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Distribution of *Meloidogyne* spp. (Nematoda: Meloidogynidae) in potato fields of Ganja-Gazakh economic region, Azerbaijan

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Abstract. Nematodes belonging to the genus *Meloidogyne spp.* infest potato causing substantial economic harm. A weakened root system and stunted growth caused by nematodes significantly reduce both yield and product quality. Within the Ganja-Gazakh economic region, Azerbaijan, approximately 25–50% of vegetable crops, particularly potato, become infected with nematodes from this genus each year leading to significant crop losses. As part of a phytopathological survey program implemented in the Ganja-Gazakh economic region, samples exhibiting characteristic signs of nematode infestation were systematically gathered from potato. Among 21 especially harmful species, four species (*M. incognita, M. javanica, M. chitwoodi, M. arenaria)* were found to be particularly detrimental to crop production and were identified in agrocenoses. *M. incognita*, specifically, showed the highest prevalence (81.8% and 80.0%) in the roots of potato seedlings, later extending to young tubers in the Tovuz and Gadabay regions. Conversely, *M. arenaria* exhibited the lowest prevalence (26.6% and 12.3%) in the Agstafa and Gadabay regions. Through morphological methods, the nematodes found in potato plants were for the first time identified in the Ganja-Gazakh economic region. Moreover, the distribution of nematodes in the reported areas and factors contributing to their spread were determined.

Keywords: potato, nematode, soil, meloidogynosis, morphology

Распространение *Meloidogyne* spp. (Nematoda: Meloidogynidae) на картофельных полях Гянджа-Газахского экономического района, Азербайджан

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Аннотация. Нематоды, принадлежащие к роду *Meloidogyne* spp. заражают растения картофеля, нанося значительный экономический ущерб. Ослабленная корневая система и замедленный рост, вызванные этими нематодами, значительно снижают как урожайность, так и качество продукции. В пределах Гянджа-Газахского экономического района примерно 25–50% овощных культур, особенно картофеля, ежегодно заражаются нематодами этого рода, что приводит к значительным потерям урожая. В рамках программы фитопатологического обследования, реализуемой в Гянджа-Газахском экономическом районе, с растений картофеля систематически собирали образцы, имеющие характерные признаки нематодной инвазии. Из двадцати одного наиболее распространённых видов этой группы четыре вида (*M. incognita, M. javanica, M. chitwoodi, M. arenaria*) были особенно вредны для растениеводства и были выявлены в агроценозах. Вид *M. incognita*, в частности, показал наибольшую распространенность (81,8% и 80,0%) в корнях проростков картофеля, позднее распространившись на молодые клубни в Товузском и Гедабейском районах. Наоборот, вид *M. arenaria* показал наименьшую распространенность (26,6% и 12,3%) в Агстафинском и Гедабейском районах. Морфологическими методами нематоды, обнаруженные в растениях картофеля, были впервые идентифицированы в Гянджа-Газахском экономическом районе. Кроме того, установлено распространение этих нематод в указанных районах и факторы, способствующие их распространению.

Ключевые слова: картофель, нематода, почва, мелоидогиноз, морфология

Introduction

The potato plant (*Solanum tuberosum* L.) cultivated in Azerbaijan has strategic importance and occupies a special place among agricultural plants. As potato is a plant cultivated between rows, the soil becomes weedless and soft after harvesting the crop. Therefore, it is considered a good predecessor for cereal grains, grain legumes, and technical plants. The practice of alternating the cultivation of potato plants with different crops in a planting field is influenced by various factors, such as soil composition, climatic conditions, farming objectives, and field structure (Atakishiyeva, Salmanov 1993).

The nematodes that damage potato most are cysts and root-knot nematodes. The root-knot nematodes of the genus *Meloidogyne spp.* (*Nematoda: Meloidogynidae*) have economic importance around the world and are the most common group of nematodes. The root-knot nematodes are sedentary endoparasites. It is one of the widespread and most pathogenic groups of plant nematodes that parasitize the roots of cultivated and wild plants in the open and protected ground and significantly reduce the productivity of potato. Nematodes feed on vascular tissue of many vegetable crops. Plant contamination with nematodes causes poor yields. The typical syndrome (symptom) of infection is the so-called 'thick root view'. When you look at a potato tuber infected with a nematode, small black spots are clearly visible on the peel.

There are 100 nominal species of root-knot nematodes described so far and over 5,500 plant hosts including vegetables, forage and fodder crops, grain legumes, fruit, technical, ornamental, and woody plants (Rusinque et al. 2022). The *Meloidogyne incognita* species which forms large and small swellings in plant roots is one of the most harmful root-knot nematodes of potato (Khan, Ahmad 2000; Adam et al. 2007). Root-knot nematodes are predominantly prevalent in countries with tropical and subtropical climates, while their occurrence in semi-desert and temperate latitudes is comparatively less common. The most dangerous and difficult to eradicate are root-knot nematodes in protected ground conditions, where they cause great damage to vegetables and many ornamental plants. The nematodes not only weaken the plants due to a decrease in cell sap minerals, but also contribute to the development of viral, fungal, and bacterial diseases. The control of meloidogynosis requires high costs, knowledge, and practical experience. The nematodes belonging to this genus are endoparasites whose lifecycle is almost completely linked to inside the mother plant.

Materials and methods

In the Ganja-Gazakh economic region, Azerbaijan, specifically in the mountainous and foothill zone encompassing Samukh, Shamkir, Gadabay, Dashkasan, Tovuz, Gazakh, and Aghstafa, a comprehensive investigation was conducted during the production season. A total of 156 samples comprising underground parts of potato roots and stems were collected for the purpose of detecting *Meloidogyne spp.* To accomplish this, the Berman method was employed. It involved utilizing a glass funnel equipped with a rubber tube measuring 10–15 cm in length. An iron mesh, with 0.25–0.5 mm holes, was placed halfway within the funnel fixed to a special tripod. Subsequently, the funnel was filled with water heated to 38°C, and a portion of the soil or root sample was placed onto the mesh. Following 1–2 hour sedimentation, the resulting sediment was filtered from the centrifuge into a test glass. Subsequently, nematodes were identified within the sediment using microscopy techniques, as outlined by Hartman and Sasser (Hartman, Sasser 1985). Furthermore, permanent preparations of male individuals belonging to the genus were created following the technique described by Hartman and Sasser (Atakishiyeva 2003). The preparations were examined under a Leica DM 1000 light-optical microscope with a x20 objective and photographed with a Leica DFG 425 digital camera. Morphological identification of root-knot nematodes was performed using

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traidional methods. To facilitate this, preparations for both larvae and males belonging to the genus *Meloidogyne spp.* were prepared. The larvae were obtained from the infected root section of potato plants and subjected to a water bath at 65°C for 2 minutes. Following this, the larvae were fixed in a solution comprising 7 ml of formalin (40% formaldehyde), 2 ml of triethanolamine, and 91 ml of distilled water (Hooper 1986). After fixation, a portion of the solution was stored in a mixture of 1 part glycerin and 79 parts distilled water at 35–40°C for 12 hours, while another portion was stored in a combination of 5 parts glycerin and 95 parts (96%) ethanol at 40°C for 3 hours. Subsequently, the nematodes were immersed in glycerin to finalize the preparations for genus determination (Perry, Moens 2006).

Results and discussion

The distribution patterns of nematodes that damage the potato plant in Azerbaijan, especially in the Ganja-Gazakh economic region, and factors influencing their distribution have not been studied. Therefore, the detection of potato nematodes in the Ganja-Gazakh economic region is relevant for these areas. This study is novel and has a practical value.

For the purpose of the study, we collected materials from the regions of Azerbaijan. Nematodes belonging to the genus *Meloidogyne* were detected in potato and classified according to their morphological indicators. Morphometric characteristics of female and male *Meloidogyne* nematodes play a decisive role in their identification and classification (Fig. 1).

Understanding the morphological characteristics of nematodes under study is essential for effective management strategies and research purposes. Female *Meloidogyne* nematodes have distinct vulval structures. The vulva, located on the ventral side of the body, consists of a vulval slit surrounded by labia. Additionally, the vulva has a muscular sphincter to control the release of eggs into the host plant root tissue. Measurements of the body length, stylet length, neck length, vulval length, and tail length are important parameters for characterizing female nematodes. Male *Meloidogyne* nematodes, on the other hand, possess a cloaca instead of a vulva. The cloaca functions as a reproductive and excretory opening. Morphometric measurements for male nematodes include body length, spicule (modified stylet) length, tail length, and cloacal length. Accurate mea-

Fig. 1. Nematodes of the genus *Meloidogyne spp* (A — female, B — male), magnification x20
Рис. 1. Нематоды рода *Meloidogyne spp* (A — самка, B — самец) (при увеличение x20)

Table 1

Some allometric criteria with the measurement values of the second stage larvae and their females belonging to the populations of *Meloidogyne spp.*

Таблица 1

Некоторые аллометрические критерии со значениями измерения личинок второго периода и самок, принадлежащих к популяциям *Meloidogyne spp.*

Body sizes	The second stage larva (nm)		Female (nm)	
	Research results	Erica&Venetta (2004)	Research results	Erica&Venetta (2004)
N	10	10–20	10	8–10
The length of the body (L)	355.96 ± 8.02 (344–369.6)	301–370	355.96 ± 6.02 (344–362.6)	650–760
The width of the largest part of the body	15.04 ± 0.82 (14.4–16.8)	10–16	385.96 ± 7.24 (344–392.3)	340–460
The body width in the secretory duct	13.84 ± 0.53 (12.8–14.4)	–	–	–
The length of the stylet	14.16 ± 0.65 (14–15.6)	14–16	12.90 ± 0.25 (11.5–14.6)	12–16
The length of the tail (L)	27.36 ± 1.49 (24–28.8)	18–26	–	–
The length of terminal tail (L)	6.72 ± 1.01 (4.8–8.0)	–	–	–

surement and analysis of these morphometric properties are crucial for differentiating *Meloidogyne spp.* and understanding their biology. However, it is important to note that specific measurements and morphological characteristics may vary across different species and populations within a species.

The analysis of the second stage larvae of the root-knot nematodes, characteristics of their females and some allometric criteria revealed that all the samples belonged to the genus *Meloidogyne spp.* (Table 1).

The research identified four types of nematodes belonging to the genus *Meloidgyne* in potato. It also provided insights into *Meloidgyne* nematodes distribution patterns, their extensiveness and intensity (Table 2).

As seen from the table, *M. incognita* is widespread in potato cultivated in the Gadabay district with 80.0% extensiveness. The other regions returned the following resutls: 65.0% in Dashkasan, 56.0% in Samukh, 81.8% in Tovuz, 63.1% in Aghstafa, and 65.0% in Goy-Gol.

M. javanica was found in potato cultivated in the Gadabay district with 30.0% extensiveness (40.0% in Dashkasan, 40.0% in Samukh, 59.0% in Tovuz, 36.8% in Aghstafa, 50.0% in Goy-Gol).

M. chitwoodi was detected in potato cultivated in the Gadabay district with 70.0% extensiveness (45.0% in Dashkasan, 68.0% in Samukh, 72.7% in Tovuz, 47.3% in Aghstafa, 55.0% in Goy-Gol).

M. arenaria was found in potato cultivated in the Gadabay district with 26.6% extensiveness (27.5% in Dashkasan, 28.0% in Samukh, 40.9% in Tovuz, 26.3% in Aghstafa, 40.0% in Goy-Gol).

From the above, it can be seen that Gadabay and Tovuz districts are marked for the spread of four nematode species, while Samukh and Goy-Gol districts are unfavorable only for the species *M. chitwoodi* and *M. arenaria*.

Thus, when studying the samples collected from the districts of the Ganja-Gazakh economic region, *M. incognita* belonging to the genus *Meloidogyne spp* was detected with

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Table 2

Nematodes found in potato (*Solonum tuberosum L.*) in the Ganja-Gazakh economic region

Таблица 2

Нематоды, обнаруженные в картофеле (*Solonum tuberosum* L.) в Гянджа-Газахском экономическом районе

Nematodes / Region	*M. incognita*	*M. javanica*	*M. chitwoodi*	*M. arenaria*
Gadabay	30–24 (80.0%)	30–9 (30.0%)	30–21 (70.0%)	30–8 (26.6%)
Dashkasan	40–26 (65.0%)	40–16 (40.0%)	40–18 (45.0%)	40–11 (27.5%)
Samukh	25–14 (56.0%)	25–10 (40.0%)	25–17 (68.5%)	25–7 (28.0%)
Tovuz	22–18 (81.8%)	22–13 (59.0%)	22–16 (72.7%)	22–9 (40.9%)
Aghstafa	19–12 (63.1%)	19–7 (36.8%)	19–9 (47.3%)	19–5 (26.3%)
Goy-Gol	20–13 (65.0%)	20–10 (50.0%)	20–11 (55.0%)	20–8 (40.0%)

the highest extensiveness in Tovuz and Gadabay districts (81.8% and 80.0%, respectively), while *M. arenaria* was detected with the lowest extensiveness in Aghstafa and Gadabay districts (26.6% and 26.3%, respectively). The main reason for this is that the areas in question offer optimal conditions for the development and widespread distribution of *M. incognita* (favorable climate, soil moisture, cultivation methods, irrigation, etc.).

The limited spread of *M. arenaria* in several areas is also due to the local conditions.

Thus, for the first time, we have identified nematodes found in potato in the Ganja-Gazakh economic region using morphological methods. We have also gained insights into the distribution patterns of nematodes in these areas and the causes of their spread.

The reported study is of practical value and is crucial in the development of preventive measures to curb the spread of *Meloidogyne* nematodes in potato (*Solanum tuberosum L.)* grown in the Ganja-Gazakh economic region of Azerbaijan.

References

Adam, M. A. M., Phillips, M. S., Blok, V. C. (2007) Molecular diagnostic key for identification of single juveniles of seven common and economically important species of root-knot nematode *(Meloidogyne* spp.*). Plant Pathology*, vol. 56, no. 1, pp. 190–197. https://doi.org/10.1111/j.1365-3059.2006.01455.x (In English).

Atakishiyeva, Y. Y. (2003) The nematodes of the potato plant in the Gadabay region and the measures to combat with them. In: *Materials of the I Congress of the Azerbaijan Society of Zoologists*. Baku: [s. n.], pp. 43–46. (In Azerbaijani).

Atakishiyeva, Y. Y. (2008) The nematode fauna of the vegetable and garden plants in the oil-contaminated soil. In: *Proceedings of the Azerbaijan Society of Zoologists. Vol. I*. Baku: Elm Publ. (In Azerbaijani).

Atakishiyeva, Y. Y., Salmanov, A. A. (1993) About the nematode fauna of the vegetable plants in the Guba-Khachmaz regions of Azerbaijan. *News of the National Academy of Sciences of Azerbaijan*, no. 3, pp. 99–105. (In Azerbaijani).

Hartman, K. M., Sasser, J. N. (1985) Identification of *Meloidogyne* species on the basis of differantial host test and perineal pattern morphology. In: K. R. Barker, C. C. Carter, S. Sasser (eds.). *An advanced treatise on Meloidogyne. Vol. II. Methodology.* Raleigh: North Carolina State University Publ., pp. 69–77. (In English).

Hooper, D. J. (1986) Extraction of free living stages from soil. In: J. F. Southey (ed.). *Labarotory methods for work with plant and soil Nematodes*. London: Her Majesty's Stationery Office Publ., pp. 5–30 (In English).

Kazachenko, I. P., Mukhina, T. I. (2013) Gallovye nematody roda Meloidogyne Goeldi. Tylenchida: Meloidogynidae mirovoj fauny [Root-knot nematodes of the genus Meloidogyne Goeldi. Tylenchida: Meloidogynidae of the world fauna]. Vladivostok: Dal'nauka Publ., 306 p. (In Russian)

Kazachenko, I. P., Volkova, T. V., Mukhina, T. I. (2012) Gallovye nematody roda Meloidogyne na Dal'nem Vostoke Rossii [Root-knot nematodes of the genus *Meloidogyne* in the Far East of Russia]. *Rossijskij parazitologicheskij zhurnal — Russian Journal of Parasitology*, no. 2., pp. 111–116. (In Russian)

Khan, H., Ahmad, R. (2000) Geographical distribution and frequency of occurrence of root-knot nematodes in Punjab–Pakistan. *International Journal of Agriculture and Biology*, vol. 2, pp. 354–355. (In English).

Roland, N. P., Maurice, M. (2006) *Plant Nematology.* Cambridge: CABI Publ., 447 p. (In English)

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