SPECIES DIVERSITY OF NEMATODE COMMUNITES OF THE RAPESEED (*Brassica napus*) AND THEIR ECONOMIC IMPORTANCE IN THE REPUBLIC OF MOLDOVA

IURCU-STRĂISTRARU Elena, BIVOL Alexei, POIRAS Nadejda, POIRAS Larisa

Abstract. Species and trophic composition of nematode communities of the rapeseed (*Brassica napus*), their abundance and distribution have been studied in eight administrative regions of the Republic of Moldova. Forty two species of free-living and plant parasitic nematodes with density 730 - 1,350 ind./100 g soil were revealed in rapeseed fields. Plant parasitic species were predominant (37 - 58%) followed by bacterivores (15 - 30%), omnivore-carnivores (11 - 27%) and fungivores (8 - 15%). Among plant parasitic species with pathogenic effects there were identified the endoparasites *Pratylenchus pratensis*, *P. penetrans*, *P. thornei*, *Ditylenchus dipsaci,* migratory ectoparasites *Rotylenchus robustus, Helicotylenchus dihystera, H. multicinctus* and the sedentary ectoparasite *Paratylenchus hamatus.* Most bacterivores were represented by species from the families Cephalobidae*,* Panagrolaimidae and fungivores – families Aphelenchidae, Aphelenchoididae*.* Maturity index values were varied 2.2 - 3.02 due to the predominance *cp*2 bacterivores, fungivores, plant parasites and partly *cp* 4, 5 omnivores - carnivores.

Keywords: Nematode community of rapeseed, species diversity, abundance, trophic groups, functional guilds, Maturity index.

Rezumat. Diversitatea specifică a comunităţilor de fitonematode la cultura rapiţei de toamnă (*Brassica napus*) şi importanţa lor economică în Republica Moldova. S-a cercetat diversitatea specifică şi compoziţia trofică a comunităţilor de fitonematode la cultura rapiţei de toamnă (*Brassica napus l.v. oleracea*) 2009 - 2010, cu răspândire şi frecvenţă majoră, cercetate în opt raioane administrative pe întreg teritoriul Republicii Moldova. S-au găsit 42 de specii de nematode fitoparazite şi libere cu o densitate de 730 - 1350 ind./100 g sol. Conform spectrului trofic, s-a constatat predominanţa speciilor de nematode fitoparazite (37 - 58%), urmate de speciile bacteriofage (15 - 30%), omnivore-carnivore (11 - 27%) şi micofage (8 - 15%), în raport cu numărul total de specii. În structura trofică a asociaţiilor de fitonematode, s-au evidenţiat frecvenţa speciilor endoparazite *Pratylen*chus *pratensis*, *P. penetrans*, *P. thornei*, *Ditylenchus dipsaci*, migratoare ectoparazite *Rotylenchus robustus, Helicotylenchus dihystera, H. multicinctus* şi sedentare ectoparazite *Paratylenchus hamatus.* Grupa speciilor bacteriofage a fost reprezentată mai frecvent de specii din familiile Cephalobidae şi Panagrolaimidae, iar micofagele din familiile Aphelenchidae şi Aphelenchoididae*.* Indicele de Maturitate (MI) relevă o variaţie de 2,2 - 3,02 cu predominanţa grupei (colonizare-persistentă) *cp*2 fitoparazite, bacteriofage, micofage şi parţial grupa persistentă *cp* 4, 5 omnivore - carnivore.

Cuvinte cheie: comunităţi de fitonematode, rapiţa de toamnă, diversitate de specii, abundenţă, grupe trofice, indice de maturitate.

INTRODUCTION

Most popular in many countries is the gained rape - oilseed crops, the seeds of which are used to obtain vegetable oil for technical and food needs. Winter rapeseed (*Brassica napus* L.) is grown for oil extracted from the seed with the high content of erucic acid (>40%) that is widely used for industrial purposes; the oil content of the low erucic acid seed (<2%) is suitable for human consumption as well (BERNARD *et al*., 1993). The program of expansion and cultivation of winter rapeseed in R. Moldova has progressively developed since 2005 and area cultivated with this plant is about 21,000 ha. There are mostly cultivated new varieties and hybrids imported from European countries (MORARU & PUNTEA, 2001; CERTAN *et al*., 2007). This culture grows during the cold period and has a relatively short growing season compared to sunflower, well feed and honey plant. During a short period, the rapeseed creates a strong vegetative mass, rich in mineral elements, so that the ploughing it into the soil as green manure, increases fertility and improves the physical properties of soil (MICU *et al*., 2005). The nematode communities of rapeseed have drawn attention of nematologists starting with 2009 (POIRAS *et al.*, 2009).

Few data on the nematode communities are available; there were studied more attentively especially plant parasitic species in plant Brassicaceae. However, studying the structure of nematode communities could be important to set up a database for the soil quality assesses the effects of future disturbance. This is particularly important considering that the diffusion of the rapeseed crop in the world is increasing because of its use as a bio-diesel source (CERTAN *et al*., 2007).

In this research, the nematode communities as bioindicators of the soil condition have been analysed. The nematode community of the rapeseed (*Brassica napus* var. *oleifera*) fields was studied, considering its abundance, species composition, trophic structure and ecological indexes.

MATERIAL AND METHODS

The rapeseed *Brassica napus* L. var. *oleifera* was investigated in the farmer fields of different districts of the Republic of Moldova such as north district – Glodeni (**Gl**), center – Ialoveni (**Ial**), Criuleni (**Cr**), Orhei (**Orh**), south east – Causeni (**Cau**) and south – Cantemir (**Cant**) (this abbreviation is used for locality index in tables 1, 2 and Fig 1).

Soil samples were collected from the depth up to 30 - 50 cm, near the plant roots. Nematodes were extracted by modified Baermann funnels and fixed in 4% formaldehyde at 60^{o} C (BEZOOIJEN, 2006). Nematodes were counted

per 100 mg soil, transferred to glycerine by the modified method of Seinhorst and prepared the mass slide collection. About hundred nematodes from each sample were identified by taxonomic keys (NESTEROV, 1979; RYSS, 1988; NICKLE, 1991; JAIRAJPURI & AHMAD, 1992; SIDDIQI, 2000; ANDRASSY, 2005, 2007; PERRY & MOENS, 2006) and arranged by nematode classification based on the SSU DNA data (DE LEY & BLAXTER, 2002).

The nematodes were assigned to the following feeding groups (YEATS *et al*., 1991) characterized by feeding habits: bacterivores (Ba); fungivores (Fu); omnivore-carnivores (Om-Ca) and plant parasites (PP). To analyse the community structures, the nematode families were allocated to functional guilds (FERRIS *et al.*, 2001).

The functional guilds are defined as combinations of feeding groups and life strategy using *cp* values from extremely r-strategy to K-strategy (BONGERS, 1990, 1999; BONGERS & BONGERS, 1999). Nematode community indices were used such as (1) Maturity index MI=$\sum v(i)$ x $f(i)$, where $v(i)$ is c-p value of taxon *i* according to their *r* and *K* characteristics; $f(i)$ is the frequency of taxon *i* in a sample; (2) Plant parasitic index (PPI) which was determined in a manner for plant parasitic genera and ratio PPI/MI (BONGERS & FERRIS, 1999).

RESULTS AND DISCUSSIONS

Forty two species of free-living and plant parasitic nematodes with density 730 - 1,350 ind./100 g soil were revealed in rapeseed fields from eight administrative regions of the Republic of Moldova during 2009 - 2010 (Table 1, 2; Fig. 1). Thus, 20 - 24 species of nematodes were collected with density of 850 - 1,250 ind./100 g soil in rapeseed plantations in central administrative regions, 16 - 23 species with density of 730 - 1,250 ind./100 g soil in the south and 21 - 28 species with density of 1,180 - 1,350 ind./100 g soil in the north. Among all the studied nematode communities, the plant parasitic species were dominant by the number of species and their densities especially in Donduseni, Drochia and Orhei regions.

Plant parasitic nematodes were predominant by the number of species and their densities; they represented 37% (Ialoveni) to 58% (Donduseni) of all the trophic groups (Fig. 1). Among plant parasitic nematodes, the species belonging to functional guild PP3 such as migratory endoparasite species *Pratylenchus penetrants, P. pratensis, P. thornei, Rotylenchus robustus,* species (guild PP2) *Ditylenchus dipsaci* and ectoparasite *Paratylenchus hamatus,* migratory ectoparasites *Merlinius dubius, Helicotylenchus dihystera*, *H. multicinctus* formed sometimes numerous populations in the root system of rapeseed plants. Plant parasitic species (PP2) without the pathogenic effects such as *Deladenus aridus, Filenchus filiformis, Aglenchus agricola, A. briophilus, Tylenchus davainei, Ditylenchus miceliophagus* are usually numerous in the rhizosphere of plants.

The species from the genus *Pratylenchus* are more dangerous for agricultural annual plants like the oilseed rape (*Brassica napus* L.) as they are mobile endoparasites mostly living in roots; sometimes they are found in above-ground parts like stems. They may multiply to very large numbers (10 - 35 x 10^3 specimens per 10 g of roots) after penetrating the root. All stages from the J2 may enter and live in the soil for some time and attack a new host root. Usually, they infected roots are dark red or brown, caused by the necrosis of the invaded cells and invasion of secondary pathogens like fungi or bacteria. Several "sickness symptoms", slowly expanding patches with poor growth plants and yellowing, are due to *Pratylenchus* species (NICKLE, 1991).

Also, in the rhizosphere of the oilseed rape, the species were numerous, *Ditylenchus dipsaci* as obligatory plant parasitic nematode which feeds on the tissues of higher plants and has an extensive intraspecific variation (many biological races) in host range. Some species of nematodes from the genera *Helicotylenchus, Rotylenchus* (Hoplolaiminae) are obligatory plant parasites, associated with plant roots.

Often infestation predisposes the plants to other diseases or it opens up opportunities for the spreading of fungal (by Aphelenchoidea) and bacterial (by Panagrolaimoidea, Cephaloboidea) decomposition (NICKLE, 1991).

The most important nematode as worldwide pathogen of agriculture is the cyst nematode from the genus *Heterodera*. In the Republic of Moldova, *Heterodera schahtii* is the most marked. The typical symptoms are the outer yellow leaves and finally death, the shortened and deformed roots with the presence of the pinhead-sized white females and brown cysts. The typical field symptoms of the nematode infestations are small patches of poorly growing plants and yield; losses may be higher than 50% (BERNARD & MONTGOMERY-DEE, 1993). At the present study we did not find the cyst nematode *Heterodera schahtii* in the rapeseed plantations; however, in case of using this culture in crop rotation together with sugar beet it may be a risk of appearance of this pathogenic nematode.

Mostly, the assemblages of the bacterivorous nematodes were not very diverse by species, but their populations were numerous. However, in rapeseed fields from Causeni and Orhei, the bacterivores (Ba2) such as the *Eucephalobus elongates, Heterocephalobus teres, Acrobeloides buetschlii* were numerous by species and their densities. The Bacterivores (Ba1), present only by genera *Mesorhabditis* and *Panagrolaimus,* were not often found in the rapeseed fields; however, their populations could be numerous. In comparison with different trophic groups, the bacterivores were 15-30% among all the trophic groups; the species from the genera *Cephalobus, Eucephalobus, Heterocephalobus* and *Acrobeloides* were the most numerous. In the rapeseed fields, the fungivorous nematodes (8 - 15%) were present by species from the genera *Aphelenchus, Aphelenchoides, Paraphelenchus.* However, the most common species (Fu2) were *Aphelenchus avenae* and *Aphelenchoides parietinus.*

Table 1. Specific biodiversity and the trophic spectrum of communities of the free-living and parasitic phytonematodes in the *Brassica napus* crop from different administrative regions of the Republic of Moldova. / Tabel 1. Diversitatea specifică şi spectrul trofic al comunităţilor de fitonematode parazite şi libere la cultura rapiţei de toamnă (*Brassica napus*) în diferite zone ale Republicii Moldova.

Species of nematodes	Guild	Rapeseed fields of administrative regions of R. Moldova							
		North		Centre			South and South-East		
		Don	Dr	Ial	Orh	Cr	Cimis	Cant	Caus
PP									
Deladenus aridus	PP2	+	+	-	+	-	-	-	+
Filenchus filiformis	PP2	+	+	-	+	-	+	+	-
Aglenchus agricola	PP2	+	+	+	+	+	-	+	+
A. briophilus	PP2	-	-	-	-	+	-	+	-
Tylenchus davainei	PP2	+	+	+	+	+	+	-	+
Helicotylenchus dihystera	PP2	-	+	+	-	+	+	+	+
H. multicinctus	PP2	+	+	-	+	+	+	-	+
Ditylenchus dipsaci	PP3	-	-	+	+	+	-	+	-
D. miceliophagus	PP2	+	+	+	-	+	-	+	-
Merlinius dubius	PP2	+	+	+	+	-	+	+	+
Pratylenchus penetrans	PP3	+	-	+	-	-	+	+	-
P. pratensis	PP3	+	+	-	+	+	-	-	+
P. thornei	PP3	-	+	-	+	-	-	-	-
Rotylenchus robustus	PP3	+	+	-	-	+	+	+	+
Nothotylenchus acris	PP2	+	-	+	-	-	-	-	+
Paratylenchus hamatus	PP2	-	+	+	+	-	+	+	-
Longidorella parva	PP2	+	-	-	+	+	-	+	+
Fu									
Aphelenchus avenae	Fu2	+	+	-	+	+	+	+	+
Aphelenchoides parietinus	Fu2	+	-	+	-	+	+	+	-
A. subtenuis	Fu2	+	+	-	-	-	+	-	+
A. composticola	Fu2	-	+	+	-	-	-	-	-
Paraphelenchus tritici	Fu2	-	+	+	-	-	+	+	+
P. ambliurus	Fu2	+	-	+	+	+	-	-	-
Om-Ca									
Aporcelaimus regius	Om5	-	+	+	-	+	-	-	+
A. obtusicaudatus	Om5	+	-	+	+	+	-	+	+
Eudorylaimus brunetti	Om4	-	+	-	-	+	-	-	+
Mesodorylaimus arvensis	Om4	+	+	+	-	-	+	+	-
M. meyli	Om4	-	-	-	+	+	-	+	-
Ecumenicus monohystera	Om4	+	-	-	+	-	+		-
Pungetus marietani	Om4	-	-	+	-	-	+		+
Clarcus papillatus	Ca5	-	-	-	+	+	-		-
Mylonchulus brachyuris	Ca4	-	-	+	-	-	-		-
Ba									
Mesorhabditis signifiera	Ba1	-	-	-	-	-	+		+
Cephalobus mucronatus	Ba2	-	-	+	-	+	+		-
C. thermophilus	Ba2	+	-	+	-	+	+		-
Eucephalobus elongatus	Ba2	+	+	-	-	-	+		+
Heterocephalobus teres	Ba2	-	+	-	+	-	+		+
Acrobeloides buetschlii	Ba2	-	+	+	-	+	-		-
Stegelletina insubricus	Ba2	-	-	-	-	+	-		-
Chiloplacus symmetricus	Ba2	+	-	-	+	-	+		-
Panagrolaimus rigius	Ba1	-	+	+	-	-	-		-
Wilsonema agrarum	Ba2	+	-	-	-	+	+		+

Table 2. Number of species of nematodes and their abundance, trophic groups (ratio %) and ecological indexes in rapeseed fields from different administrative regions of Republic Moldova. / Tabel 2. Efectivul numeric al speciilor de fitonematode, spectrul trofic (rata %) şi indicele ecologic la cultura rapiţei de toamnă în diverse zone ale Republicii Moldova.

Trophic groups and ecological indexes	Rapeseed fields of administrative regions R. Moldova						
	Don	Dr	Ial	Cr	Orh	Cau	Cant
Trophic groups **(%)**:							
Plant parasites (PP)	58	47	37	42	48	40	44
Bacterivores (Ba)	17	26	24	27	23	30	15
Fungivores (Fu)	14	13	15	8	8	10	14
Omnivore-carnivores (Om-Ca)	11	14	24	23	21	20	27
Total (%)	100	100	100	100	100	100	100
Maturity index (MI)	2.67	2.65	2.55	3.02	2.2	2.47	2.33
Ratio indexes PPI/MI	0.8	0.86	0.84	0.63	0.95	1.1	0.68
Number of species	21	28	24	20	21	23	16
Average number of ind./100 g soil	1180	1350	1250	850	998	1250	730

The trophic group of carnivores (11 - 27%) is present by *Clarcus papillatus* (Ca5) and *Mylonchulus brachyuris* (Ca4) which were found only in the rapeseed plantation of the central administrative region. The omnivores were

present by species (Om4, Om5) from families *Aporcelaimidae, Quidsinematidae* and *Dorylaimidae.* The diversity and the number of the omnivorous and carnivorous species depend on the soil structure and their humidity.

The Maturity index (MI) varied between 2.2 and 3.02; the rate is higher than 2.0 because the *cp*1 taxa is represented by few species, *Mesorhabditis signifiera* and *Panagrolaimus rigius*, with no numerous populations. Most nematode communities of the rapeseed consist of plant parasitic nematodes with *cp* 2 and 3, also, the bacterivores *cp*2 and fungivores *cp* 2. The omnivorous Nematodes with *cp* 4, *cp*5 and the carnivores with *cp* 4, *cp*5 were present in the all studied fields. The MI value is low in the situation when *cp*1 taxa have a high proportion of species and decreasing number of *cp* 3-5 taxa. The Ratio PPI/MI (Plant Parasitic Index and the Maturity Index) is between 0.63 - 1.1. A value of Ratio PPI/MI less than 0.9 means plants make optimal use of natural sources, a value of 0.9 - 1.2 - slight nutrient disturbance (BONGERS, 1999; FERRIS *et al*., 2001). Plant parasitic nematodes are potentially more responsive to host plants than to soil amendment and crop species may have influenced the nematode community structure more than management practices (NEHER, 2001).

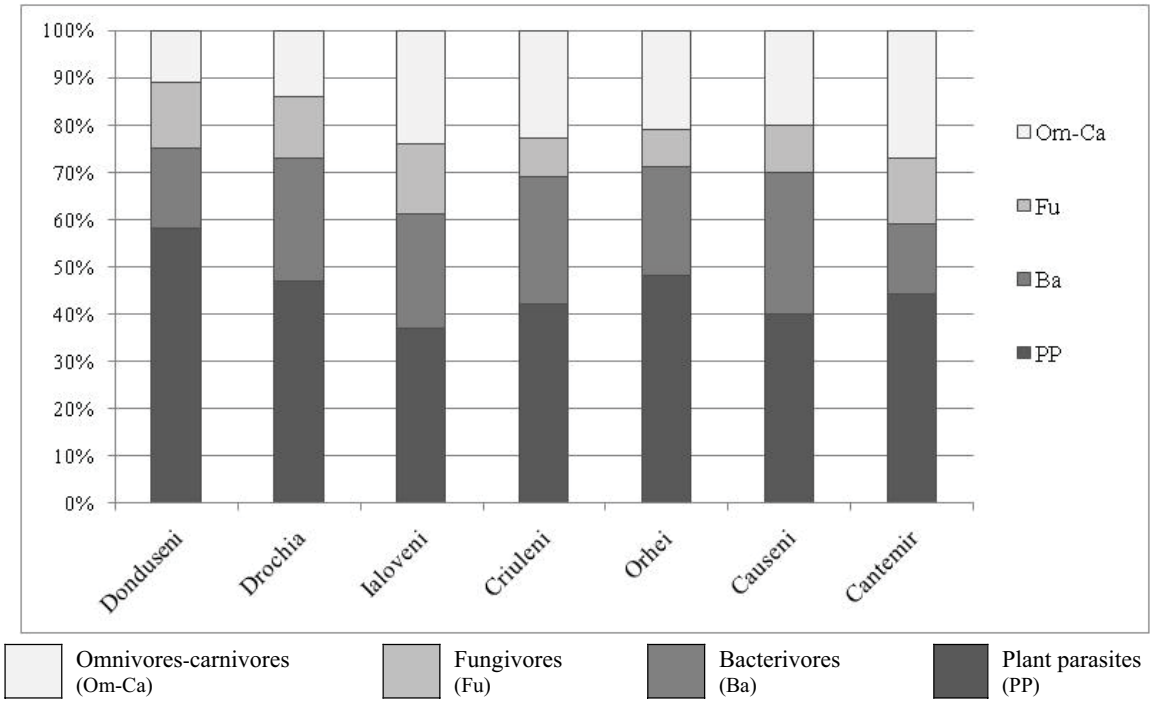

Figure 1. The variation of percentages of the trophic groups of nematode communities from different administrative regions of the Republic of Moldova. / Figura 1. Variaţia procentajelor grupelor trofice ale comunităţilor de nematode în diferite zone ale Republicii Moldova.

CONCLUSIONS

The species and trophic composition of nematode communities of rapeseed (*Brassica napus l. v. oleracea*) were studied in eight administrative regions in the Republic of Moldova during 2009 - 2010. During the studied years, the conditions for growing of rapeseed were favourable, namely enough precipitations and sunny days. According to the taxonomic identifications, forty two species of free-living and plant parasitic nematodes with density 730 – 1,350 ind./100 g soil were revealed in rapeseed fields. Thus, there were identified 20 - 24 species of nematodes with density 850 - 1,250 ind./100 g soil in rapeseed plantations in central administrative regions, 16 - 23 species with density 730 - 1,250 ind./100 g soil in south regions and 21 - 28 species with density 1,180 - 1,350 ind./100 g soil in north regions. The plant parasitic species were predominant (37 - 58%) followed by bacterivores (15 - 30%), omnivore-carnivores (11 - 27%) and fungivores (8 -15%). Among the plant parasitic species with pathogenic effects we mention the following species: endoparasites: *Pratylen*chus *pratensis*, *P. penetrans*, *P. thornei*, *Ditylenchus dipsaci,* migratory ectoparasites: *Rotylenchus robustus, Helicotylenchus dihystera, H. multicinctus* and sedentary ectoparasites: *Paratylenchus hamatus.* Mostly, bacterivores were represented by species from the families: Cephalobidae, Panagrolaimidae*,* fungivores from the families: Aphelenchidae, Aphelenchoididae*.* Maturity index values varied from 2.2 to 3.02, due to the predominance of *cp*2 bacterivores, fungivores, plant parasites and partly *cp* 4, 5 omnivores - carnivores. The development of lateral roots of the rapeseed and the volume of root hairs contribute to increasing the trophic and species diversity of plant parasitic nematodes. The species diversity of nematode communities of rapeseed depends on agriculture management and microclimate (humidity, temperature, soil type and topography).

REFERENCES

ANDRASSY I. 2005. *Free-living nematodes of Hungary*. Hungarian Natural History Museum. Budapest. **5**(1). 497 pp.

ANDRASSY I. 2007. *Free-living nematodes of Hungary*. Hungarian Natural History Museum. Budapest. **5**(2). 475 pp.

BERNARD E. C. & MONTGOMERY-DEE M. E. 1993. *Reproduction of plant-parasitic nematodes on winter rapeseed (Brassica napus ssp. oliifera).* Supplement to Journal of Nematology. Publisher Society of Nematologists, Marceline, MO, ETATS UNIS. **25**(4S): 863-868.

BEZOOIJEN J. V. 2006. *Methods and techniques for nematology*. Publisher, Wageningen University. Netherlands: 112 pp.

BONGERS T. 1990. *The maturity index: an ecological measure of enviromental disturbance based on nematode species composition*. Oecologia. Springer-Verlag. **83**: 14-19.

BONGERS T. 1999. *The Maturity Index, the evolution of nematode life history trails, adaptive radiation and cp-scaling.* Plant and Soil. Springer Link. **212**: 13-22.

BONGERS T. & BONGERS M. 1998. *Functional diversity of nematodes*. Applied Soil Ecology. Elsevier. **10**: 239-251.

BONGERS T. & FERRIS H. 1999. *Nematode community structure as a bioindicator in environmental monitoring.* Trends in Ecology and Evolution. Elsevier. **14**(6): 224-228.

CERTAN A., SOH N., SOH G. 2007. *Rapiţa de toamnă.* Tipografia Centrala. Chisinau. 28 pp.

DE LEY P. & BLAXTER M. 2002. *Systematic position and phylogeny.* Chapter In: Lee D.L. (Ed.) The biology of nematodes. UK, Taylor & Francis. London: 1-30.

FERRIS H., BONGERS T., GOEDE R. G. M. 2001. *A framework for soil food web diagnostics: Extension of the nematode faunal analysis concept*. Applied Soil Ecology. Elvesiver. **18**: 13-29.

JAIRAJPURI M. S. & AHMAD W. 1992. *Dorylaimida: free-living, predaceous and plant-parasitic nematodes*. E. J. Brill. New York. 458 pp.

MICU V. E., CARASTAN D. I., CHISNICEAN V. I. 2005. *Recomendaţii tehnologice în cultivarea rapiţei de toamnă in R. Moldova*. Chisinau. 65 pp.

MORARU G. & PUNTEA A. 2001. *Tehnologia modernă de cultivare în investigarea soiurilor şi hibrizilor de rapiţă de toamnă în Moldova*. Edit. Ştiinţa, Chisinau. 48 pp.

NESTEROV P. I. 1979. *Plant parasitic and free-living nematodes of South-West of USSR*. Edit. Ştiinţa. Chisinau. 312 pp. [In Russian].

NEHER D. 2001. *Role of nematodes in soil health and their use as indicators.* Journal of Nematology (SON Executive Board). **33**: 161-168.

NICKLE W. R. (Ed.) 1991. *Manual of agricultural nematology.* Marcel Dekker. Inc. New York. 1035 pp.

POIRAS LARISA., IURCU ELENA, BIVOL A., MELNIC MARIA, ANTOFICA A. 2009. *Biodiversity of phytonematode communities of rapeseed in cenral and south regions of R. Moldova.* Plant Protection: Achivments and prospectives. Intern. Scientific symposium, Institute of Plant Protection ASM. Chisinau: 77-79. [In Romanian].

PERRY R. N. & MOENS M. 2006. *Plant nematology.* CAB International. Oxfordshire UK, Cambridge USA. 438 pp.

RYSS A. Y. 1988. *Parasitic nematodes of roots of fam. Pratylenchidae (Tylenchida) world fauna*. Nauka. Leningrad. 350 pp. [In Russian].

SIDDIQI M. T. 2000. *Tylenchida. Parasites of plants and insects.* CABI Publishing. 833 pp.

YEATES G. W., BONGERS R. G., GOEDE R. G. M., FRECKMAN D. W., GEORGIEVA S. S. 1993. *Feeding habits in soil nematode families and genera – an outline for soil ecologists*. Journal of Nematology (SON Executive Board). **25**(3): 315-331.

Iurcu-Străistraru Elena, Poiras Larisa
Institute of Zoology, Academy of Science of Moldova,
Academiei Str. 1, 2028, Chişinău, Moldova.
E-mail: iurcuelena@mail.ru
E-mail: poiras@yahoo.co.uk

Received: March 30, 2012
Accepted: June 28, 2012