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Article

Morphological Characteristics of Phytoparasitic Nematodes Found in Beet Agroecosystems Under The Conditions of Surkhandarya Region

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Abstract: This article examines the taxonomic composition, distribution across localities, and morphological and morphometric characteristics of phytoparasitic nematodes occurring in beet agroecosystems under the conditions of the Surkhandarya Region. The studies were conducted in 2024–2026 in beet agroecosystems at the "Mash'al" farm in Jarkurgan District, the "Abdiyev Shodi" farm in Sherabad District, the "Angor asil mevalari" farm in Angor District, and the Soliobod neighbourhood in Termez District. Samples were collected from plant roots and rhizosphere soil using the "route" and "envelope" sampling methods. During sampling, the upper 10 cm of soil was removed, and the area extending 30 cm vertically and 30 cm horizontally was selected for sampling. The Baermann funnel method was used to extract migratory nematodes, while the root dissection method was used to extract sedentary forms. The classical de Man morphometric method was used to determine the species composition of the extracted samples. The study recorded 21 taxa belonging to the genera Paratylenchus, Meloidogyne, Tylenchorhynchus, Merlinus, Helicotylenchus, Rotylenchus, Pratylenchus, Aglenchus, Ditylenchus, Aphelenchus, and Aphelenchoides. Meloidogyne arenaria, M. incognita, Merlinus dubius, Rotylenchus robustus, Pratylenchus pratensis, Aphelenchus avenae, A. solani, Aphelenchoides subtenuis, and A. zeravschanicus were found in all study localities. The morphometric parameters of the identified species were considered the main criteria for their diagnosis at the species level.

Keywords: Beet, Agroecosystem, Phytonematode, Plant-Parasitic Nematode, Soil Nematodes, Morphology, Morphometry, De Man, Meloidogyne, Surkhandarya

Introduction

Beet is one of the important crops in agriculture and is widely used in the food, livestock, and industrial sectors. Its main types include sugar beet and table beet. Sugar beet is one of the principal raw materials used for sugar production. It yields high amounts of sucrose, while its roots and leaves are considered nutritious feed for livestock. They help improve the quality of animal nutrition. In addition, sugar beet is an important crop in crop-rotation systems and, when cultivated using appropriate agronomic practices, creates favourable conditions for subsequent crops. Sugar processing produces not only sugar but also beet by-products, which are used in feed production and for other

purposes. Table beet is rich in vitamins, minerals, and other beneficial compounds and is consumed as part of the daily diet.[1][2]

Beet (Beta vulgaris L.) is an important agricultural crop that forms a storage root. Its root system and rhizosphere soil may harbour nematodes belonging to various taxonomic groups. In particular, representatives of the genera Meloidogyne, Pratylenchus, Ditylenchus, Helicotylenchus, and Rotylenchus are noteworthy because of their association with plant root systems.[3][4]

This indicates that the nematode community in agroecosystem soils has a complex trophic structure.[5]

Morphological and morphometric characteristics are of considerable diagnostic importance in identifying nematodes at the species level. Traits such as body length and width, stylet length, the structure and length of the oesophagus, tail morphology, vulva position, and body indices are used to distinguish nematode species. In representatives of the genus Meloidogyne, the perineal pattern of the female, as well as the morphology of the head region and stylet, are among the important diagnostic characteristics.[6]

Therefore, studying the nematode composition, determining its distribution across localities, and describing its morphometric characteristics in beet agroecosystems in different districts of the Surkhandarya Region are of considerable scientific and practical importance.[7]

Materials and Methods

The studies were conducted in 2024–2026 in four localities of the Surkhandarya Region. The study material consisted of samples collected from the roots and rhizosphere soil of beet agroecosystems. Samples were collected from beet agroecosystems at the “Mash’al” farm in Jarkurgan District, the “Abdiyev Shodi” farm in Sherabad District, the “Angor asil mevalari” farm in Angor District, and the Soliobod neighbourhood in Termez District. Route and envelope sampling methods were used. The distance between sampling points was 5 metres. Before collecting soil samples, the upper 10 cm layer was removed. Samples were then taken to a depth of 30 cm vertically and along a 30 cm section horizontally.[8][9]

Rhizosphere soil samples were collected from the soil layer immediately adjacent to the beet root system. Plant roots were also collected separately and microscopically examined for nematode infestation.[10]

The Baermann funnel method was used to extract nematodes from soil samples. This method makes it possible to separate motile nematodes from the soil into a water medium. The dissection method was used to identify nematodes associated with roots and plant tissues.

The extracted nematodes were examined under a microscope after the preparation of temporary and permanent slides. Their body shape, cuticle structure, head region, stylet apparatus, oesophagus, tail, and reproductive-system morphology were taken into account.[11]

The de Man morphometric indices were used for identification at the species level. The parameters considered included body length (L), body width, oesophageal length, tail length, the a, b, c, and V indices, and stylet length in certain groups. [2]

For taxonomic grouping, the phytogelminthological systematic approach developed by the Russian plant nematologist A.A. Paramonov was used. [3][4]

Results

Among the nematodes identified during the study, the following results were obtained for selected species for which the most complete morphometric measurements were available.[12]

Meloidogyne arenaria was one of the root-parasitic nematodes found in all study localities. Morphometric examination of female specimens showed that body length was 0.061 ± 0.01 mm, body width was 0.06 ± 0.01 mm, and oesophageal length was 0.08 ± 0.03 mm.

Table 1. Distribution of nematodes identified in beet agroecosystems across localities

No.	Nematode species	Jarkurgan	Sherabad	Angor	Termez District
1	*Paratylenchus macrophallus*	+	–	–	+
2	*Meloidogyne arenaria*	+	+	+	+
3	*M. incognita*	+	+	+	+
4	*M. javanica*	+	+	+	–
5	*Tylenchorhynchus capitatus*	–	–	+	+
6	*Merlinus dubius*	+	+	+	+
7	*Helicotylenchus multicinctus*	+	+	–	+
8	*Rotylenchus robustus*	+	+	+	+
9	*Pratylenchus pratensis*	+	+	+	+
10	*Aglenchus agricola*	+	+	+	+
11	*Ditylenchus destructor*	+	+	+	+
12	*D. dipsaci*	+	+	–	+
13	*D. intermedius*	+	+	+	–
14	*Aphelenchus avenae*	+	+	+	+
15	*A. cylindricudatus*	–	+	+	+
16	*A. solani*	+	+	+	+
17	*Aphelenchoides cyrtus*	+	+	+	+
18	*A. helophilus*	+	–	+	+
19	*A. parietinus*	+	+	+	–
20	*A. subtenuis*	+	+	+	+
21	*A. zeravschanicus*	+	+	+	+

Note: + – detected; – – not recorded in the study material

M. incognita was recorded in all study localities. The morphometric parameters of second-stage juveniles were as follows: body length 322–353 μm, a = 28–32, b = 3.7, c = 8.4–11.5, stylet length 10–13.0 μm, and tail length 40–58 μm.

These parameters were used for the morphometric description of second-stage juveniles of M. incognita.

Paratylenchus macrophallus was recorded in Jarkurgan and Termez districts. In females, body length was 0.2–0.3 mm, a = 17–24.2, b = 4.8–7.1, c = 10.7–11.9, and V = 80–83%. In males, body length was 0.2–0.3 mm, with a = 22–23.3, b = 3.7–3.9, and c = 11.6–12.9.

These morphometric characteristics indicate that the species belongs to a group of parasitic nematodes with a small body size.

Helicotylenchus multicinctus was found in Jarkurgan, Sherabad, and Termez districts. In females, body length was 0.5–0.6 mm, a = 24.4–26.0, b = 4.7–6.0, c = 48.5–53.4, and V = 65–71%. In males, body length was 0.4–0.6 mm, a = 27.5–31.2, b = 3.9–4.6, and c = 28.4–28.7.

Ditylenchus intermedius was identified in Jarkurgan, Sherabad, and Angor districts. According to the morphometric parameters of females, body length was 0.7–0.9 mm, a = 36.9–64.5, b = 4.5–6.5, c = 9.4–12.1, and V = 78–81%. These parameters are of diagnostic importance for assessing the body proportions and the position of the reproductive system in this species.

D. dipsaci was recorded in Jarkurgan, Sherabad, and Termez localities. In females, body length was 1.1–1.2 mm, a = 44.9–46.1, b = 8.8–9.2, c = 12.8–14.0, and V = 79–80%. In males, body length was 0.9–1.1 mm, with a = 36.7–44.0, b = 6.0–6.2, and c = 11.9–14.9.

The available morphometric data for D. destructor indicated a body length of 801.7–1009.5 μm, a = 25.4–36.5, b = 6.2–7.0, c = 10.4–15.0, V = 77.2–80.0%, and stylet length of 8.7–12.5 μm.

For Aglenchus agricola, body length was recorded as 625–667 μm, a = 26.4–34.4, b = 6.3–6.9, V = 53–56%, tail length approximately 114–126 μm, and stylet length 10–13 μm.

Aphelenchus avenae was recorded in all study localities. In females, body length was 0.7–0.9 mm, a = 26.5–33.0, b = 8.6–9.0, c = 26.9–31.5, and V = 72–76%. In males, body length was 0.7–0.8 mm, with a = 28.9–29.1, b = 5.6–5.9, and c = 26.5–27.0.

A. solani was identified in all four study localities. In females, body length was 0.7–0.8 mm, a = 48.4–48.5, b = 8.7–8.8, c = 31.4–31.5, V = 76–77%, and stylet length was 20 μm.

Aphelenchoides helophilus was recorded in Jarkurgan, Angor, and Termez districts. In females, body length was 0.62–0.91 mm, a = 41.3–56.9, b = 12.8–13.1, c = 16.3–18.5, and V = 70.1–73.9%. In males, body length was 5.8–8.5 mm, with a = 46.7–49.8, b = 8.7–10.1, and c = 15.8–17.5.

Aphelenchoides parietinus was recorded in Jarkurgan, Sherabad, and Angor localities. In females, body length was 0.5–0.7 mm, a = 22.6–36.0, b = 7.7–9.4, c = 14.3–18.5, and V = 68–69%. In males, body length was 0.5–0.8 mm, with a = 24–26, b = 8.4–9.5, and c = 12.9–15.1.

Grouping the identified nematodes according to the number of localities in which they occurred made it possible to assess their geographical distribution.

Species recorded in all four localities: Meloidogyne arenaria, M. hapla, Merlinus dubius, Rotylenchus robustus, Pratylenchus pratensis, Aphelenchus avenae, A. solani, Aphelenchoides subtenuis, A. zeravschanicus, A. cyrtus, Aglenchus agricola, and Ditylenchus destructor.[13]

Species recorded in three localities: Meloidogyne javanica, Helicotylenchus multicinctus, Ditylenchus dipsaci, D. intermedius, Aphelenchus cylindricudatus, Aphelenchoides helophilus, and A. parietinus.[14]

Species recorded in two localities: Paratylenchus macrophallus and Tylenchorhynchus capitatus.

The study results showed that the nematode community in beet agroecosystems of the Surkhandarya Region is taxonomically and ecologically diverse. The occurrence of the 21 identified taxa in different localities indicates that various ecological conditions for nematodes exist in the soils of beet agroecosystems.[15]

Three species of the genus Meloidogyne were identified in the study: M. arenaria, M. incognita, and M. javanica.

The occurrence of M. arenaria in all study localities indicates that this species is widely distributed in beet agroecosystems of the Surkhandarya Region. However, since its population density was not determined, no definitive conclusion can be drawn that this species is "dominant."

The occurrence of M. incognita in all four localities is also noteworthy. Morphometric characteristics of its second-stage juveniles, such as body length, stylet length, and tail length, were used for species diagnosis.

The recording of Pratylenchus pratensis, Helicotylenchus multicinctus, Rotylenchus robustus, and representatives of the genus Ditylenchus in our study indicates the presence of a nematode complex associated with the roots and rhizosphere environment in beet agroecosystems.

Furthermore, the abundance of representatives of the genera Aphelenchus and Aphelenchoides indicates that the nematode community does not consist solely of the classical root-parasitic forms.

Analysis of the morphometric data showed that body length, body width, the a, b, c, and V indices, and stylet length are important parameters for species diagnosis. For example, the short stylet

and long tail of Aglenchus agricola are important features in the morphological diagnosis of this species.

At the same time, morphometric characteristics may show a certain degree of variation at both population and individual levels. Therefore, final identification should be based on a combination of morphological characteristics rather than on a single measurement.

Discussion

The studies revealed a diverse nematode fauna in samples collected from various beet agroecosystems in the Surkhandarya Region. Based on morphological and morphometric characteristics, 21 species belonging to the genera Paratylenchus, Meloidogyne, Tylenchorhynchus, Merlinus, Helicotylenchus, Rotylenchus, Pratylenchus, Aglenchus, Ditylenchus, Aphelenchus, and Aphelenchoides were recorded. The distribution of the identified species across localities was found to be uneven. Some species occurred in all study localities, whereas others were recorded in only two or three localities.

The data presented above show that Meloidogyne arenaria, M. incognita, Merlinus dubius, Rotylenchus robustus, Pratylenchus pratensis, Aglenchus agricola, Ditylenchus destructor, Aphelenchus avenae, A. solani, Aphelenchoides cyrtus, A. subtenuis, and A. zeravschanicus occurred in all four study localities.

These species can be considered the most widely distributed taxa within the areas covered by the study. However, concluding that they are "dominant species" requires calculating their population density and relative abundance (the research is ongoing).

Conclusion

As a result of nematological studies conducted in 2024–2026 in beet agroecosystems in Jarkurgan, Sherabad, Angor, and Termez districts of the Surkhandarya Region, 21 nematode taxa belonging to 11 genera were recorded.

The identified taxa belong to the genera Paratylenchus, Meloidogyne, Tylenchorhynchus, Merlinus, Helicotylenchus, Rotylenchus, Pratylenchus, Aglenchus, Ditylenchus, Aphelenchus, and Aphelenchoides.

The results provide a scientific basis for assessing the diversity of phytoparasitic nematodes in beet agroecosystems of the Surkhandarya Region, determining their geographical distribution, and organising subsequent phytosanitary monitoring. Our research is ongoing, and the results will be presented in our subsequent publications.

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