BIODIVERSITAS
Volume 25, Number 11, November 2024
Pages: 4033-4042

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d251103

A comprehensive study of phytonematodes of grape plants in the conditions of the Surkhandarya Valley, Uzbekistan

ALISHER KHURAMOV[1,♥], LOBAR BOBOKELDIEVA[1], SIROJ CHORIYEV[1], BAKHODIR RAKHMATULLAEV[1], NAVRUZ KHIMMATOV[1], SHAKHBOZ RAIMOV[1], GULCHEKHRA NARZULLAEVA[2], SHAKHNOZA BOBOKELDIYEVA[1], MUKHLISA MUKHIDDINOVA[1], MAKHBUBA KARSHIEVA[1]

[1]Department of Zoology, Faculty of Natural Sciences, Termez State University. F. Khodjaev Street, Termez 190111, Surkhandarya, Republic of Uzbekistan. Tel.: +998-93-7992003, ♥email: khurramov10@mail.ru

[2]Department of Medical Biology and Histology, Termez Branch of Tashkent Medical Academy. Islam Karimov 64. Termez 132000, Surkhandarya, Uzbekistan

Manuscript received: 27 March 2024. Revision accepted: 4 November 2024.

Abstract. *Khuramov A, Bobokeldieva L, Choriyev S, Rakhmatullaev B, Khimmatov N, Raimov S, Narzullaeva G, Bobokeldiyeva S, Mukhiddinova M, Karshieva M. 2024. A comprehensive study of phytonematodes of grape plants in the conditions of the Surkhandarya Valley, Uzbekistan. Biodiversitas 25: 4033-4042.* Article analyzes the faunal complex of grape phytonematodes collected from 2018 to 2020 from 14 districts and 28 farms of the Surkhandarya Valley, Uzbekistan. Sample collection was carried out using the route (collecting samples by going to predetermined areas in a certain direction) method generally accepted in modern faunal studies. The Berman funnel method was used to isolate nematodes permanent and temporary preparations for determination of the type and gender of nematodes were prepared according to the Seinhorst method; when determining the species of phytonematodes, the works of domestic and foreign authors were used, as well as morphometric indicators obtained using the generally accepted de Mann formula. During the study period, we found 118 species of phytonematodes belonging to 54 genera, 33 families, 9 orders, and 2 subclasses on grape agrocenoses. The discovered nematodes are distributed among the orders as follows: The order Monhysterida is represented by 5 species: Enoplida-1, Mononchida-6, Dorylaimida-23, Alaimida-5, Rhabditida-7, Teratocephalida-25, Aphelenchida-19 and the order Tylenchida-27 species. The degree of dominance of registered phytonematodes in the roots and root soil of grapes was studied. According to the frequency of occurrence of the detected species of phytonematodes in root and soil samples, there were no dominant or eudominant species; in the root soil of grapes; of the subdominants 10 species and 108 species were classified as subrecedents. In the root system of grapes, the subdominants are total 10 species. In the root system of grapes, all other species of phytonematodes registered (74 species) are classified as subrecedents.

Keywords: Degree of dominance, ecological classification, fauna, grapes, phytonematodes

INTRODUCTION

In the Republic of Uzbekistan, much attention is paid to providing the population with high-quality fruits and vegetables, in particular grapes (currently 181,000 hectares). In addition, targeted measures have been developed to solve economic and social problems in the development of viticulture and, first of all, to provide the population with high-quality fresh and dried products, raw materials for the processing industry, as well as export to the world market to increase the export potential of Uzbekistan and the economic efficiency of viticulture (20th place in 2023) (Abduvaliyev et al. 2021). Grapes are a cultivated plant that grows in temperate and subtropical regions, and grapes are grown in 80 countries of the world. Due to its valuable taste and dietary and medicinal (in the treatment of diseases such as tuberculosis, anemia, impotence, gastrointestinal tract, urinary tract, heart disease) properties, it is of great importance and occupies an important place among other agricultural crops.

In recent years, in woody plants such as coffee, olive, and kiwi new root-knot nematode species have been discovered (Ali et al. 2015; Tao et al. 2017; Trinh et al. 2019). *Vitis vinifera* L. is one of the most widely grown fruit crops in many areas of the world (Rahmani et al. 2015; Ahmed et al. 2016). It is a woody vine plant whose fruits can be eaten raw as fresh fruit or made into dried fruit, juices, and wine; thus, it is of great economic value. Grape cultivation is believed to have originated in Armenia, near the Caspian Sea in Russia, from where it spread westward to Europe and eastward to Iran and Afghanistan (Krithika et al. 2015); at present, it is widely grown in tropical, temperate, and subtropical regions worldwide. China Yunnan Province is one of the major provinces for the grape industry in China. As of the end of 2014, the total output value of grapes in Yunnan exceeded 7 billion yuan; thus, grape plays an important role in the agricultural industry in this province (Zhang et al. 2015). However, various pathogens, including plant-parasitic nematodes, pose a serious threat to the production of grapes worldwide, and root-knot nematodes are one of the important factors restricting grape production (Smith et al. 2017; Smith et al. 2018; Hamzayevich et al. 2022).

Meloidogyne incognita (Kofoid & White, 1919) Chitwood, 1949 and *M. hapla* are common grape root pests (Zhu et al. 2014), and Liu and Zhang (2017) reported that grapes from the Huaihai economic zone were infected by *M. incognita* (Liu and Zhang 2017). The *M. javanica* (Treub, 1885) Chitwood, 1949 is the predominant root-knot nematode in Australian vineyards (Smith et al. 2017), and *M. hapla* is abundant and widespread in Washington's semiarid vineyards (Howland et al. 2015). The most recorded species from vineyards in southern Brazil were found to belong to the genera *Helicotylenchus, Mesocriconema, Xiphinema* and *Hemicycliophora* (Carneiro et al. 2014; Divers et al. 2019).

When a study was conducted between 2015 and 2022 in order to identify nematode species belonging to the families Longidoridae and Trichodoridae in the agriculture of the Thrace Region of Turkey. 11 species of nematodes belonging to the genera Xiphinema, Longidorus, and Trichodorus were found in the soil around the rhizosphere of 28 plants, including vines. The identified species include *Xiphinema pachtaicum* (Tulaganov, 1938) (26 plants), *X. turcicum* Luc & Dalmasso, 1964 (grapes), *X. pyrenaicum* Dalmasso, 1969 (grapes and figs), *X. ingens* Luc & Dalmasso, 1964 (grapes), *X. italiae* Meyl, 1953 (grapes and olives), *X. index* Thorne & Allen, 1950 (nine plants), *X. diversicaudatum* (Micoletzky, 1927) (grapes and figs), *X. opisthohysterum* Siddiqi, 1961 (grapes), *Longidorus elongatus* (de Man, 1876) Micoletzky, 1922 (four plants), *L. attenuatus* Hooper, 1961 (olives and grapes) and *Trichodorus similis* Seinhorst, 1963 (grapes and walnuts) (Öztürk et al. 2023).

A total of 150 soil samples were studied for the detection of plant parasitic nematodes in five grape varieties (Bangalore Blue, Muscadine, Pinotnoir, Pantara, and Jitawa) at the Federal College of Horticulture, Dadin-Kowa Gombe State, Nigeria. In the conducted research, *Meloidogyne* spp., *Paratylenchus* spp., *Xiphinema* spp., *Scutellenema* spp., *Longidorus* spp., *Heterodera* spp., *Aphelenchoides* spp., *Trichodorus* spp., *Hoplolaimus* spp. and *Rotylenchus* nematodes population density was studied (Jidere et al. 2023). During 2017-2023, about 150 soil samples were studied from vineyards and lands intended for planting vineyards located in the Central, South-Western, and South-Eastern regions of Crimea. As a result of these works, 29 species of plant-parasitic nematodes belonging to 9 families were identified (Volkova et al. 2023).

When studying the literature data, information about plant nematodes in the vineyards of Uzbekistan needs to be sufficiently research. Therefore, carrying out phytohelminthological studies on this crop, studying the faunal complex of phytonematodes of grape plants, and identifying parasitic species is relevant in viticulture. Based on this, we carried out a comprehensive faunistic study to study the phytonematode fauna of the root system and root soil of vineyards and identify phytoparasitic species in the conditions of the Surkhandarya Valley of Uzbekistan.

MATERIALS AND METHODS

The study is the first study on vine nematodes in Surkhandarya Region of the Republic of Uzbekistan (Figure 1). This study was conducted over a period of 2 years and 8 months.

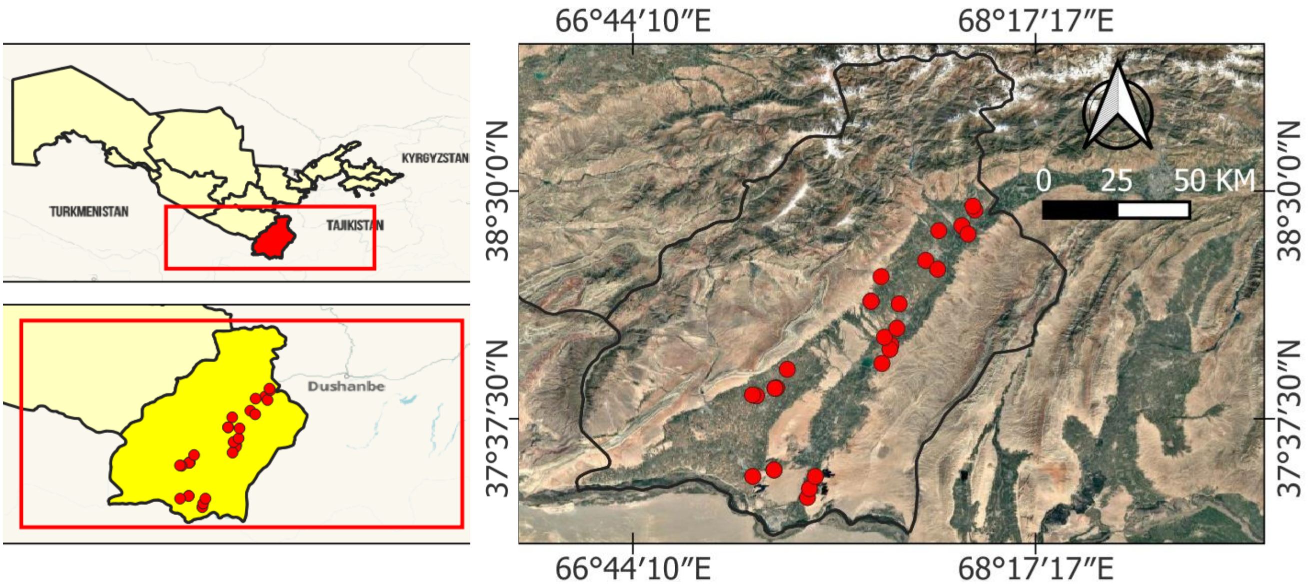

Figure 1. Locations where vines were sampled in Surkhandarya Region of the Republic of Uzbekistan

Collection of samples

For the first time in the Surkhandarya Valley of the Republic of Uzbekistan, comprehensive phytohelminthological research was carried out by us. In order to study the species composition of grape phytonematodes fauna, 14 districts of Surkhandarya Region (Termiz, Angor, Muzrabot, Sherabad, Boysun, Kyzyriq, Bandikhon, Jarqor'gan, Kumqor'gan, Sho'rchi, Altinsoy, Denov, Sariosiyo, Uzun) 2 farms were selected. Samples of 17 plant roots along with 17 soil samples were taken from different points of each farm in the months of 2018-2019, the most favorable for the life of phytonematodes, i.e. April, May, September, October. Thus, 476 plant roots and 476 soil samples were taken from 28 farms, and a total of 952 samples were taken (Sattorovich and Aramova 2021; Sattorovich et al. 2021) (Figure 1). "Sherali-Namuna" farm in Termiz District was selected to study the dynamics of phytonematodes during vine vegetation. Samples were taken on the 25th day of every month for a total of 32 months (from April 2018 to November 2020), 5 plant roots and 5 soil samples, a total of 320 samples.

"Sherali-Namuna" farm in Termiz District was selected to study the dynamics of phytonematodes during vine growth. Samples were taken on the 25th day of every month for a total of 32 months (from April 2018 to November 2020). 5 plant roots and 5 soil samples were taken, a total of 320 samples. Each sample was 50 grams for the study of phytonematodes and 1272 samples from the root system were taken and analyzed. In the field, each soil sample was placed in a separate polythene bag along with the roots and labeled.

Isolation and fixation of nematodes from samples

The collected samples were analyzed in the phytohelminthological laboratory. First, the roots of the plant were carefully examined for infestation with nematodes. Then, the root soil and the root system were studied separately. The modified Berman funnel method was used to isolate nematodes from the plants' soil and the root system (Bekmurodov and Raxmatova 2020; Choriyev et al. 2024a). Exposure in the room temperature +25^{0}C was 20-28 hours, at +30^0-35^{0}C was 10-12 hours. Soil samples for the presence of the cyst nematode were usually analyzed according to the Dekker method (Khurramov et al. 2024). Next, to fix nematodes, 4-6% formalin or a mixture of 2 mL triethanolamine + 91 mL water + 7 mL of 40% formalin (TAF) was used.

Nematodes were clarified in a mixture of glycerol and alcohol (1:3), and permanent preparations of glycerol were prepared for laboratory processing of the material according to the Seinhorst method (Ryss 2017; Choriyev et al. 2024b; Khurramov et al. 2024).

Making perineal patterns

Specifically, female adults were selected from grape root-knot tissue under an anatomical microscope, and a hard plastic consisting of 45% lactic acid solution was used to make an impression of the perineal cuticular pattern with a scalpel. Then, the perineal pattern was cleaned with a 45% lactic acid solution, placed on a glass slide, and covered with a coverslip using pure glycerine as a floating carrier.

Light microscopy

All nematode samples were observed and examined under a trinocular microscope N-300M. A1 inverted microscope. All samples were measured using the de Man indices (Choriyev et al. 2024a) and the measurements were expressed in micrometers.

Identification of the type and sex of nematodes

To determine the type and sex of nematodes, a trinocular microscope N-300M was used, as well as nematode identification books and atlases (Raxmatova and Soatova 2020; Sattorovich and Aramova 2021; Anvarovna et al. 2022; Hindy et al. 2022; Khan et al. 2023). Next, to determine the size of nematodes, the De Man formula was used, accepted by most researchers, and modified by Mikoletsky (Choriyev et al. 2024a; Khurramov et al. 2024). In our work, we used a system of plant nematodes developed by A. A. Paramonov based on the methods of evolutionary morphology and ecological-morphological analysis (Choriyev et al. 2024b; Khurramov et al. 2024). The degree of dominance of plant nematodes in roots and soil samples was determined by the percentage of individuals of certain species to the number of all detected (Khurramov et al. 2024). At the same time, species that make up more than 10% of all detected species are dominant or eudominant, dominant - 5.1-10%, subdominant - 2.1-5%, subrecedent less than 2.1% of individuals.

RESULTS AND DISCUSSION

Composition of species and individuals of nematodes

As a result of phytohelminthological studies in grape agrocenoses in the southern region of Uzbekistan, we have found 118 species of plant nematodes belonging to 54 genera, 39 subfamilies, 33 families, 20 superfamilies, 13 suborders, 9 orders and 2 subclasses (Table 1).

In total, the detected nematodes are distributed by orders as follows: Order Monhysterida is represented by 5 species, Enoplida-1, Mononchida-6, Dorylaimida-23, Alaimida-5, Rhabditida-7, Teratocephalida-25, Aphelenchida-19, and Tylenchida-27 species. In our material, the subclass Adenophorea is represented by 5 orders: Monhysterida, Enoplida, Mononchida, Dorylaimida, and Alaimida.

The order Monhysteri is represented by 2 families: Plectidae and Monhysteridae; 4 genera: *Anaplectus*, *Plectus*, *Proteroplectus* and *Monhystera*; 5 species (which is 4.2% of the total number of species) and only 176 specimens (1.3% of the total number of plant nematodes found). The order Enoplida includes one family: Onchulidae; one genus: *Prismatolaimus* and 1 species (0.9%), a total of 28 specimens (0.2%) of plant nematodes. The order Mononchida includes 2 families: Mononchidae, Mylonchulidae; 3 genera: *Mononchus*, *Clarcus* and *Mylonchulus*; and 6 species (5.1%), total 153 specimens (1.2%) of plant nematodes.

Table 1. Species and quantitative composition of phytonematodes were found in the root and basal soil of vineyards

Subclasses	Orders	Families	Genera	Species	Number of individuals			%	Degree of dominance
					Soil	Root	Total		
Adenophorea	Monhysterida	Plectidae	*Anaplectus*	1. *Anaplectus granulosus*	4	-	4	0.03	Subrecedent
			Plectus	2. *Plectus cirratus*	24	6	30	0.22	Subrecedent
				3. *Plectus parietinus*	52	21	73	0.55	Subrecedent
			Proteroplectus	4. *Proteroplectus parvus*	17	-	17	0.12	Subrecedent
		Monhysteridae	*Monhystera*	5. *Monhystera filiformis*	38	14	52	0.39	Subrecedent
	Enoplida	Onchulidae	*Prismatolaimus*	6. *Prismatolaimus intermedius*	28	-	28	0.21	Subrecedent
	Mononchida	Mononchidae	*Mononchus*	7. *Mononchus truncates*	18	-	18	0.13	Subrecedent
			Clarcus	8. *Clarkus papillatus*	31	-	31	0.23	Subrecedent
				9. *Clarkus parvus*	13	9	22	0.16	Subrecedent
		Mylonchulidae	*Mylonchulus*	10. *Mylonchulus parabrachyurus*	17	-	17	0.12	Subrecedent
				11. *Mylonchulus solus*	22	-	22	0.16	Subrecedent
				12. *Mylonchulus sigmaturus*	43	-	43	0.32	Subrecedent
	Dorylaimida	Encholaimidae	*Enchodelus*	13. *Enchodelus macrodorus*	31	-	31	0.23	Subrecedent
		Nygolaimidae	*Nygolaimus*	14. *Nygolaimus brachyuris*	15	-	15	0.11	Subrecedent
				15. *Nygolaimus intermedius*	18	-	18	0.13	Subrecedent
		Dorylaimidae	*Paradorylaimus*	16. *Paradorylaimus filiformis*	16	-	16	0.12	Subrecedent
			Mesodorylaimus	17. *Mesodorylaimus bastiani*	44	-	44	0.33	Subrecedent
				18. *Mesodorylaimus bastianoides*	22	-	22	0.16	Subrecedent
				19. *Mesodorylaimus parasubulatus*	27	-	27	0.20	Subrecedent
			Dorylaimellus	20. *Dorylaimellus mirus*	13	-	13	0.09	Subrecedent
		Qudsianematidae	*Eudorylaimus*	21. *Eudorylaimus centrocercus*	72	-	72	0.55	Subrecedent
				22. *Eudorylaimus kirjanovae*	31	-	31	0.23	Subrecedent
				23. *Eudorylaimus labiatus*	18	-	18	0.13	Subrecedent
				24. *Eudorylaimus monohystera*	23	-	23	0.17	Subrecedent
				25. *Eudorylaimus paraobtusicaudatus*	51	-	51	0.38	Subrecedent
				26. *Eudorylaimus parvus*	59	-	59	0.45	Subrecedent
				27. *Eudorylaimus pratensis*	60	-	60	0.46	Subrecedent
		Aporcelaimidae	*Aporcelaimus*	28. *Aporcelaimus superbus*	72	-	72	0.55	Subrecedent
			Aporcelaimellus	29. *Aporcelaimellus abtusicaudatus*	63	-	63	0.49	Subrecedent
				30. *Aporcelaimellus obscurus*	44	-	44	0.33	Subrecedent
		Discolaimidae	*Discolaimium*	31. *Discolaimium cylindricum*	27	-	27	0.20	Subrecedent
		Nordiidae	*Longidorella*	32. *Longidorella parva*	21	-	21	0.16	Subrecedent
		Xiphinemidae	*Xiphinema*	33. *Xiphinema americanum*	28	11	39	0.29	Subrecedent
				34. *Xiphinema elongatum*	41	-	41	0.31	Subrecedent
				35. *Xiphinema index*	32	5	37	0.28	Subrecedent
	Alaimida	Alaimidae	*Alaimus*	36. *Alaimus primitivus*	17	9	26	0.19	Subrecedent
				37. *Alaimus striatus*	14	7	21	0.16	Subrecedent
		Diphtherophoridae	*Diphtherophora*	38. *Diphtherophora communis*	28	-	28	0.21	Subrecedent
				39. *Diphtherophora kirjanovae*	16	-	16	0.12	Subrecedent
				40. *Diphtherophora pseudoperplexans*	19	-	19	0.14	Subrecedent

Secernentea	Rhabditida	Rhabditidae	*Mesorhabditis*	41. *Mesorhabditis irregularis*	38	16	54	0.41	Subrecedent
				42. *Mesorhabditis monhystera*	88	31	119	0.91	Subrecedent
			Pelodera	43. *Pelodera cylindrical*	35	18	53	0.4	Subrecedent
			Rhabditis	44. *Rhabditis brevispina*	174	97	271	2.07	Subrecedent
				45. *Rhabditis filiformis*	68	20	88	0.67	Subrecedent
				46. *Rhabditis longicaudata*	49	22	71	0.54	Subrecedent
		Diplogasteroididae	*Mesodiplogaster*	47. *Mesodiplogaster lheritieri*	28	13	41	0.31	Subrecedent
	Teratocephalida	Panagrolaimidae	*Panagrolaimus*	48. *Panagrolaimus armatus*	19	6	25	0.19	Subrecedent
				49. *Panagrolaimus longicaudatus*	86	19	105	0.8	Subrecedent
				50. *Panagrolaimus multidentatus*	118	85	203	1.55	Subrecedent
				51. *Panagrolaimus rigidus*	304	161	465	3.6	Subdominant
				52. *Panagrolaimus spondyli*	21	34	55	0.42	Subrecedent
				53. *Panagrolaimus subelongatus*	172	149	321	2.5	Subdominant
		Cephalobidae	*Heterocephalobus*	54. *Heterocephalobus elongates*	138	71	209	1.6	Subrecedent
				55. *Heterocephalobus filiformis*	77	29	106	0.81	Subrecedent
			Cephalobus	56. *Cephalobus persegnis*	353	104	457	3.5	Subdominant
			Eucephalobus	57. *Eucephalobus cornis*	49	21	70	0.53	Subrecedent
				58. *Eucephalobus oxyuroides*	81	5	86	0.65	Subrecedent
				59. *Eucephalobus striatus*	43	27	70	0.53	Subrecedent
			Acrobeloides	60. *Acrobeloides buetschlii*	176	82	258	1.97	Subrecedent
				61. *Acrobeloides emarginatus*	85	34	119	0.91	Subrecedent
				62. *Acrobeloides labiatus*	94	28	122	0.93	Subrecedent
				63. *Acrobeloides maximus*	79	49	128	0.97	Subrecedent
				64. *Acrobeloides nanus*	124	72	196	1.49	Subrecedent
				65. *Acrobeloides tricornis*	47	22	69	0.52	Subrecedent
			Chiloplacus	66. *Chiloplacus demani*	64	23	87	0.66	Subrecedent
				67. *Chiloplacus lentus*	25	11	36	0.27	Subrecedent
				68. *Chiloplacus propinquus*	276	82	358	3	Subdominant
				69. *Chiloplacus sclerovaginatus*	76	28	104	0.79	Subrecedent
				70. *Chiloplacus symmetricus*	24	-	24	0.18	Subrecedent
			Acrobeles	71. *Acrobeles ciliatus*	19	-	19	0.14	Subrecedent
			Cervidelus	72. *Cervidelus insubricus*	41	14	55	0.42	Subrecedent
	Aphelenchida	Aphelenchidae	*Aphelenchus*	73. *Aphelenchus avenae*	394	248	642	5	Subdominant
				74. *Aphelenchus cylindricaudatus*	82	34	116	0.88	Subrecedent
				75. *Aphelenchus solani*	43	25	68	0.51	Subrecedent
		Paraphelenchidae	*Paraphelenchus*	76. *Paraphelenchus pseudoparietinus*	66	39	105	0.80	Subrecedent
				77. *Paraphelenchus tritici*	27	12	39	0.29	Subrecedent
		Aphelenchoididae	*Aphelenchoides*	78. *Aphelenchoides clarolineatus*	85	28	113	0.86	Subrecedent
				79. *Aphelenchoides dactylocercus*	82	39	121	0.92	Subrecedent
				80. *Aphelenchoides helophilus*	31	17	48	0.36	Subrecedent
				81. *Aphelenchoides limberi*	92	35	127	0.97	Subrecedent
				82. *Aphelenchoides parietinus*	137	38	175	1.33	Subrecedent
				83. *Aphelenchoides parabicaudatus*	33	19	52	0.39	Subrecedent
				84. *Aphelenchoides parascalacaudatus*	47	21	68	0.51	Subrecedent
				85. *Aphelenchoides parasubtenuis*	53	38	91	0.69	Subrecedent

				86. *Aphelenchoides pusillus*	38	12	50	0.38	Subrecedent
				87. *Aphelenchoides sacchari*	28	9	37	0.28	Subrecedent
				88. *Aphelenchoides subtenuis*	41	14	55	0.42	Subrecedent
				89. *Aphelenchoides teres*	24	13	37	0.28	Subrecedent
				90. *Aphelenchoides trivialis*	81	14	95	0.72	Subrecedent
			Bursaphelenchus	91. *Bursaphelenchus talonus*	23	8	31	0.23	Subrecedent
	Tylenchida	Tylenchidae	*Tylenchus*	92. *Tylenchus davainei*	113	44	157	1.19	Subrecedent
			Filenchus	93. *Filenchus filiformis*	242	73	315	2.40	Subdominant
			Aglenchus	94. *Aglenchus thornei*	78	35	113	0.86	Subrecedent
			Lelenchus	95. *Lelenchus leptosome*	55	23	78	0.59	Subrecedent
		Dolichodoridae	*Tylenchorhynchus*	96. *Tylenchorhynchus capitatus*	75	32	107	0.81	Subrecedent
				97. *Tylenchorhynchus brassicae*	152	68	220	1.68	Subrecedent
			Bitylenchus	98. *Bitylenchus dubius*	258	112	370	2.82	Subdominant
		Psilenchidae	*Psilenchus*	99. *Psilenchus clavicaudatus*	56	19	75	0.57	Subrecedent
		Hoplolaimidae	*Helicotylenchus*	100. *Helicotylenchus dihystera*	301	152	453	3.46	Subdominant
				101. *Helicotylenchus erythrinae*	114	68	182	1.39	Subrecedent
				102. *Helicotylenchus multicinctus*	125	77	202	1.54	Subrecedent
		Rotylenchulididae	*Rotylenchus*	103. *Rotylenchus robustus*	94	36	130	0.99	Subrecedent
		Pratylenchidae	*Pratylenchus*	104. *Pratylenchus pratensis*	401	227	628	4.79	Subdominant
				105. *Pratylenchus tumidiceps*	83	32	115	0.9	Subrecedent
				106. *Pratylenchus neglectus*	216	58	274	2.09	Subrecedent
			Pratylenchoides	107. *Pratylenchoides crenicauda*	76	27	103	0.78	Subrecedent
		Meloidogynidae	*Meloidogyne*	108. *Meloidogyne arenaria*	48	12	60	0.46	Subrecedent
				109. *Meloidogyne incognita*	76	25	101	0.77	Subrecedent
		Paratylenchidae	*Paratylenchus*	110. *Paratylenchus amblycephalus*	42	16	58	0.44	Subrecedent
				111. *Paratylenchus macrophallus*	37	21	58	0.44	Subrecedent
		Neotylenchidae	*Neotylenchus*	112. *Neotylenchus abulbosus*	115	57	172	1.31	Subrecedent
		Anguinidae	*Ditylenchus*	113. *Ditylenchus dipsaci*	478	131	609	4.65	Subdominant
				114. *Ditylenchus intermedius*	105	28	133	1.01	Subrecedent
				115. *Ditylenchus myceliophagus*	210	53	263	2.0	Subrecedent
				116. *Ditylenchus tulaganovi*	79	36	115	0.9	Subrecedent
		Sychnotylenchidae	*Neoditylenchus*	117. *Neoditylenchus pinophilus*	47	11	58	0.44	Subrecedent
			Nothotylenchus	118. *Nothotylenchus allii*	73	39	112	0.85	Subrecedent
Total: 2	9	33	54	118 (soil) 84 (root)	9456	3630	13086	100	Subdominant: 10 Subrecedent: 108

The order Dorylaimi is represented by 8 families: Encholaimidae, Nygolaimidae, Dorylaimidae, Qudsianematidae, Aporcelaimidae, Discolaimidae, Nordiidae, Xiphinemidae; 11 genera: *Enchodelus, Nygolaimus, Paradorylaimus, Mesodorylaimus, Dorylaimellus, Eudorylaimus, Aporcelaimus, Aporcelaimellus, Discolaimium, Longidorella, Xiphinema;* 23 species (19.5%), total 844 individuals (6.3%) phytonematodes. The order Alaimida includes 2 families: Alaimidae, Diphtherophoridae; 2 genera: *Alaimus, Diphtherophora* and 5 species (4.2%), total 110 specimens (0.8%) of plant nematodes.

The subclass Secernentea includes the orders Rhabditida, Teratocephalida, Aphelenchida, and Tylenchida. The order Rhabditida includes 2 families: Rhabditidae, Diplogasteroididae; 4 genera: *Mesorhabditis, Pelodera, Rhabditis, Mesodiplogaster*; 7 species (5.9%), total 697 individuals (5.3%) phytonematodes. The order Teratocephalida is represented by 2 families: Panagrolaiminae and Cephalobinae; 8 genera: *Panagrolaimus, Heterocephalobus, Cephalobus, Eucephalobus, Acrobelides, Chiloplacus, Acrobeles, Cervidelus*; 25 species (21.2%), total 3747 individuals (28.9%) phytonematodes.

The order Aphelenchida is represented by 3 families: Aphelenchidae, Paraphelenchidae, Aphelenchoididae; 4 genera: *Aphelenchus, Paraphelenchus, Aphelenchoides, Bursaphelenchus*; 19 species (16.1%), total 2070 individuals (15.8%) phytonematodes. Order Tylenchida includes 11 families: Tylenchidae, Dolichodoridae, Psilenchidae, Hoplolaimidae, Rotylenchulididae, Pratylenchidae, Meloidogynidae, Paratylenchidae, Neotylenchidae, Anguinidae, Sychnotylenchidae; 17 genera: *Tylenchus, Filenchus, Aglenchus, Lelenchus, Tylenchorhynchus, Bitylenchus, Psilenchus, Helicotylenchus, Rotylenchus, Pratylenchus, Pratylenchoides, Meloidogyne, Paratylenchus, Neotylenchus, Ditylenchus, Neoditylenchus, Nothotylenchus*; 27 species (22.9%), total 5,261 specimens (40.2%) of phytonematodes.

The above analysis shows that in terms of species composition, the order Tylenchida occupies the first place, making up 22.9% of all detected species of vine plant nematodes. Then, the order Teratocephalida (21.2%), the order Dorylaimida (19.5%), and the order Aphelenchida (16.1%). In terms of the number of individuals among the orders, the order Tylenchida occupies the first place, which is 40.2% of the total number of plant nematodes found. Then the order Teratocephalida (28.6%), the order Aphelenchida (15.8%) and the order Dorylaimida (6.4%).

The degree of dominance or the frequency of occurrence of the detected plant nematode species in root and soil samples dominating or eudominant species are absent. Of the subdominants of the rhizosphere of the plant, 10 species were found *Panagrolaimus rigidus* (Schneider, 1866), *P. subelongatus* (Cobb, 1914), *Cephalobus persegnis* (Bastian, 1865), *Chiloplacus propinquus* (de Man, 1921) Thorne, 1937, *Aphelenchus avenae* (Bastian, 1865), *Filenchus filiformis* (Bütschli, 1873) Meyl, 1961, *Bitylenchus dubius* (Bütschli, 1873) Filipjev, 1934, *Helicotylenchus dihystera* (Cobb, 1893) Sher, 1966, *Pratylenchus pratensis* (de Man, 1880) Filipjev, 1936 and *Ditylenchus dipsaci* (Kühn, 1857) Filipjev, 1936. The remaining registered species (108 species) are classified as subrecedents.

In the root system of grapes, Among the species found in the roots, the subdominants are the following: *P. rigidus, P. subelongatus, C. persegnis, Ch. propinquus, A. avenae, F. filiformis, B. dubius, H. dihystera, P. pratensis* and *D. dipsaci* (total 10 species). In the root system of grapes, all other species of phytonematodes registered (74 species) are classified as subrecedents.

The species composition of plant nematodes of the root system and root soil of grapes differs significantly from each other both in terms of species composition and the number of individuals. In the root soil of grapes, 9,456 nematodes belonging to 118 species were recorded. The main faunistic complex of phytonematodes in the root soil is *Rhabditis brevispina* 1906, *P. rigidus, Panagrolaimus multidentatus, P. subelongatus, C. persegnis, H. elongatus, Acrobeloides buetschlii* (de Man, 1884) Steiner & Buhrer, 1933, *Acrobeloides nanus* (de Man, 1880) Anderson, 1968, *Ch. propinquus, A. avenae, Aphelenchoides parietinus* (Bastian, 1865) Steiner, 1932, *Tylenchus davainei* (Bastian, 1865), *Tylenchorhynchus brassicae* (Siddiqi, 1961), *B. dubius, F. filiformis H. dihystera, Helicotylenchus erythrinae* (Zimmermann, 1904) Golden, 1956, *Helicotylenchus multicinctus* (Cobb, 1893) Golden, 1956, *P. pratensis, Pratylenchus neglectus* (Rensch, 1924) Filipjev & Schuurmans Stekhoven, 1941, *D. dipsaci, Ditylenchus myceliophagus* (Goodey, 1958 (22 species in total). Of the above species, such as *P. rigidus, C. persegnis, A. avenae, H. dihystera, P. pratensis,* and *D. dipsaci* belong to mass species and form the largest biomass in the soil. The fauna of the root soil is characterized by an abundance of species from the families Aphelenchoididae (248), Panagrolaimidae (310), and Pratylenchidae (227), in particular, the species *P. rigidus* and *P. pratensis*. In the root system of the vineyards, 3,630 nematodes belonging to 84 species were found. There are no mass species in the root system. *P. rigidus, P. subelongatus, C. persegnis, A. avenae, B. dubius, H. dihystera, P. pratensis, D. dipsaci* and others are often found. The species composition is dominated by the families Aphelenchoididae (394), Cephalobidae (629), and Pratylenchidae (401).

Ecological grouping of nematode species

Phytonematodes unite very different ecological groups. Paramonov proposed an ecological classification based on the trophic relationships of nematodes with plants or other soil organisms and identified 5 ecological groups. Phytonematodes identified from the root system and rhizosphere of grape plants, according to the ecological classification, are distributed as follows: pararhizobionts: 29 species (24.6% of the total number of species), 970 individuals (7.4% of the total number of plant nematodes found); devisaprobionts: 11 species (9.3%), 797 individuals (6.1%) of phytonematodes; eusaprobionts: 29 species (24.6%), 3871 individuals (29.6%) of phyto-nematodes; phytohelminths of nonspecific pathogenic effect: 30 species (25.4%), 3661 individuals (28.0%) of phytonematodes; phytohelminths of a specific pathogenic effect: 19 species (16.1%), 3787 individuals (28.9%) of phytonematodes (Table 2).

Table 2. The qualitative and quantitative ratio of nematode vineyards by ecological groups

Environmental groups	Number of species	%	Number of individuals	%
Pararhizobionts	29	24.6	970	7.4
Eusaprobionts	11	9.3	797	6.1
Devisaprobionts	29	24.6	3871	29.6
Phytohelminths of nonspecific pathogenic effect	30	25.4	3661	28.0
Phytohelminths of specific pathogenic effect	19	16.1	3787	28.9
Total	118	100	13086	100

Pararhizobionts belong to the orders: Monhysterida, Enoplida, Mononchida, Alaimida, Dorylaimida and are represented by the families Monhysteridae, Onchulidae, Mononchidae, Mylonchulidae, Encholaimidae, Nygolaimidae, Dorylaimidae, Qudsianematidae, Aporcelaimidae, Discolaimidae, Nordiidae, Alaimidae, Diphtherophoridae. Representatives of this ecological group were found mainly in the rhizosphere, where 94.6% of the total number of nematodes were recorded.

Species *Monhystera filiformis* (Biitschli, 1873), *Prismatolaimus intermedius* (Bütschli, 1873) de Man, 1880, *Clarkus papillatus* (Bastian, 1865) Jairajpuri, 1970, *Mesodorylaimus bastiani* (Bütschli, 1873) Andrássy, 1959, *M. parasubulatus* (Meyl, 1954), *Eudorylaimus centrocercus* (de Man, 1880) Andrássy, 1959, *E. kirjanovae* (Tulaganov, 1949) Andrássy, 1959, *E. paraobtusicaudatus* (Micoletzky, 1922) Andrássy, 1959, *E. parvus* (de Man, 1880) Andrassy, 1959, *E. pratensis* (de Man, 1880) Andrassy, 1959, *Aporcelaimus superbus* (de Man, 1880) Goodey, 1951, *Aporcelaimellus abtusicaudatus* (Heyns, 1965), *A. obscurus* (Thorne & Swanger, 1936) Heyns, 1965 and *Discolaimium cylindricum* (Thorne, 1939) root soil in large numbers.

Species *Anaplectus granulosus* (Bastian, 1865) De Coninck & Schuurmans Stekhoven, 1933, *Proteroplectus parvus, Mylonchulus parabrachyurus* (Thorne, 1924) Schneider, 1939, *Nygolaimus brachyuris* (de Man, 1880) Thorne, 1930, *Paradorylaimus filiformis* (Bastian, 1865) Andrássy, 1969, *Dorylaimellus mirus* (Kirjanova, 1951) Andrássy, 1967, *Alaimus striatus* (Loof, 1964) are the smallest in terms of the number of individuals.

The group of eusaprobionts in the material studied by us turned out to be the group with the smallest number of species (11 species), only 9.3% of the total number of species. The representatives of this group include the family Rhabditidae (6 species). Of the eusaprobionts *R. brevispina* is found in large numbers in the root system of plants and root soil. Species *M. parabrachyurus* and *Mylonchulus solus* (Mulvey, 1961) were found only in the rhizosphere and in the smallest number of individuals.

The group of devisaprobionts includes 29 species (only 24.6% of the total number of species), which belong to the orders Plectida and Teratocephalida; family Plectidae, Cephalobidae, and Paragrolaimidae. They were found in the root system and rhizosphere of plants.

Species *P. rigidus, P. multidentatus, P. subelongatus, H. elongatus, C. persegnis, A. buetschlii, A. nanus, Ch. propinquus* found in the rhizosphere and root system of grape plants were the most numerous in terms of the number of individuals.

Species *Panagrolaimus armatus* (Fuchs, 1930), *Panagrolaimus spondyli* (Korner, 1954), *Chiloplacus lentus* (Maupas, 1900) Thorne, 1937, and *Cervidelus insubricus* (Steiner, 1914) Thorne, 1937 were in insignificant numbers in terms of the number of individuals.

Species *Chiloplacus symmetricus (*Thorne, 1925) Thorne, 1937 and *Acrobeles ciliatus* (von Linstow, 1877) are found only in the rhizosphere of plants. The group of phytohelminths with a nonspecific pathogenic effect was the most numerous in terms of the number of species, including 30 species belonging to the orders Aphelenchida and Tylenchida; families Aphelenchidae, Paraphelenchidae, Aphelenchoididae, Tylenchidae, Psilenchidae. Among the families in terms of the number of individuals and species composition, Aphelenchoididae occupies the first place, which is 63.3% of the total number of species and 8.3% of the total number of individuals of the found phytonematodes.

Species *A. avenae, Aphelenchus cylindricaudatus, Paraphelenchus pseudoparietinus* (Micoletzky, 1922) Micoletzky, 1925, *Aphelenchoides clarolineatus* (Baranovskaya, 1958), *Aphelenchoides dactylocercus* (Hooper, 1958), *Aphelenchoides limberi* (Steiner, 1936), *A. parietinus, Aphelenchoides parasubtenuis* (Shavrov, 1967), *Aphelenchoides trivialis* (Franklin & Siddiqi, 1963), *T. davainei, F. filiformis, Aglenchus thornei, Neotylenchus abulbosus* (Steiner, 1931), *Ditylenchus intermedius* (de Man, 1880) Filipjev, 1936, *D. myceliophagus, Ditylenchus tulaganovi, Nothotylenchus allii* (Khan & Siddiqi, 1968) were found in the rhizosphere and the root system of grapes, and were the most numerous in terms of the number of individuals.

Phytonematodes *Paraphelenchus tritici* (Baranovskaya, 1958), *Aphelenchoides helophilus* (de Man, 1880) Goodey, 1933, *Aphelenchoides parabicaudatus* (Shavrov, 1967), *Aphelenchoides pusillus* (Thorne, 1929), *Aphelenchoides sacchari* (Hooper, 1958), *Aphelenchoides teres* (Schneider, 1927), and *Bursaphelenchus talonus* were insignificant in the number of individuals.

Phytohelminths with a specific pathogenic effect, including 19 species belonging to the orders Dorylaimida and Tylenchida; families Xiphinematidae, Dolichodoridae, Hoplolaimidae, Rotylenchulididae, Pratylenchidae, Meloidogynidae, Paratylenchidae, Anguinidae were found in a large number of plant nematodes.

The true parasites were dominated by the species *Tylenchorhynchus capitatus* (Allen, 1955), *T. brassicae, B. dubius, H. dihystera, H. erythrinae, H. multicinctus, P. pratensis, P. neglectus, D. dipsaci*. They were found in the rhizosphere and the root system of plants and were the most numerous in terms of the number of individuals. The increase in the diversity of phytonematodes species in the vine plant and its root and sub-root soils was closely linked to the spring season (March to April). In this case, the peak of species diversity increase in phytonematode population was observed by April. However, with the beginning of the summer season (June, July, August), the number of individuals in vine agrocenoses, corresponding to the types of phytonematodes in plant roots and in the soil near the roots, decreases sharply. This seasonal fluctuation in phytonematode population is primarily influenced by abiotic factors such as biomass management, soil moisture, and temperature, which are considered to be decisive factors for plant life and phytonematode life.

The research carried out in the horticultural farms of our region specializing in planting vines made it possible to determine the faunal complex of phytonematodes found in vine roots and in the soil before the roots. Among them, economically important phytopathogenic species such as *P. pratensis*, *Meloidogyne arenaria* (Neal, 1889) Chitwood, 1949, *M. incognita*, and *D. dipsaci* were recorded in vine agrocenoses. A wide area spread can be shown as a result of the failure to implement preventive and agrotechnical countermeasures in cultivated fields.

Special attention should be paid to the presence of reservoir transformative plants (weeds) in the occurrence of nematodes in vine agrocenoses. For this, plant protection workers must apply the necessary preventive measures aimed at preventing plant diseases (cleaning the cultivated fields from weeds) and be able to correctly analyze the reasons for the death of the plant crop in a timely manner.

Based on the above information, it is advisable to apply the following measures - activities in order to identify phytohelminth foci and quickly eliminate these foci, as well as to prevent them from spreading to other areas: (i) Based on the results of the phytohelminthological analysis of each vine agrocenosis, it is necessary to compile nematodological cartograms showing the degree of infestation of areas where phytonematodes belonging to the genus *Meloidogyne* have been recorded in regional departments; (ii) s\Strict prohibition of planting planting materials infected with phytohelminths; (iii) Irradiating the soil under the influence of sunlight by plowing the fields 4-5 times a year and avoiding monoculture when planting intermediate crops. This prevents the occurrence of phytohelminthosis foci in cultivated fields; (iv) All preventive measures should be carried out on the basis of cartograms aimed at preventing the entry of phytoparasites into undamaged vineyard plots; (v) It is necessary to introduce alternating planting of intermediate crops (legumes, technical and cultural crops) that limit the harmful effects of phytopathogens in vineyards infected with meloydogins and ditylenchus; (vi) It is necessary to plant the distance between one young seedling and the second seedling at a distance of 40-50 cm more than the usual distance; (vii) It is necessary to introduce systematic strict control measures to limit the growth of weeds harboring invasive larvae of phytopathogenic nematodes in vine intervals; (viii) In order to prevent foci of phytoparasitic nematodes, it is necessary to introduce a capillary irrigation system in vine fields; (ix) it is necessary to use the solarization method in the physical fight against vine phytoparasites.

Timely and systematic implementation of all the preventive and agrotechnical measures listed above will lead to a sharp decrease in the number of extremely dangerous parasitic phytonematodes in vine agrocenoses. Although the application of these measures in grape agrocenoses creates certain difficulties, the timely application of these measures not only gives a great economic effect in the fight against phytoparasitic nematodes, but also serves to increase productivity by 7-10%.

ACKNOWLEDGEMENTS

We express our gratitude to the management of Termez State University, Uzbekistan and all members of the Department of Zoology for their practical help in conducting this scientific research.

REFERENCES

Abduvaliyev AA, Musayeva RA, Barbu GF. 2021. Digest on the Development of Viticulture and Winemaking in the World and the Republic of Uzbekistan. Tashkent. Scientific and Technical Information Center under the Ministry of Innovative Development of the Republic of Uzbekistan.

Ahmed M, Sapp M, Prior T, Karssen G, Back MA. 2016. Technological advancements and their importance for nematode identification. Soil 2: 257-270. DOI: 10.5194/soil-2-257-2016.

Ali N, Tavoillot J, Mateille T, Chapuis E, Besnard G, Bakkali AE, Kantalapiedra-Navarret K, Liebanas G, Kastillo P, Palomares-Rius XE. 2015. A new root-knot nematode *Meloidogyne spartelensis* n. sp (Nematoda: Meloidogynidae) in northern Morocco. Eur J Plant Pathol 143 (1): 25-42. DOI: 10.1007/s10658-015-0662-3.

Anvarovna SE, Tovoshovna NS, Sattorovich BA. 2022. Ecological grouping of nematodes of nut crops in the Surkhandarya Region of Uzbekistan. Peerian J 13: 108-111.

Bekmurodov AS, Raxmatova MU. 2020. Parasitic phytonematodes of pomegranate agrocenosis of southern regions of Uzbekistan. Am J Appl Sci 2 (10): 28-32. DOI: 10.37547/tajas/Volume02Issue10-05.

Carneiro RMDG, Correa VR, Almeida MRA, Gomes ACMM, Deimi AM, Castagnone-Sereno P, Karssen G. 2014. *Meloidogyne luci* n. sp. (Nematoda: Meloidogynidae), a root-knot nematode parasitising different crops in Brazil, Chile and Iran. Nematology 16 (3): 289-301. DOI: 10.1163/15685411-00002765.

Choriyev S, Khurramov A, Khurramov S, Mardonayeva D. 2024a. Ecological analysis of peanut nematodes in Surkhondaryo Region. BIO Web Conf 100 (04006): 6. DOI: 10.1051/bioconf/202410004006.

Choriyev SH, Khurramov ASh, Khurramov ShKh, Khimmatov ND, Mardonaeva DN, Raimov ShQ. 2024b. Phytonematodes of peanut plants in the south of Uzbekistan. Afr J Bio Sci 6 (8): 104-110. DOI: 10.33472/AFJBS.6.8.2024.104-110.

Divers M, Gomes CB, Menezes-Netto AC, Lima-Medina I, Nondillo A, Bellé C, De Araújo Filho JV. 2019. Diversity of plant-parasitic nematodes parasitising grapes in Southern Brazil. Trop Plant Pathol 44: 401-408. DOI: 10.1007/s40858-019-00301-3.

Hamzayevich CS, Norkhonovna MD, Abdukarim ogli OK, Hero ogli AE. 2022. Measures to control parasitic nemates. International Journal of Scientific Trends 1 (2): 75-78.

Hindy YK, Ismail SM, Aziz JM. 2022. The importance of crop rotation and some inducing factors in indicators of infection of wheat Galls nematode *Anguina tritici.* Tikrit J Agric Sci 22 (3): 130-136. DOI: 10.25130/tjas.22.3.15.

Howland AD, Skinkis PA, Wilson JH, Riga E, Pinkerton JN, Schreiner RP, Zasada IA. 2015. Impact of grapevine (*Vitis vinifera*) varieties on reproduction of the northern root-knot nematode (*Meloidogyne hapla*). J Nematol 47 (2): 141-147.

Jidere CI, Simon LD, Usman I, Peter A, Sulaiman I. 2023. Survey on plant parasitic nematode associated with grapevine (*Vitis vinifera* L.) at federal college of horticulture Dadin-Kowa Gombe Nigeria. EQA-Intl J Environ Qual 55 (1): 33-41. DOI: 10.6092/issn.2281-4485/16767.

Khan RM, Manzoor S, Anwar Ansari MSh. 2023. Effectiveness of *Trichoderma* species in controlling the seed-borne infestation of *Anguina tritici* in wheat seed-galls. Indian Phytopathol 76 (4): 1083-1090. DOI: 10.1007/s42360-023-00681-2.

Khurramov A, Mukhiddinova M, Karshieva M, Temirova M, Narzullaeva G. 2024. On the study of the wheat nematode *Anguina tritici* chitwood, 1935 and their importance in wheat cultivation in Uzbekistan conditions. BIO Web Conf 100 (04023): 6. DOI: 10.1051/bioconf/202410004023.

Krithika V, Naik R, Pragalyaashree S. 2015. Functional properties of grape (*Vitis vinifera*) seed extract and possible extraction techniques-A review. Agric Rev 36 (4): 313-320. DOI: 10.18805/ag.v36i4.6668.

Liu Y, Zhang H. 2017. Present situation and control strategy of grape root-knot nematode disease in the Huaihai economic zone. Anhui Agri Sci Bull 23 (12): 76-79.

Öztürk L, Behmand T, Öcal A, Avcı GG, İbrahim HE. 2023. New data on plant hosts of Longidoridae and Trichodoridae nematodes in Türkiye. Bitki Koruma Bülteni / Plant Protection Bulletin 63 (3): 5-16. DOI: 10.16955/bitkorb.1245271.

Rahmani MM, Bakhshi D, Qolov M. 2015. Impact of pruning severity and training systems on red and white seedless table grape (*Vitis vinifera*) qualitative indices. Aust J Crop Sci 9 (1): 55-61.

Raxmatova MU, Soatova ZA. 2020. Phytonematodaphauna of vegetable crops and anti-parasitic measures in the greenhouse conditions of the Surkhandarya Region. Am J Appl Sci 2 (10): 63-69. DOI: 10.37547/tajas/Volume02Issue10-11.

Ryss AY. 2017. A simple express technique to process nematodes for collection slide mounts. J Nematol 49 (1): 27-32. DOI: 10.21307/jofnem-2017-043.

Sattorovich AS, Aramova GB. 2021. Phytonematodes of the apricot (*Prunus Armeniaca*) in the Southern Regions of the Surkhandarya Region of Uzbekistan. JournalNX 7 (12): 47-49. DOI: 10.17605/OSF.IO/QUSR8.

Sattorovich AS, Mamarajabova MT, Saidova EA. 2021. Distribution of Phytonematodes Representatives of the Order Tylenchida (Filipjev, 1934) Thorne, 1949 in the Apple Orchards of the Surkhandarya Region of Uzbekistan. JournalNX 7 (12): 42-46. DOI: 10.17605/OSF.IO/UX5AQ.

Smith BP, Morales NB, Thomas MR, Smith HM, Clingeleffer PR. 2017. Grapevine rootstocks resistant to the root-knot nematode *Meloidogyne javanica*. Aust J Grape Wine Res 23 (1): 125-131. DOI: 10.1111/ajgw.12242.

Smith HM, Smith BP, Morales NB, Moskwa S, Clingeleffer PR, Thomas MR. 2018. SNP markers tightly linked to root knot nematode resistance in grapevine (*Vitis cinerea*) identified by a genotyping-by-sequencing approach followed by sequenom MassARRAY validation. PLoS One 13 (2): e0193121. DOI: 10.1371/journal.pone.0193121.

Tao Y, Xu C, Yuan C, Wang H, Lin B, Zhuo K, Liao J. 2017. *Meloidogyne aberrans* sp. nov. (Nematoda: Meloidogynidae), a new root-knot nematode parasitizing kiwifruit in China. PLoS One 12 (8): e0182627. DOI: 10.1371/journal.pone.0182627.

Trinh QP, Le TML, Nguyen TD, Nguyen HT, Liebanas G, Nguyen TAD. 2019 *Meloidogyne daklakensis* n. sp. (Nematoda: Meloidogynidae), a new root-knot nematode associated with Robusta coffee (*Coffea canephora* Pierre ex A. Froehner) in the Western Highlands, Vietnam. J Helminthol 93 (2): 242-254. DOI: 10.1017/S0022149X18000202.

Volkova M, Volkov Y, Lychagina S, Tabolin S. 2023. Plant-parasitic nematodes in soils of agricultural lands in Crimea. Bio Web Conf 78 (05002): 6. DOI: 10.1051/bioconf/20237805002.

Zhang W, Zhang YH, Lu XY, Bai MD, Kong WX, Ma CH. 2015. A study on the present situation and countermeasures of Yunnan grape industry development. Chin Trop Agric (4): 25-28.

Zhu H, Sun Q, Du Y, Gao Z, Zhai H. 2014. Detection of grape phylloxera on grapevine roots with diagnostic polymerase chain reaction methods targeted to the internal transcribed space region 2 nuclear gene. Aust J Grape Wine Res 21 (1): 143-146. DOI: 10.1111/ajgw.12111.