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NEMATODES FOUND IN AGRICULTURAL CROPS GROWN IN THE FOOTHILL AREAS OF THE TASHKENT OASIS

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Abstract
This article provides information on the nematode fauna found in the agricultural crops in the foothills. The specificity of the nematode fauna in tomato, carrot and sunflower crops is substantiated. It was determined that the diversity of cultivated crops affects the taxonomic composition and quantitative density of nematodes. The highest rate of biodiversity was observed in 48 species (528 ind.) in the roots and rhizosphere of long-term-planted-tomatoes, the soil of which is fine loamy in terms of their mechanical composition. In the fields with crop rotation, the number of nematodes was slightly lower, ie 45 species (499 ind.) in tomatoes planted after wheat, 39 species (479 ind.) in carrots, 33 species (357 ind.) in sunflowers grown in medium loamy soils and 28 species (247 ind.) in sunflowers cultivated in coarse loamy soils. The occurrence of nematode fauna in the agricultural crops is explained by the application of agro-technical measures to crops, the cultivation of the same crops in the long run, soil properties and other reasons. The distribution characteristics of nematodes in the soil of roots and the rhisophera, as well as their trophic relationship with plants were revealed. Moreover, dominant species of nematodes found in crops have also been identified. True parasitic nematode species, such as, Bitylenchus dubius, Merlinius bogdanovi-katjkovi, Helicotylenchus multicinctus, H. buxophilus, H. nannus, Pratylenchus pratensis, Ditylenchus dipsasi, Meloidogyne hapla have been identified in foothills.

Keywords: phytonematoda, fauna, ecological group, foothill, tomato, carrot, sunflower, root, soil, spread, parasites, dominant.

Introduction

The protection of cultivated plants from various pests and diseases, the identification of organisms, damaging them and the development of control measures are considered the most topical issues in the world today. For this reason, expanding arable fields by developing lands in mountainous and foothill areas along with irrigated agricultural areas, as well as, determining the adaptation characteristics of the pests, especially parasitic phytonematoids, to the new environment are of great importance.

Nowadays, the nematode fauna are a widespread, biologically progressive group in nature, and more than 24,000 nematode species are known in the world (Gruzdeva et al., 2008). Nematodes include free-living, freshwater, marine, and terrestrial species, some species being bacteriophages, mycophages, and predators. Most species are parasitic on plants and animals. Phytohelminths that are parasitic nematodes encountered on plants, infect all types of cultivated plants and can cause their mass extinction, reducing the yield of agricultural crops by 60-80%. Nematodes damage plant tissues and allow phytopathogenic microorganisms to enter the plant. Together, they form pathogenic complexes and cause great damage to agriculture. Plant damage and crop loss by parasitic nematodes range from 25% to 70% in different countries. Representatives of 20 phytonematoid generations have been identified as true plant parasites, which cause problems in agriculture. The damage caused by parasitic nematodes to agricultural crops is estimated at about 100 billion per year (Galagan, Belyavskaya, 2017). Accordingly, the identification of the nematode fauna in agricultural crops and the assessment of their ecological and taxonomic composition are of great scientific and practical importance.

The aim of the research is to enclose the composition of the nematode fauna found in agricultural crops in the foothills of the Tashkent oasis, to reveal their distributional characteristics in the soil of roots and rhizosphere, as well as their trophic relationships with plants.

Materials and Methods

Tashkent region in the Republic of Uzbekistan consists of the Chirchik-Akhangaran physical and geographical complex, located between the Syrdarya River (middle reaches of the river) and the Western Tien Shan valleys. The area's relief is very complex, its south-western part is surrounded by plains, the north-eastern and eastern part by mountains. Mountains and mountain slopes occupy more than 80% of the area (Kuziev, 2009). The area's climate is peculiar, especially in the plains, where summer is very hot and lasts a long time. In the plains, the average temperature in July is 26, 27^{0}C, while in the mountainous areas the average temperature is 20, 24^{0}C. In summer, the maximum temperature can reach 42-44^{0}C. Winter is very cold, with the average temperature in January is -1-3^{0}C. Precipitation is not always in the same standard. In the north-eastern part, an increase in precipitation is observed near the mountains. Thus, the annual precipitation is 300 mm in

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the northern Syrdarya, 367 mm in Tashkent, and 700-800 mm in the north-eastern part of the Pskem Valley.

In this region, the conditions and types of soil are diverse from the south-western plains to the north-eastern mountains. The valley soils around the Chirchik and Akhangaran rivers and the riverbed of the Syrdarya are mainly composed of gray soil. As it rises, the composition of the soil changes. At an altitude of 300-400 m above sea level, the soil consists of fine gray soils, and around the riverbed there are swamp-meadow soils. The swamps on the slightly sloping plains consist of saline soils on the ground. On the northeastern slopes and mountain peaks at altitudes of 1000–1400 m above sea level, there are dark-gray soils and brown-gray soils, as well as brown and gray-forest soils at altitudes of 2,000–2,500 m. High rocky forest areas consists of light gray soils (Kuziev, 2009).

The region is divided into two subregions, in terms of several specific features: the first subregion includes Bostanlyk, Parkent, Akhangaran districts, mainly involve the mountain and foothill zone, the soils of which consist of dark and hilly-gray soils. The second subregion is an oasis (plain), including Kibray, Tashkent, Zangiota (Eshonguzar), Yangiyul, Akkurgan, Yukorichirchik, Urtachirchik, Quyichirchik, Chinoz, Pskent, the soils of which are hill-gray soils, and to the north, Buka and Bekabad districts, which consist of old irrigated, hilly, desert and gray soils.

The materials of the research were collected in 2011-2020 from the main agricultural crops of “Karakalpak” farm in the Parkent district, “Khojayli” farm in the Bostanlyk district and “Ozod” farm in the Akhangaran district, which are located in the foothills of Tashkent region.

The generally accepted route method was used in the faunistic research (Kiryanova, Krall, 1969, 1971). Plant and soil samples were obtained from the root and rhizosphere of the following plants, such as, tomatoes (Lycopersicum esculentum Mill.) and carrots (Daucus vulgaris L.) were collected from the Parkent district; tomatoes (Lycopersicum esculentum) and sunflowers (Helianthus annua L.) were collected from the Bostanlyk district and sunflowers (Helianthus annua L.) from the Akhangaran district. Collection of plant roots and soil samples was carried out in August-October at the time of harvest. During the sample collection, main attention was paid to soils with different mechanical composition: pre-planted tomatoes; carrots and tomatoes, planted after wheat in fine loamy soils; sunflowers planted in medium loamy soils and sunflowers planted in coarse loamy soils were chosen. Plant and soil samples were taken from a 0–20 cm layer of soil of the root and rhizosphere of each plant five times. 100 samples were taken from each plant (50 from the root, 50 from the rhizosphere), a total of 500 samples were obtained.

While extracting nematodes from plant roots and soil, laboratory-modified Berman funnel and soil washing methods were used (Kiryanova, Krall, 1971; Metlitsky, 1976; Mavlonov, 1993). During the research, the number of nematodes in 100 g soil was taken into account.

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In order to identify the nematode species, 1724 permanent (glycerin-gelatinous) and temporary drugs were prepared. The nematode species were identified under the MBI-3 microscope. Morphometric indicators (L-the total length of the body of the nematode; a-the widest part of the body; b-the length of the esophagus; c-the length of the tail and V-the position of the vulva in the body) in the generally accepted de Man formula, modified by G.Micoletzky (1922), were used to identify species. In identifying the species composition of nematodes, the researches by A. A. Paramonov (1962, 1964), A. T. Tulaganov, A.Z. Usmanova (1975, 1978), E.S. Kiryanova, E.L. Krall (1969, 1971) and others were used.

The dominance degree of nematodes in soil and plant samples was determined as a percentage of the number of individual species represented by all encountered species. Species greater than 10% of all identified representatives being eudominant (most common species) species; 5 -10% dominants (common species); 2-5% subdominants (moderately rare species), 1-2% recendents (rare species); less than 1% are subrecendents (the rarest species) (Witkowsky, 1967). Comparison of the nematode communities found in agrocenoses and assessment of their similarity was calculated using the S'erensen-Chekanovsky (Mirchik, 1988) coefficient.

Results and discussions

As a result of the conducted research, 66 species of nematodes belonging to 2 subclasses, 7 order, 23 families, 39 genera were identified in agricultural crops. By orders, Rhabditida accounted for 33% of all identified nematode species, consisting of 22 species. Tylenchida order had 17 species (26%), Aphelenchida order had 12 species (18%), and Dorylaimida order had 8 species (12%). The remaining orders are rare, Mononchida order consists of 4 species (6%), Plectida order - 2 species (3%), and Enoplida order - 1 species (2%). The most numerous of nematode representatives are Rhabditida order (1046 ind., 49.6%), followed by Aphelenchida order (420 ind., 19.9%), followed by Tylenchida order (297 ind. 14.1%) and Dorylaimida order (282 ind., 13.4%). The number of nematodes belonging to the orders Mononchida (38 ind., 1.8%), Plectida (23 ind., 1.1%), Enoplida (4 ind., 0.2%) is slightly lower, and in some cases is recorded in one copy. (Table 1).

Table 1 Distribution of the number of nematodes and the number of individuals in agricultural crops in the foothills by category

№	Categories	Number of species	Percent (%)	Number of individuals	Percent (%)
1	Plectida	2	3	23	1,1
2	Enoplida	1	2	4	0,2
3	Mononchida	4	6	38	1,8
4	Dorylaimida	8	12	282	13,4
5	Rhabditida	22	33	1046	49,6
6	Aphelenchida	12	18	420	19,9
7	Tylenchida	17	26	297	14,1
Total		66	100	2110	100

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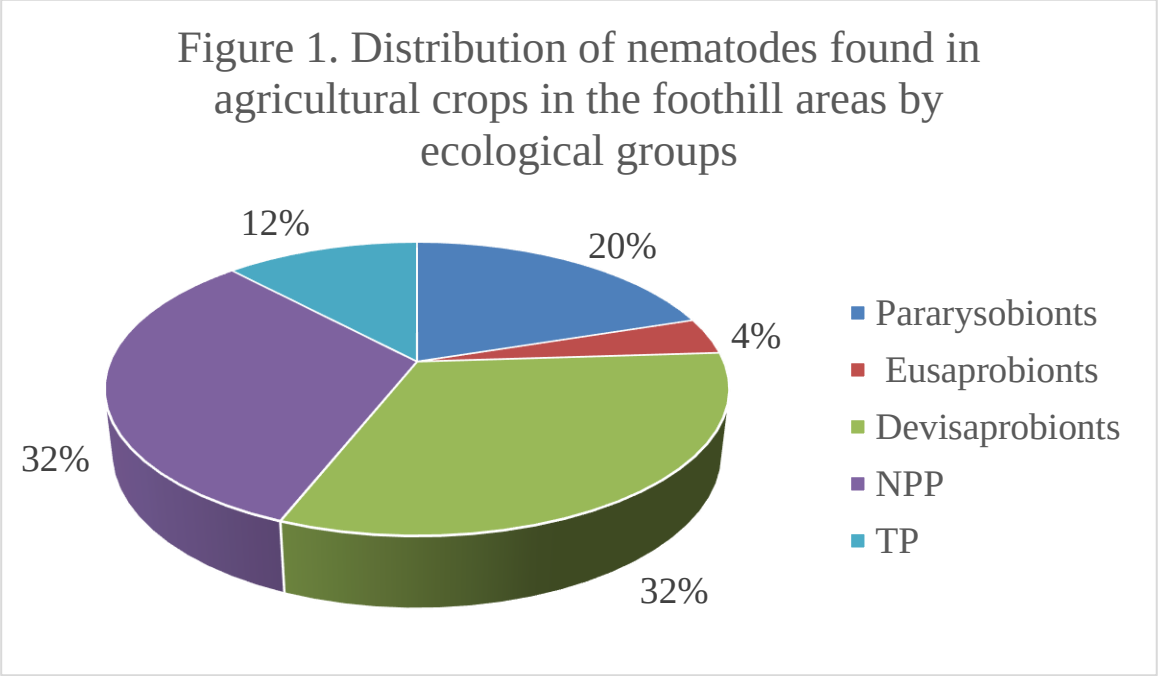
During the research, for presenting the differences among nematode communities in local soils, the species were categorized into ecological-trophic groups according to the classification of A.A. Paramonov (1962). The identified phytonematoids were divided into ecological groups as follows: pararysobionts – 324 individuals, belonging to 13 species (20.0% of all determined nematodes), eusaprobionts – 352 individuals, belonging to 3 species (4.0%), devisaprobionts – 717 individuals, belonging to 21 species (32.0%), non-pathogenic phytohelminths (NPP) – 520 individuals, belonging to 21 species (32.0%), true parasites (TP) – 197 individuals, belonging to 8 species (12.0%) (Figure 1).

To study the composition of pre-monocultural agrocenoses in nematode communities gave a chance to determine the impact of agricultural cultivation on free-living and plant parasitic nematodes, to comparatively analyze nematode species in agrocenosis communities (by the periods of arable lands), to identify specific aspects of agrocenoses and the importance of agro-technical measures.



In our study, the composition of nematode species and the number of individuals in agricultural crops were analyzed according to districts and plants, resulting in significant differences in quality and quantity of nematodes: in Parkent distric, fine loamy soils were common in the tomato fields. 499 nematodes belonging to 45 species were identified in the soil of root and rhizosphere of the tomatoes, in particular, 139 individuals, belonging to 27 species in the root system and 445 individuals, belonging to 45 species in the rhizosphere. The species found in the root are Eudorylaimus monochystera, E. paraobtusicaudatus, E. pratensis, Aporcelaimellus abtusicaudatus, Tylencholaimus teres, Rhabditis brevispina, Mesorhabditis monochystera, Cephalobus persegnis, C. nanus, C. parvis, Eucephalobus striatus, E. cornis, E. oxyuroides, Acrobeles siliatus, Acrobeloides buetschieli, Cervidellus

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insubricus, Chiloplacus symmetricus, Ch. propinquus Panogralaimus rigidus, Aphelenchus avenae, Aphelenhoides clarolineatus, Aph. limberi, Aph. parietinus, Aglenchus agricola, Ditylenchus dipsasi, Helicotylenchus multicinctus, Pratylenchus pratensis. Quantitatively, the species of nematodes, including Rhabditis brevispina, Cephalobus persegnis, Aphelenchus avenae, Ditylenchus dipsasi were found to be more common at the root, while the remaining species were found to be 1 to 10 individuals.

In the rhizosphere of the tomatoes, all of the identified nematode species were encountered. Quantitatively, the species of nematodes, including Prismatolaimus intermedus, Rhabditis brevispina, Cephalobus persegnis, Acrobeles siliatus, Acrobeloides buetschieli, Chiloplacus symmetricus, Aphelenchus avenae, Aphelenhoides limberi, Ditylenchus dipsasi were found to be more common.

By ecological groups, pararysobionts – 41 individuals, belonging to 9 species (8.2% of all determined nematodes), eusaprobionts – 48 individuals, belonging to 2 species (9.6%), devisaprobionts – 191 individuals, belonging to 16 species (38.3%), non-pathogenic phytohelminths – 161 individuals, belonging to 14 species (32.3%), true parasites (TP) – 58 individuals, belonging to 4 species (11.6%) were observed.

In the root, pararysobionts – 9 individuals, belonging to 5 species (6.5%), eusaprobionts – 18 individuals, belonging to 2 species (13.0%), devisaprobionts – 41 individuals, belonging to 12 species (29.4%), non-pathogenic phytohelminths – 40 individuals, belonging to 5 species (28.7%), true parasites (TP) – 31 individuals, belonging to 3 species (22.3%) were identified.

In the rhizosphere, pararysobionts – 42 individuals, belonging to 9 species (9.4%), eusaprobionts – 40 individuals, belonging to 2 species (8.9%), devisaprobionts – 150 individuals, belonging to 16 species (33.7%), non-pathogenic phytohelminths – 154 individuals, belonging to 12 species (34.6%), true parasites (TP) – 59 individuals, belonging to 6 species (13.2%) were encountered.

In the agrocenosis of the carrot, fine loamy soils are common in terms of their mechanical composition. 39 species, including 479 nematodes were detected in the soil of carrot root and rhizosphere zone, in particular, in the root system, 135 nematodes, belonging to 28 species, and in the rhizosphere soil, 344 nematodes, belonging to 38 species were encountered.

The species found in the root are Eudorylaimus monochystera, E. paraobtusicaudatus, E. pratensis, Aporcelaimellus abtusicaudatus, Rhabditis brevispina, Mesorhabditis monochystera, Cephalobus persegnis, C. nanus, Eucephalobus striatus, E. oxyuroides, Acrobeles siliatus, Acrobeloides buetschieli, Cervidellus insubricus, Chiloplacus symmetricus, Ch. propinquus Panogralaimus rigidus, Panagrolaimus armatus, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides clarolineatus, Aph. limberi, Aph. parietinus, Tylenchus davainei, Filenchus filiformus, Merlinius dubius, Ditylenchus dipsasi, Nothotylenchus arcus, Pratylenchus pratensis. The species of nematodes, including Mesorhabditis monochystera, Cephalobus persegnis, Aphelenchus avenae were found to

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be more common at the root, while the remaining species were found to be 1 to 10 individuals.

38 species were determined in the rhizosphere soil, the most common species are Eudorylaimus monochystera, E. pratensis, Ditylenchus dipsasi, while the remaining species were found to be 1 to 20 individuals.

By ecological groups, pararysobionts – 137 individuals, belonging to 12 species (28.6% of all determined nematodes), eusaprobionts – 37 individuals, belonging to 2 species (7.7%), devisaprobionts – 150 individuals, belonging to 11 species (31.3%), non-pathogenic phytohelminths – 114 individuals, belonging to 10 species (23.8%), true parasites (TP) – 41 individuals, belonging to 4 species (8.6%) were observed.

In the root, pararysobionts – 21 individuals, belonging to 4 species (15.5%), eusaprobionts – 22 individuals, belonging to 2 species (16.2%), devisaprobionts – 56 individuals, belonging to 11 species (41.4%), non-pathogenic phytohelminths – 25 individuals, belonging to 7 species (19.0%), true parasites (TP) – 11 individuals, belonging to 4 species (8.0%) were encountered.

In the rhizosphere, pararysobionts – 166 individuals, belonging to 12 species (34.0%), eusaprobionts – 15 individuals, belonging to 2 species (4.0%), devisaprobionts – 94 individuals, belonging to 10 species (28.0%), non-pathogenic phytohelminths – 74 individuals, belonging to 9 species (21.0%), true parasites (TP) – 45 individuals, belonging to 5 species (13.0%) were determined.

In the rural area Khojayli in the Bostanlyk district, nematodes found in the root and rhizosphere of tomatoes and sunflowers were studied. In this area, tomatoes are pre-planted and fine loamy soils are spread in terms of their mechanical composition. 48 species of 528 nematodes were detected in tomato root and rhizosphere soil, in particular, 180 individuals, belonging to 33 species in the root system, and 284 individuals, belonging to 40 species in the rhizosphere.

Quantitatively, the species of nematodes, including Eudorylaimus monochystera (30 та), Rhabditis brevispina (28 та), Mesorhabditis monochystera – (30 та), Panogralaimus rigidus (28 та) were found to be more common at the root. The species Eucephalobus striatus, Aphelenchus avenae, Aphelenhoides clarolineatus were found to be 10 to 15 individuals in the root, while the remaining species were found to be 1 to 10 individuals.

24 nematode species, including Plectus parietinus, Eudorylaimus monochystera, Aporcelaimellus abtusicaudatus, Rhabditis brivispina., Mesorhabditis monochystera, Protorhabditis sp., Panogralaimus armatus, P. rigidus, Cephalobus persegnis, Eucephalobus striatus, E. cornis, Acrobeles siliatus, Chiloplacus symmetricus, Ch. lentus, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides clarolineatus, Aph. helophilus, Bursaphelenchus talonus, Tylenchus davainei, Filenchus filiformus, Ditylenchus trifornis, Hexatylenchus viviparous, Helicotylenchus multicinctus are common species in root and rhizosphere soil.

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By ecological groups, pararysobionts – 99 individuals, belonging to 6 species (18.8%), eusaprobionts – 162 individuals, belonging to 3 species (30.6%), devisaprobionts – 150 individuals, belonging to 13 species (28.4%), non-pathogenic phytohelminths – 99 individuals, belonging to 19 species (18.8%), true parasites (TP) – 18 individuals, belonging to 7 species (3.4%) were observed.

In the root, pararysobionts – 38 individuals, belonging to 3 species (13.0%), eusaprobionts – 102 individuals, belonging to 3 species (34.0%), devisaprobionts – 90 individuals, belonging to 9 species (31.0%), non-pathogenic phytohelminths – 49 individuals, belonging to 11 species (17.0%), true parasites (TP) –16 individuals, belonging to 6 species (5.0%) were identified.

In the rhizosphere, pararysobionts – 66 individuals, belonging to 5 species (24.0%), eusaprobionts – 100 individuals, belonging to 3 species (36.0%), devisaprobionts – 56 individuals, belonging to 11 species (21.0%), non-pathogenic phytohelminths – 30 individuals, belonging to 9 species (11.0%), true parasites (TP) – 38 individuals, belonging to 10 species (22.0%) were determined.

In the sunflower fields, medium loamy soils are common in terms of their mechanical composition. 33 species of 357 nematodes were detected in the sunflower root and rhizosphere soil, in particular, 84 individuals, belonging to 18 species in the root system, and 273 individuals, belonging to 30 species in the rhizosphere.

Nematode species Panogralaimus rigidus, Chiloplacus lentus, Aphelenhoides helophilus, Ditylenchus intermedius were encountered only in the root. The most common species are Panogralaimus rigidus, Chiloplacus symmetricus, the remaining species were found to be 1 to 10 individuals.

Nematode species Chiloplacus symmetricus, Ch. propinquus, Eucephalobus striatus, Aphelenchus avenae, Pratylenchus pratensis турлари were found to be common in the rhizosphere.

By ecological groups, pararysobionts – 36 individuals, belonging to 2 species (10.1%), eusaprobionts – 27 individuals, belonging to 2 species 7.6%), devisaprobionts – 151 individuals, belonging to 13 species (42.3%), non-pathogenic phytohelminths – 73 individuals, belonging to 10 species (12.4%), true parasites (TP) – 70 individuals, belonging to 6 species (19.6%) were observed.

In the root, pararysobionts – 44 individuals, belonging to 1 species (35.5%), eusaprobionts were not encountered, devisaprobionts – 54 individuals, belonging to 10 species (43.5%), non-pathogenic phytohelminths – 18 individuals, belonging to 4 species (14.5%), true parasites (TP) –8 individuals, belonging to 4 species (6.5%) were encountered.

In the rhizosphere, pararysobionts – 2 individuals, belonging to 2 species (0.6%), eusaprobionts – 27 individuals, belonging to 2 species (8.6%), devisaprobionts – 117 individuals, belonging to 11 species (37.4%), non-pathogenic phytohelminths – 60 individuals, belonging to 6 species (19.2%), true parasites (TP) – 107 individuals, belonging to 8 species (34.2%) were determined.

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In the sunflower field at the farm "Ozod", in the Akhangaran district, coarse loamy soils are common. 28 species of 247 nematodes were detected in the soil of sunflower root and rhizosphere, in particular, 95 individuals, belonging to 20 species in the root system, and 152 individuals, belonging to 23 species in the rhizosphere. (Table 4.1.9.)

The species found in the root are Eudorylaimus monochystera, Rhabditis brevispina, Mesorhabditis monochystera, Panogralaimus rigidus, Cephalobus nanus, Eucephalobus striatus, Chiloplacus symmetricus, Ch. lentus, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides clarolineatus, Aph. dactylocercus, Aph. helophilus, Ap. limberi, Ap. parietinus, Tylenchus davainei,, Filenchus filiformus, Ditylenchus dipsasi, Pratylenchus pratensis, Criconema similis. Quantitatively, the species of nematodes, including Mesorhabditis monochystera, Aphelenchus avenae were found to be more common at the root, while the remaining species were found to be 1 to 20 individuals. Species Aphelenhoides clarolineatus, Aph. helophilus, Ditylenchus dipsasi, Pratylenchus pratensis, Criconema similis were only encountered in the root system.

The nematode species in the rhizosphere are Plectus parietinus, Eudorylaimus monochystera, Aporcelaimellus abtusicaudatus, Rhabditis brevispina, Mesorhabditis monochystera, Panogralaimus subelongatus, P. rigidus, Cephalobus persegnis, C. nanus, Eucephalobus striatus, E. cornis, Acrobeles siliatus, Chiloplacus symmetricus, Ch. lentus, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides dactylocercus, Aph. limberi, Aph. parietinus, Tylenchus davainei, Filenchus filiformus, Ditylenchus intermedius, Helicotylenchus multicinctus. The species Mesorhabditis monochystera, Panogralaimus rigidus, Chiloplacus symmetricus were found to be more common.

15 nematode species, including Eudorylaimus monochystera, Rhabditis brevispina, Mesorhabditis monochystera, Panogralaimus rigidus, Cephalobus nanus, Eucephalobus striatus, Chiloplacus symmetricus, Ch. lentus, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides dactylocercus, Ap. limberi, Ap. parietinus, Tylenchus davainei, Filenchus filiformus are common species, encountered in both root and rhizosphere soil.

By ecological groups, pararysobionts – 11 individuals, belonging to 2 species (4.5%), eusaprobionts – 78 individuals, belonging to 2 species (Rhabditis brevispuna, Mesorhabditus monchystera) (31.5%) were determined. During the researches, devisaprobionts – 75 individuals, belonging to 10 species (30.4%) were determined. Non-pathogenic phytohelminths – 73 individuals, belonging to 11 species (29.5%), true parasites (TP) – 10 individuals, belonging to 3 species (4.1%) were observed.

In the root, pararysobionts – 2 individuals, belonging to 1 species (1.0%), eusaprobionts – 59 individuals, belonging to 2 species (41.0%), devisaprobionts – 22 individuals, belonging to 5 species (15.0%), non-pathogenic phytohelminths – 47 individuals, belonging to 9 species (33.0%), true parasites (TP) –14 individuals, belonging to 3 species (10.0%) were observed.

In the rhizosphere, pararysobionts – 9 individuals, belonging to 2 species (8.0%), eusaprobionts – 19 individuals, belonging to 2 species (18.0%), devisaprobionts – 53

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individuals, belonging to 10 species (49.0%), non-pathogenic phytohelminths – 25 individuals, belonging to 7 species (23.0%), true parasites (TP) – 2 individuals, belonging to 2 species (2.0%) were observed.

According to the comparative analysis of the species diversity of nematodes in the studied agricultural crops, it was noted that 16 species of nematodes Eudorylaimus monohystera, Aporcelaimellus abtusicaudatus, Cephalobus nanus, C. persegnis, Eucephalobus striatus, Acrobeles ciliatus, Chiloplacus symmetricus, Panagrolaimus rigidus, Rhabditis brevispina, Mesorhabditis monhystera, Aphelenchus avenae, A. cylindricaudatus, Filenchus filiformis, Helicotylenchus multicinctus, Pratylenchus pratensis, D. Dipsaci are common species for all plants.

According to the species of nematodes found only in individual plants, 3 species of nematodes Acrobeloides emarginatus, Zeldia punctate, Aphelenchoides saprophilus in tomatoes, 3 species of nematodes Prismatolaimus dolichurus, Mesodorylaimu bastiani, Tylencholaimus minimus in carrots were found in the Parkent district. 6 species of nematodes Mylonchulus solus, Heterocephalobus filiformus, Mesorhabditis irregularis, Megadorus megadorus, Bitylenchus dubius, Helicotylenchus buxophilus in tomatoes, 2 species of nematodes Acrobeloides tricornus, Meloidogyne hapla in sunflowers were found in the Bostanlyk district. Only 1 species of nematodes Panagrolaimus subelongatus in sunflowers were encountered in the Akhangaran district. The nematode species mentioned above are specific to a particular plant, while other nematode species are common to two, three, or more plants.

It can be said from the analysis of the collected materials, Aphelenchus avenae, Cephalobus persegnis, Chiloplacus symmetricus species are common species on all farms. Pectus parietinus, Bursaphelenchus talonus, Nothotylenchus arcus, Meloidogyne hapla species were found to be rare in separate farms.

In the studied areas, 6 species of nematodes were identified as dominants, 9 species as subdominants, 14 species as recedents, and 37 species as subrecedents.

In plant and soil samples of equal size obtained from 0-20 cm layer of root and rhizosphere soil of different agricultural crops, a relatively high level of species diversity and quantity of nematodes were observed in the pre-planted tomato agrocenosis in Bostanlyk district, low biodiversity in nematodes was observed in the agrocenosis of sunflowers, in Akhangaran district.

According to the literature, the soil is a natural habitat and mass reproduction environment for a variety of invertebrates, including nematodes. Soil invertebrates are bioindicators that provide an increase in soil fertility and determine the state of the environment (Gilyarov et al., 1975). The species composition, quantity and development of nematodes directly depend on the mechanical composition of the soil, temperature, water-air regime, supply of organic matter, relief structure, plant type, as well as agrotechnical measures, including the application of mineral fertilizers, plowing depth, etc. (Mavlonov, 1993, Romanenko, 2012, Saidova, Eshova, 2020). The results obtained in our study confirm this

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evidence. In terms of species diversity of the studied agricultural nematodes, species found in the root and rhizosphere soil of tomatoes, pre-planted in fine loamy soils were the highest- 48 species (Bostanlyk), followed by tomatoes grown after wheat in the second year - 46 species, then carrots - 39 species (Parkent) were detected. 33 species of nematodes were observed in sunflowers grown in medium loamy soils (Bostanlyk), and 28 nematode species (Akhangaran) were observed to be the lowest in sunflowers grown on coarse loamy soils. This situation is explained by the application of agro-technical measures in agricultural crops, the cultivation of the same crops in the long run, soil properties and other reasons.

When analyzing the representatives of the ecological group in the nematode community in terms of biotopes, the diversity of devisaprobionts and non-pathogenic phytohelminths was high in all plants, diversity in parasisobionts and true parasites was relatively low, and the species of eusaprobionts was rare (Table 2).

Table 2 **Distribution of ecological groups of nematodes found in agricultural crops by biotopes**

Ecological group	Districts				
	Parkent		Bostanlyk		Akhangaran
	Tomato	Carrot	Tomato	Sunflower	Sunflower
Pararizobionts	9/41	12/137	6/99	2/36	2/11
Eusaprobionts	2/48	2/37	3/162	2/27	2/78
Devisaprobionts	16/191	11/150	13/150	13/151	10/75
Non-pathogenic phytohelminths	14/161	10/114	19/99	10/73	11/73
True parasites	4/58	4/41	7/18	6/70	3/10
Total	45/499	39/479	48/528	33/357	28/247

Note. The numerator shows the species, the denominator presents the number of individuals.

The coefficient of similarity of species composition in the nematode communities of agricultural crops in the foothills was determined by comparative analysis. As a result, the similarity of the nematode complex found in the root and rhizosphere soils of tomatoes and carrots in Parkent district was highest (81.0%), the similarity of the complex of carrot and sunflower nematodes in Parkent district and Bostanlyk district was low (58.3%). The low coefficient of similarity of species composition in the community of nematodes indicates that their migration is inactive, their distribution being explained by water and other factors.

It was determined that the diversity of crops grown in different agricultural fields affects the taxonomic composition and quantitative density of nematodes. The highest rate of biodiversity was observed in the tomato field soils,which have a long-term crop in fine

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loamy soils, the average amount of species in the soil was 528 ind./10 cm^3. The amount of nematodes was slightly lower in fine loamy soils of the fields with the crop rotation: in tomatoes planted after wheat - 499 ind/10 cm^3, in carrots - 479 ind/10 cm^3, in sunflowers in medium loamy soils- 357 ind/10 cm^3, in sunflowers in coarse loamy soils - 247 ind/10 cm^3 were observed (Fig. 2).

There were sharp differences between the groups depending on the crops grown, the number of nematodes changed from 247 ind/10 cm^3 to 528 ind/10 cm^3. There is evidence that crop rotation technology primarily affects the density of nematode populations and, to a lesser extent, the number of their taxa, for example, the cultivation of carrot or turnip crops after potatoes reduces nematode population density (3.7-4.3 times) and unifies the taxonomic status of the fauna. During the next cabbage cultivation (after carrots), the number of nematodes in the soil increased sharply (10 times), and the taxonomic composition did not change. When cabbage was replaced by a potato, it was observed that the variety of nematodes increased and the quantity decreased (Matveeva et al. 2015).

In our study, a difference in the density of nematode populations was observed as a result of cultivation of tomato and carrot crops planted after wheat. It was found that the diversity status of nematode fauna in soils of carrot root and its rhizophere, relative to tomatoes is low in the number of individuals (in 100 gr soil, 499 individuals were observed in tomatoes, 479 individuals- in carrots.

Nematodes form the main biomass of invertebrates in the soil, are actively involved in the food chain and are a source of nitrogen in the soil (Gruzdeva, 2011). Nematodes play an important role in the decay of plant residues in the soil, the formation of humus in the soil and increase the biological activity of the soil, in general, improve soil properties. Soil nematodes are nutritionally related to bacteria, fungi, plants and other organisms, actively participate in the mineralization of substances and ensure soil fertility (Ferris, 2007). Nematodes are soil organisms, their type and number in the soil depends on the nature of the soil. Soil also plays a key role in the life of nematodes. In particular, the mechanical composition and physical properties of the soil are important for nematodes, and fine loamy soils have been found to have a high number of nematodes (Romanenko, 2012).

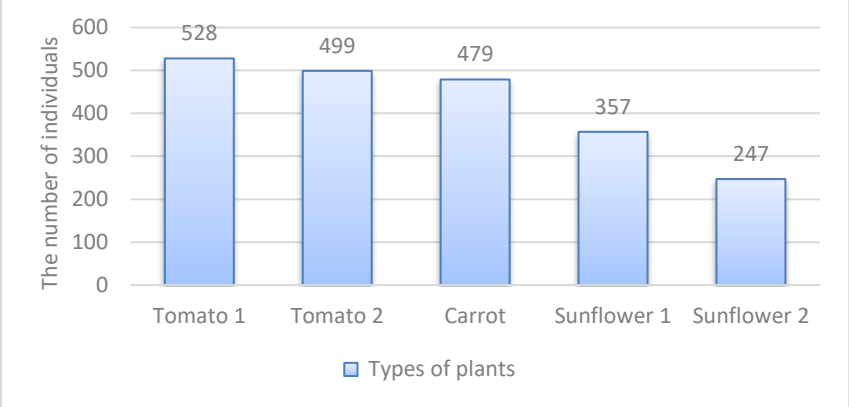

Figure 2. Distribution of the number of nematodes found in the foothills by plant and soil types.

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Our study also proved that nematodes depend on soil properties, i.e., a comparative analysis of the species composition of nematodes found in fine, medium and coarse soils in terms of mechanical composition was conducted. It was determined that 25 species of nematodes Alaimus primitivus, Clarcus papillatus, Mylonchulus solus, Prismatolaimus intermedius, P. dolichurus, Eudorylaimus paraobtusicaudatus, E. pratensis, Mesodorylaimus bastiani, Aporcelaimellus abtusicaudatus, Tylencholaimus minimus, T. teres, Diphterophora communis, Mesorhabditis irregulars, Cephalobus parvis, Panogralaimus armatus, Zeldia punctata, Aphelenchus solani, Aphelenhoides sabparietinus, Megadorus megadorus, Aglenchus agricola, Tylenchorhynchus bogdanovi-katjakovi, Merlinius dubius, Ditylenchus trifornis, Nothotylenchus arcus, Helicotylenchus buxophilus were determined in fine loamy soils. Nematodes that are special for medium loamy soils were 2 species Acrobeloides tricornus, Meloidogyne hapla. The nematodes of coarse loamy soils are included in only one species Panogralaimus subelongatus. In non-compacted fine loamy soils, nematodes do not have great difficulty for movement, while in small-grained, cohesive coarse loamy soils, their movement is somewhat difficult.

23 species of nematodes- Plectus parietinus, Eudorylaimus monochystera, Aporcelaimellus abtusicaudatus, Cephalobus persegnis, C. nanus, Eucephalobus striatus, E.cornus, Acrobeles siliatus, Chiloplacus symmetricus, Ch. lentus, Panogralaimus rigidus, Rhabditis brevispina, Mesorhabditis monochystera, Aphelenchus avenae, Aph. cylindricaudatus, Aphelenhoides helophilus, Tylenchus davainei, Filenchus filiformus, Helicotylenchus multicinctus, Pratylenchus pratensis, Ditylenchus dipsasi, Ditylenchus intermedius were found in all types of soils. 8 species of nematodes were determined in fine and medium loamy soils, 4 species in fine and coarse loamy soils, and no species of common nematodes were determined in medium and coarse loamy soils.

The nematode communities of agricultural crops is influenced by the physical properties of the soil - its mechanical composition. Due to the low density of larger granular particles in loamy soils, resistance to the movement and other properties of nematodes in these soils is low. Due to the relatively high density of small-grained loamy soils and the strong adhesion of soil particles to each other, it was observed that nematodes are rare in species and quantities, especially in coarse loamy soils (the sunflower rhisophere soils, in the Akhangaran district). With the exception of some species of nematodes, fine loamy soils are preferred for them. High amounts of nematodes were observed in these soils.

Our research proved that the number of phytophagous nematodes were observed to be relatively high in coarse loamy soils in terms of the mechanical composition. The main lifestyle factors for phytophagous nematodes are their plant hosts and soil moisture (Romanenko et.al, 2007). Data from the literature indicate a relatively high prevalence of phytophagous nematodes in mountainous and foothill areas (Mavlonov et al., 2019). Confirming this data, our research has shown that nematodes are less common in sunflowers grown in coarse loamy soils than other soils, although nematodes are less common in coarse loamy soils, phytophagous nematodes are more abundant, the main

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factor for phytophagous nematodes is their plant hosts and soil moisture.

Thus, according to the comparative analysis of nematode fauna in foothill agricultural crops and their root soils, nematodes in the soil of root and rhizosphere of pre-planted tomatoes is highest (48 species) in fine loamy soils, in terms of the mechanical composition, followed by tomatoes planted after wheat (45 species) and carrots (39 species), the results were relatively low in sunflowers (33 species), planted in the medium loamy soils, and the least result (28 species) was found in sunflowers planted in coarse loamy soils. A higher incidence of nematodes was observed in the soil of the rhizosphere, relative to the plant roots.

Nematode species that are characteristic to the fine loamy soils are Prismatolaimus intermedius, Mylonchylis solus, Mylonchylis papilatus, Panogralaimus armatus, Aphelenchus solani, Tylenchorhynchus bogdanovi-katjakovi, Merlinius dubius, Ditylenchus tulaganovi, D.trifornis; for medium loamy soils- Aphelenhoides tricornus, Meloidogyne hapla; for coarse loamy soils- Panogralaimus subelongatus. As a result of studying the nematodes fauna of agricultural crops in the foothills, 8 species of true parasitic nematodes were identified (Table 5).

Table 5 Number of species and individuals of parasitic nematodes in plants

Nematode species	Biotops					Total
	1	2	3	4	5	
Bitylenchus dubius	2	2	2	18	-	24
Merlinius bogdanovi-katjkovi	-	-	1	-	-	1
Ditylenchus dipsasi	46	30	4	3	3	86
Helicotylenchus multicinctus	8	5	7	6	1	27
H. buxophilus	-	-	1	-	-	1
H. nannus	-	-	1	3	-	4
Pratylenchus pratensis	2	4	2	33	6	47
Meloidogyne hapla	-	-	-	7	-	7
Total	58	41	18	70	10	197

Note: 1-tomato (Parkent), 2-tomato (Bostanlyk), 3-carrot, 4-sunflower (Bostanlyk), 5-sunflower (Akhangaran).

Currently, more than 25,000 species of nematodes are known, of which 12,000 species are animal parasites, more than 2,000 species are true plant parasites, 6,000 species are free-living soil nematodes, and 4,000-5,000 species are free-living marine nematodes (Matveeva, Sushuk, 2015). The parasitic nematodes belong to 200 genera, most of which included into the Tylenchida family (Siddiqi, Shaukat, 2002). More than 555 species of soil-dwelling nematodes and 25 species of cyst-forming nematodes have been identified in the Republic of Uzbekistan (Tulaganov, Usmanova, 1975, 1978). Different numbers of plant parasitic nematodes have been observed in the soils of different countries. In France and Switzerland - 10 - 25 species, in Hungary, Bulgaria, Slovakia, Germany - 3-8 species, in the USA - 18 species, in Canada - about 30 species, in Russia - 12 species were studied (Galagan, Belyavskaya, 2017). More than 30 species of true plant parasitic nematodes are known in Uzbekistan (Mavlonov, 1993).

When we analyzed the nematode fauna found in the studied plants by crop species, 61 species were identified in tomato crops, 39 species in carrots, and 38 species in sunflowers. In total, 28 species (45%) of these identified nematodes were detected in tomato crops, 14 species (36%) in carrots, and 19 species (50%) in sunflowers. Among the parasitic phytonematodes, it was noted that species such as Bitylenchus dubius, Ditylenchus dips, Helicotylenchus multicinctus, Pratylenchus pratensis are widespread.

The literature provides information on the formation of phytoparasite complexes, it was observed that the complex of migratory nematodes in the field include stem nematodes Ditylenchus dipsaci, seedling nematodes- representatives of the genus Pratylenchus, spiral nematode Helicotylenchus dihystera, and the species of Tylenchorhynchus dubius, Paratylencus nanus (Galagan, Belyavskaya, 2017). As a result of our research, the formation of a specific phytoparasite fauna of nematodes was detected in each of the studied plants. For example, a complex of migratory nematodes was observed to form stem nematodes Ditylenchus dipsaci, seedling nematode- Pratylenchus pratensis, spiral nematode Helicotylenchus dihystera, and the species of Bitylenchus dubius. The northern bulging nematode - Meloidogyne hapla is trophically very plant-hosting, like other bulging nematodes is the endoparasite of the root system of plants (Butorina et al., 2006). We believe that the diversity of the fauna of parasitic nematodes depends on the structure of the plant root system, agronomic techniques and cultivation of crops, as well as soil properties.

Parasitic nematodes have an active effect on their plant host, and their exposure as a result of the proliferation of pathogens in different cultivated plants leads to negative consequences (Sushchuk, 2009). The damage caused by parasitic nematodes to plants varies: first, by parasitizing the roots of plants, they negatively affect the conductive path of the root, and they prevent the passage of nutrients; secondly, the parasitic nematodes cause swelling, spots on plant roots, cause “stunting”, leaf wrinkling and other diseases, and hinder the proper growth of plants; third, nematodes provide a pathway for microbial flora as an inoculator (Zinoveva et al., 2012). Phytoparasites are a large group of practical importance, they have not been fully studied as a complex of plant roots and rhizosphere nematodes. During the developmental period of anthropogenic processes, the damage of these nematodes is great and they parasitize all types of plants. Among the parasitic nematodes identified in our study, dangerous species for agricultural crops are Ditylenchus dips, Helicotylenchus multicinctus, Pratylenchus pratensis, Meloidogyne hapla (larvae in the soil around the roots). These nematodes cause various diseases in plants. For example, it causes meloydoginosis (caused by Meloidogyne hapla), ditelenchosis (caused by Ditylenchus dips), pratylenchosis (caused by Pratylenchus pratensis) and other diseases. The presence of true parasites such as Ditylenchus dipsa, Pratylenchus pratensis, Meloidogyne hapla in the studied plants can cause various diseases in agricultural crops, so it is important to pay attention to the spread risk of parasitic nematodes. Parasitic nematodes belonging to the genera Ditylenchus, Helicotylenchus, Pratylenchus,

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Meloidogyne cause damage to agricultural crops. During our study, small numbers of northern bulging nematodes were noted. However, the expansion of arable land, the cultivation of crops in monoculture can lead to an intensive proliferation of northern bulging nematodes, their spread in the areas that agricultural crops planted and great damage. As a result of the research, organizational-prophylactic and agro-technical control measures against parasitic nematodes of agricultural crops are recommended.

Conclusions. In the complex phytohelminthological researches on the nematode fauna of agricultural crops in the foothills of the Tashkent oasis, 66 species of nematodes belonging to 2 subclasses, 7 order, 23 families, 39 genera were identified. According to the ecological classification of nematodes of agricultural crops: parasisobionts accounts for 13 species, eusaprobionts - 3 species, devisaprobionts - 21 species, non-pathogenic phytohelminths - 21 species, true parasites - 8 species. The nematode fauna of agricultural crops of the foothills is characterized by the peculiarities of the species composition, in the soil of tomato root and rhizosphere zone planted in the Parkent district, identified phytonematodas account for 45 species, in carrots - 39 species, in tomatoes planted in the Bostanlyk district - 48 species, in sunflowers - 33 species, in sunflowers planted in the Akhangaran district - 28 species. Comparative study of the composition of nematode fauna in agricultural crops revealed that the basis of the fauna consists of 16-25 species of nematodes, including bacteriotrophs nematodes of the family Cephalobidae, mycotrophs of the genera Aphelenchoides, Aphelenchus, and parazites of the genera Pratylenchus, Ditylenahus. It was determined that the diversity of crops grown in different agricultural fields affects the taxonomic composition and quantitative density of nematodes. The highest rate of biodiversity was observed in the tomato field soils,which have a long-term crop in fine loamy soils, the average amount of species in the soil was 528 ind./10 cm^3. The amount of nematodes was slightly lower in fine loamy soils of the fields with the crop rotation: in tomatoes planted after wheat - 499 ind/10 cm^3, in carrots - 479 ind/10 cm^3, in sunflowers in medium loamy soils- 357 ind/10 cm^3, in sunflowers in coarse loamy soils - 247 ind/10 cm^3 were observed. In foothill agricultural crops, the real parasitic nematodes Bitylenchus dubius, Merlinius bogdanovi-katjkovi, Helicotylenchus multicinctus, H. buxophilus, H. nannus, Pratylenchus pratensis, Ditylenchus dipsasi, Meloidogyne hapla (larvae of this species encountered in the rhisophere of the root) were found to be common.

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