cm) of which 1g was used for each replicate to extract nematodes (Hooper *et al.*, 2005).

PPNs were extracted from 200 cm^3 soil sample (replicate) using serial sieves and the same

modified Baermann technique through 60 and 325 mesh sieves according to Goodey (1957). The obtained suspension was shifted to a modified Baermann pan filtered with soft tissue paper. After 72 h. the extracted PPNs were collected and counted as follows: for each sample (replicate), replicated aliquots, each of 1 ml of PPNs extraction was pipetted into a counting slide, and PPNs were examined under a stereo microscope. PPNs populations were expressed as nematode stages per 200 cm^3 soil and 1g of root pieces for each sample (replicate).

2.3. Identification of PPNs genera

PPNs identification to the genus level was based on morphology of adult and juvenile forms with the aid of that illustrated by (Mai and Lyon, 1975; Siddiqi, 1986). Population density (PD) per 200 cm^3 soil and 1g of roots and frequency of occurrence (FO) were calculated as Norton (1978) formulas as:

$$\textbf{Population density (PD)} = \frac{\text{No.of nematodes}}{\text{Total no.of samples}}$$

$$\textbf{Occurrence (\%)} = \frac{\text{No.of positive samples}}{\text{Total no.of samples}} \times 100$$

2.4. Statistical analysis

Collected data were subjected to statistical analysis of variance test. The least significant differences (LSD) at the 5% level were computed by CoStat, 6400 (2008) and Duncan's Multiple Range test (DMRT) was used to compare the total averages and LSD 5% values were used to compare the average or mean numbers (population density).

3. Results

3.1. Plant parasitic nematodes (PPNs) and occurrence % in the soil of Superior Seedless grape yard, *Vitis vinifera* L. at Qena locality along January, February and March 2022

The obtained results in Table (1) and Figs. (1&2) show the average numbers of PPNs and occurrence % extracted from the rhizosphere soil of Superior Seedless grape yard, at Qena locality along January, February and March 2022.

Data reported the presence of nine genera of nematodes i.e., *Meloidogyne, Tylenchorhynchus, Longidorus, Pratylenchus, Xiphinema, Trichodorus, Tylenchulus semipenetrans, Helicotylenchus* and *Paratylenchus.* The highest nematode numbers were recorded with root knot nematode, *Meloidogyne* spp. 2550.78 individuals per 200 cm^3 soil followed by orange nematode, *T. semipenetrans* 1236.89, and stubby root nematode, *Trichodorus* 929.56, dagger nematode, *Xiphinema*, lesion nematode, *Pratylenchus* and pin nematode, *Paratylenchus* genera occupied intermediate status as 664.22, 472.22, and 373.56 individuals per 200 cm^3 soil, respectively. While the rest genera were presented in low numbers as 273.56, 172.22, and 40.99 individuals per 200 cm^3 soil for *Longidorus, Tylenchorhynchus* and *Helicotylenchus*, respectively.

The obtained data in Table (1) reported that there were significant differences in the numbers of nematode among registered genera LSD 5% = 154.8.

As for occurrence percentages of nematode genera in grape yard soil, *Meloidogyne* spp. occupied the highest occurrence percentages as 37.99 % followed by *T. semipenetrans* as 18.42 % and *Trichodorus* as 13.85% while, the rest genera were ranged between 0.61 to 9.89 %.

Regarding to the average numbers of PPNs along the examined three months as shown in Table (1), the obtained results reported that the highest numbers were recorded in February and March as 7654.33 and 7650.33 individuals per 200 cm^3 followed by January as 4837.35 individuals per 200 cm^3 soil. The obtained data

reported that there were no significant differences in the numbers of nematode between February & March while there were significant differences between both months and January month LSD 5% = 369.3.

Table 1. Average numbers of plant parasitic nematode genera and occurrence % extracted from the soil of Superior Seedless grape yard, *Vitis vinifera* L. at Qena locality along January, February and March 2022.

Nematode genera	Ave. no. of PPNs stages/ 200 cm^3 soil			Overall mean	Occurrence %
	January	February	March		
Meloidogyne	1380.67	3135.67	3136.00	2550.78 [a]	37.99
Tylenchorhynchus	167.67	174.67	174.33	172.22 [gh]	2.57
Longidorus	254.67	283.00	283.00	273.56 [fg]	4.07
Pratylenchus	437.67	489.67	489.33	472.22 [e]	7.03
Xiphinema	601.33	697.33	694.00	664.22 [d]	9.89
Trichodorus	858.67	965.33	964.67	929.56 [c]	13.85
Tylenchulus	849.67	1430.33	1430.67	1236.89 [b]	18.42
Helicotylenchus	46.33	38.33	38.33	40.99 [h]	0.61
Paratylenchus	240.67	440.00	440.00	373.56 [ef]	5.56
Total	4837.35 [b]	7654.33 [a]	7650.33 [a]	6714	
LSD 5%		for months 369.3		for genera 154.8	

means in column or row followed by different letter (s) are significantly different at 5% level

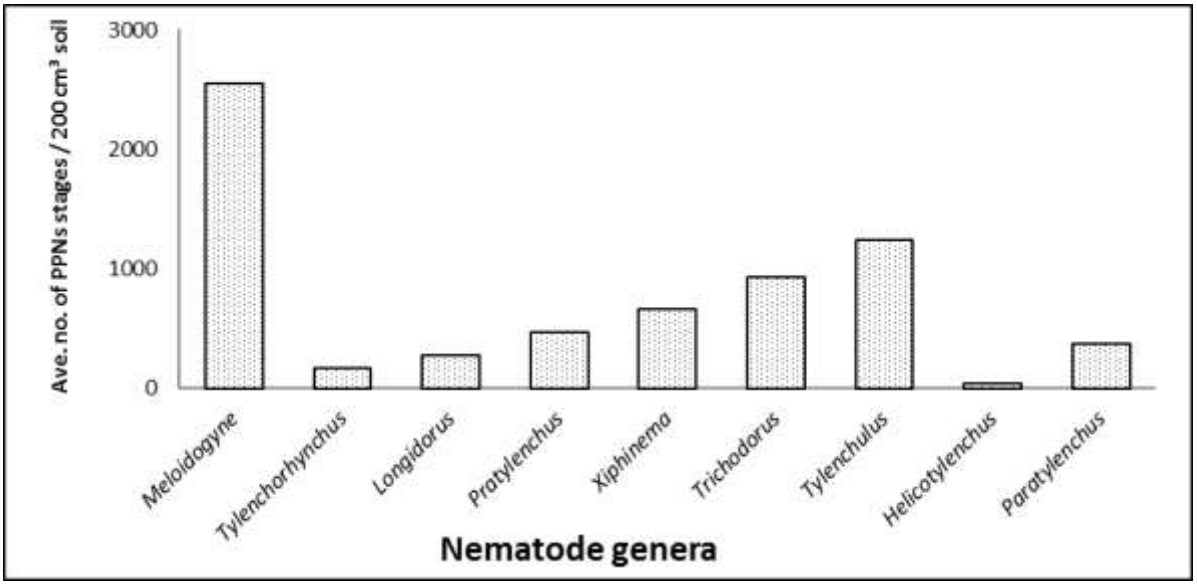

Figure 1. Average numbers of plant parasitic nematode genera extracted from the soil of Superior Seedless grape yard, at Qena locality along January, February and March 2022.

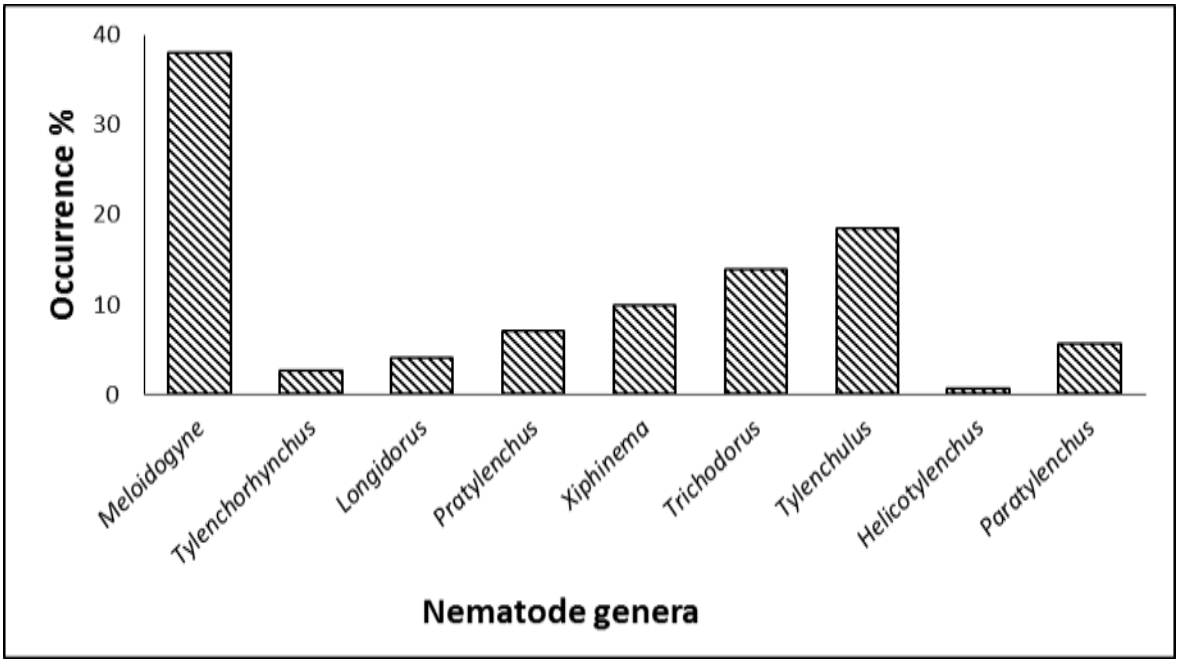

Figure 2. Occurrence % of plant parasitic nematode genera extracted from the soil of Superior Seedless grape yard, at Qena locality along January, February and March 2022.

3.2. Phytonematodes and occurrence % in the roots of Superior Seedless grape yard, *Vitis vinifera* L. at Qena locality along January, February and March 2022.

The obtained results in Table (2) and Figs. (3&4) show the average numbers of PPNs and occurrence % extracted from the roots of Superior Seedless grape yard, *Vitis vinifera* L. at Qena locality along January, February and March 2022.

Data reported the presence of three genera of PPNs viz., *Meloidogyne, Tylenchulus* and *Pratylenchus.* The highest nematode numbers were recorded with *Meloidogyne* spp. as 1228.89 individuals per 1g roots followed by *T. semipenetrans* 649.89, while *Pratylenchus* was presented as the least numbers as 341.11 individuals per 1g roots.

The obtained data in Table (2) reported that there were significant differences in the numbers of nematode among registered genera LSD 5% = 292.4.

As for occurrence percentages, *Meloidogyne* spp. occupied the highest as 55.36 % followed by *T. semipenetrans* as 29.28 %, while *Pratylenchus*, was present as 15.37 %. Regarding to the average numbers of PPNs along the examined three months as shown in Table (2), the obtained results reported that the highest number was recorded in March as 2714.34 individuals per 1g roots followed by February 2467.33 without significant differences, while it was 1478.00 individuals per 1g roots in January with a significant difference with the other two months LSD 5% = 338.4.

Table 2. Average numbers of plant parasitic nematode genera and occurrence % extracted from roots of Superior Seedless grape yard, *Vitis vinifera* L. at Qena locality along January, February and March 2022**.**

Nematode genera	Ave. no. of PPNs stages/ 1g roots			Overall mean	Occurrence %
	January	February	March		
Meloidogyne	821.67	1366.33	1498.67	1228.89 [a]	55.36
Pratylenchus	264.00	338.33	421.00	341.11 [c]	15.37
Tylenchulus	392.33	762.67	794.67	649.89 [b]	29.28
Total	1478.00 [b]	2467.33 [a]	2714.34 [a]	2219.89	
LSD 5%		for months 338.4		for genera 292.4	

means in column or row followed by different letter (s) are significantly different at 5% level

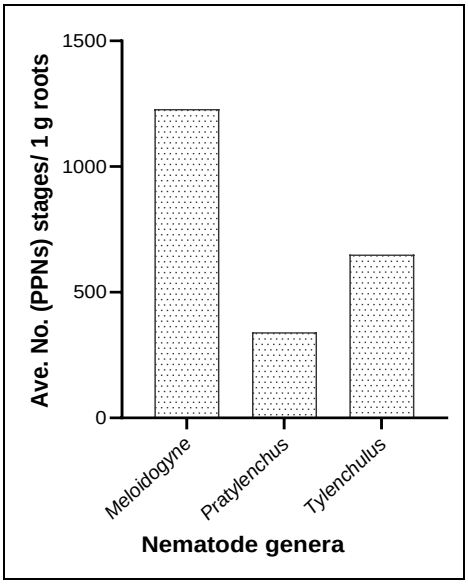

Figure 3. Average numbers of plant parasitic nematode genera extracted from the roots of Superior Seedless grape yard, *Vitis vinifera* at Qena locality along January, February and March 2022.

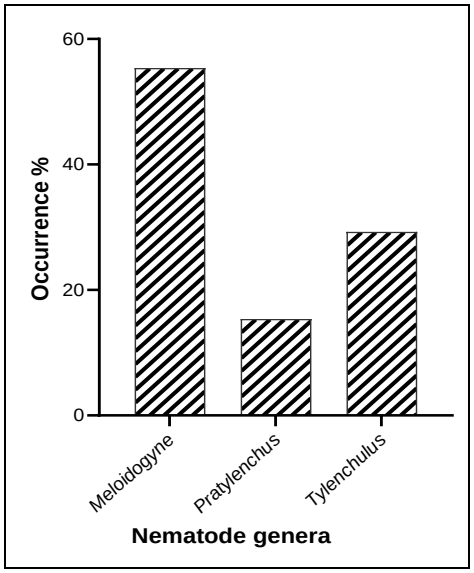

Figure 4. Occurrence % of plant parasitic nematode genera extracted from the roots of Superior Seedless grape yard, *Vitis vinifera* at Qena locality along January, February and March 2022.

4. Discussion

The obtained results from this study revealed the presence of nine genera of PPNs associated with soil rhizosphere of grape trees namely, *Meloidogyne, Tylenchorhynchus, Longidorus, Pratylenchus, Xiphinema, Trichodorus, Tylenchulus, Helicotylenchus* and *Paratylenchus.* While, only three genera of PPNs were reported to be in grape root samples viz., *Meloidogyne, Pratylenchus* and *Tylenchulus.* The highest nematode numbers were recorded with root knot nematode, *Meloidogyne* spp. in soil rhizosphere and grape root samples. These results are in line with the findings of Aballay *et al.* (2009) who indicated that the genera of PPNs associated with grape soil and roots were: *Aphelenchus, Criconema, Criconemella, Criconemoides, Ditylenchus, Dolichodorus, Helicotylenchus, Hoplolaimus, Longidorus, Meloidogyne, Paratylenchus, Pratylenchus, Rotylenchulus, Rotylenchus, Scutellonema, Tylenchorhynchus, Tylenchulus* and *Xiphinema.* Abd-El-Baset *et al.* (2013) conducted a survey to study the population density of phytonematodes associated with grape yards (*Vitis vinifera* L.) in five different locations in Ismailia Governorate viz., Ismailia, El-Tall al Kabir, Abou Swair, El- Qantara Shark, and El – Kassasen, and reported eleven genera of phytonematodes associated with grapevines, namely: *Meloidogyne* spp., *Hoplolaims* spp., *Tylenchorhynchus* spp., *Xiphinema* spp., *Pratylenchus* spp., *Rotylenchulus* spp., *Helicotylenchus* spp., *Trichodorus* spp., *Criconemella* spp., *Tylenchulus semipenetrans* and *Longidorus* spp., where *Meloidogyne* spp. was present in all the studied regions. Furthermore, Mohamed *et al.* (2017) conducted a survey to study the occurrence and population density of PPNs associated with six grape cultivars viz., Bez-Alanza, Flame seedless, King Ruby, Romy Red, Superior and Thomoson Seedless during 2010/2011 season in Giza, Qualiabia and Behaira governorates of Egypt, and added that 10 genera of PPNs were found to be associated with grape cultivars viz., *Criconemoides, Ditylenchus, Helicotylenchus, Hoplolaimus, Meloidogyne, Pratylenchus, Rotylenchulus, Tylenchorhynchus, Tylenchulus* and *Xiphinema*, where, *Meloidogyne* was prevalent nematode in

all cultivars and localities. The same authors revealed that the frequency and population density of each nematode genera were different according to grape cultivars and soil type. In Minia Governorate Hassan *et al.* (2019) extracted phytonematodes associated with grape during 2012/2013 season and identified six genera viz., needle nematode (*Longidorus*), spiral nematode (*Helicotylenchus*), root knot nematode (*Meloidogyne*), lesion nematode (*Pratylenchus*), orange nematode (*T. semipenetrans*) and lance nematode (*Hoplolaimus*) where also, *Meloidogyne* spp., occupied the highest density and occurrence. Recently, Abdel-Baset *et al.* (2022) conducted a survey in Ismailia governorate of Egypt in order to know occurrence, population density and distribution of phytonematodes associated with grape, guava, olive & pomegranate, in addition to green bean, pea, strawberry & tomato. The results showed that ten genera of phytonematodes were identified i.e., *Criconemoides, Helicotylenchus, Longidorus, Meloidogyne, Pratylenchus, Rotylenchulus, Trichodorus, Tylenchorhynchus, Tylenchulus* and *Xiphinema* and added that *Meloidogyne* genus was the most dominant one in grape trees. Sweelam *et al.* (2022) reported that *Meloidogyne*, *Pratylenchus*, *Criconemoides* & *Xiphinema* genera were found to be the highest genera in grape yards. Zoubi *et al.* (2022) indicated that PPNs distributions were correlated with soil physicochemical properties such as soil texture, pH levels, and mineral content. Based on their obtained results, it was concluded that besides the direct effects of the host plant, physicochemical factors of the soil could greatly affect PPNs communities in growing orchards. Jidere *et al.* (2023) identified 10 genera of phytonematodes i.e., *Meloidogyne*, *Hoplolaimus*, *Scutellonema*, *Xiphinema*, *Paratylenchus*, *Rotylenchulus*, *Heterodera*, *Trichodorus*, *Aphelenchoides* & *Longidorus*) in grapevines of Gombe State, Nigeria, and reported that *Meloidogyne* genus had the highest population in all tested varieties. Finally, Adamu *et al.* (2024) reported that the occurrence of PPNs was probably due to the local environmental and soil conditions were more suitable for their growth.

5. Conclusion

This work revealed the incidence of nine genera of PPNs associated with the soil rhizosphere of grape yard viz., *Meloidogyne, Tylenchorhynchus, Longidorus, Pratylenchus, Xiphinema, Trichodorus, Tylenchulus semipenetrans, Helicotylenchus,* and *Paratylenchus* while, three genera of PPNs were identified in grape root samples viz., *Meloidogyne, Pratylenchus* and *Tylenchulus.* It could be concluded that *Meloidogyne* genus was the most abundant one in grape yard, therefore, the control of *Meloidogyne* spp., is essential to prevent the loss of grape yield.

Authors' Contributions

All authors are contributed in this research

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Institutional Review Board Statement

All Institutional Review Board Statements are confirmed and approved.

Data Availability Statement

Data presented in this study are available on fair request from the respective author.

Ethics Approval and Consent to Participate

Not applicable

Consent for Publication

Not applicable.

Conflicts of Interest

The authors disclosed no conflict of interest.

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