



MELOIDOGYNE (NEMATODA: HETERODERIDAE) DETECTED IN GREENHOUSES IN ZETA-BJELOPAVLIĆI VALLEY

Igor PAJOVIĆ¹, Georg W. BIRD², Saša ŠIRCA³, Gregor UREK³, Dragana RAJKOVIĆ⁴, László BARSÍ⁵ and Milan RADIVOJEVIĆ⁶

1 University of Montenegro, Biotechnical faculty, M. Lalića 1, 20000 Podgorica,
e-mail: pajovicigor@yahoo.com

2 Michigan State University, East Lansing.

3 Kmetijski Inštitut Slovenije, Ljubljana.

4 University of Novi Sad, Faculty of Agriculture, Novi Sad.

5 University of Novi Sad, Faculty of Science, Department for Biology and Ecology, Novi Sad.

6 University in Beograd, Faculty of Agriculture, Beograd.

SYNOPSIS

Key words:

Meloidogyne species,
greenhouses,
polyacrylamide-gel
electrophoresis.

Twenty greenhouses were selected for the survey, representing various structural types, management systems and willingness of the system manager to cooperate with the project on a long-term basis.

Species within *Meloidogyne* genus can be differentiated using polyacrylamide-gel electrophoresis. Combining malate dehydrogenase (MDH) and esterase (EST) phenotypes patterns were analyzed by calculating relative migration rates (*R_m*). Identification of the species was made by combining morphometric and isozyme phenotypes patterns.

The nematodes were identified as: *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949; *M. arenaria* (Neal, 1889) Chitwood, 1949; *M. javanica* (Treub, 1885) Chitwood, 1949; *M. hapla* Chitwood, 1949 and *M. ardenensis* de Santos, 1968.

INTRODUCTION

Production of vegetables in greenhouses in Montenegro has increased significantly in recent years. Since 2003, 50 hectares of new vegetable greenhouses have been constructed and brought into operation. It is estimated that an additional 100-150 hectares will be developed within the next years. Relatively little is known about the role of plant-parasitic nematodes in relation to crop production in Montenegro. The objectives of this contribution is to present the results of presence

a nematodes from genus *Meloidogyne* survey in 20 vegetable greenhouses of various types, ages and management categories.

Root-knot nematodes, the genus *Meloidogyne*, represent a relatively small, but economically very important, group of obligate plant parasites. They are distributed worldwide and parasitize thousands of higher plant species including monocotyledons, dicotyledons, herbaceous and woody plants (Eisenback & Hirschman, 1991).

They reproduce and feed within the roots and usually cause the formation of knots and galls on roots of susceptible host plants. The physiology of infected plants is disordered, crop yield is reduced and the quality of the plant products is affected (Karssen, 2002). Twenty two root-knot nematode species have been detected in Europe so far, thirteen of them having been described from an European type locality (Karssen & Van Hoenselaar, 1998). Most species were described from agricultural areas. It's interesting to highlight that among all described root-knot nematodes, two species: *M. chitwoodi* Golden, O'Bannon, Santo and Finley, 1980 and *M. fallax* Karssen, 1996 were recently added to the European list of quarantine organisms, to prevent further distribution within Europe. They parasitize on monocotyledons and dicotyledons, including several crop plants as potatoes, carrots and tomatoes (Santo et al., 1980; O'bannon et al., 1982; Karssen, 2002).

Root-knot nematodes were also studied in several regions of former Yugoslavia. Protić mentioned the presence of the root-knot nematodes on tomato and egg plant roots in Hercegovina already in 1926 while Martinović in 1947 established the root knot nematodes on cucumber plants grown in one of glasshouses near Belgrade in Serbia (cited in Grujičić, 1971). KLINDIĆ (1955) reported about damages on red pepper caused by root-knot nematodes in Hercegovina. GRUJIČIĆ (1959) reported about the presence of the *Meloidogyne* spp. on tomato (*Solanum lycopersicum* L.), red pepper (*Capsicum annum* L.), cucumber (*Cucumis sativus* L.), lettuce (*Lactuca sativa* L.), celery (*Apium graveolens* L.) and the weed species *Solanum nigrum* L. on the territory of Serbia where he examined the influence of temperature, moisture and soil on nematode population dynamics. In 1967 GRUJIČIĆ established *M. naasi* Franklin, 1965 on sugar beet, wheat and barley in Serbia. Some reports about damages caused by root-knot nematodes, especially from the regions of Istria and Dalmatia, derived from Croatia; no species were identified (Maceljski, 1967). In 1969 KLINDIĆ & BUMBIĆ isolated *M. incognita*, *M. incognita* var. *incognita* (today the same species), *M. arenaria*, *M. hapla* and *M. javanica* from different locations in Hercegovina. In 1971 GRUJIČIĆ & PAUNOVIĆ for the first time detected *M. hapla* in the open field in Serbia. Grujičić also reported about the presence of *M. incognita*, *M. arenaria*, *M. acrita* (Chitwood, 1949) Esser et al., 1976 (today sinonim for *M. incognita*), *M. hapla* and *M. javanica* on various vegetable plants, particularly in glasshouses in Serbia. KRNJAJIĆ (1977) reported about the spreading of *M. incognita* and *M. arenaria* in

glasshouses in Macedonia. In Slovenia have been founded *M. hapla* and *M. incognita* (Širca et al, 2003).

Summary eight root-knot nematodes are detected in former Yugoslavia (Alpey & Ivezić, 1985), and five in Montenegro, until 2010 (Pajović, 2010) (Table 01). Knowledge about the dissemination of *Meloidogyne* spp. in Montenegro is rather poor, infrequently was reported about the presence of root-knot nematodes in the country. This was the reason for starting more intensive survey on *Meloidogyne* species in greenhouses in Zeta-Bjelopavlići valley. So far, five different species of the genus *Meloidogyne* were detected. The nematodes were identified with morphological and biochemical methods as *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949, *M. arenaria* (Neal, 1889) Chitwood, 1949, *M. javanica* (Treub, 1885) Chitwood, 1949, *M. hapla* Chitwood, 1949 and *M. ardenensis* de Santos, 1968. The last one was detected for the first time not only in Montenegro than in former Yugoslavia countries.

Table 1: Root-knot nematodes reported from ex Jugoslavia countries and Montenegro.

<i>Meloidogyne</i> species	Ex Jugoslavia country	Montenegro
<i>M. ardeniensis</i> Santos, 1968	/	X
<i>M. arenaria</i> (Neal, 1889) Chitwood, 1949	Serbia and in Vojvodina, Bosnia and Herzegovina, Slovenia, Macedonia	X
<i>M. ethiopica</i> Whitehead, 1968	Slovenia	
<i>M. hapla</i> Chitwood, 1949	Serbia and in Vojvodina, Bosnia and Herzegovina, Slovenia	X
<i>M. incognita</i> (Kofoid & White, 1919) Chitwood, 1949 (sin. <i>M. acrita</i>)	Serbia and in Vojvodina, Bosnia and Herzegovina, Slovenia, Macedonia	X
<i>M. javanica</i> (Treub, 1885) Chitwood, 1949	Serbia and in Vojvodina, Bosnia and Herzegovina	X
<i>M. naasi</i> Franklin, 1965	Serbia	

MATERIALS AND METHODS

VEGETABLE GREENHOUSE NEMATODE SURVEY

Twenty greenhouses were selected for the survey, representing various structural types, management systems and willingness of the system manager to cooperate with the project on a long-term basis. Soil and root tissue samples were collected from the 20 sites in 2006 and 2007. Each greenhouse was sampled from one to nine times. Soil sampling consisted of taking two cm-in-diameter cores of soil from a 0-30 cm soil depth, in the planted rows, every four paces throughout the entire greenhouse. The soil was mixed in the laboratory and a 200 g sub-sample

taken for nematode extraction. Each sub-sample was processed for nematodes using Oostenbrink's 1960 modification of Cobb's 1918 procedure combined with the procedure of HRŽIĆ (1973), followed by the Baermann process of 1907 as modified by KRNJAJIĆ & KRNJAJIĆ (1981). The plant parasitic nematodes recovered were identified to genus using both stereoscopic and compound microscope technology.

Whenever a plant was observed to have shoot system symptoms of a possible nematode problem (stunting, wilting, yellowing) during the soil sampling process (Figure 01-04), the root system was removed from the soil, assigned a root-knot nematode gall index number (0-5) and returned to the laboratory for mechanical extraction of root-knot nematode females for species identification. Root-knot species were identified by assessment of perennial patterns (Karszen, 2002).



Figure 1: Symptoms on *Lactuca sativa* L. var. *capitata* crops.



Figure 2: Symptoms on *Beta vulgaris* L. ssp. *vulgaris* var. *cicla* crops.



Figure 3: Symptoms on *Lycopersicon esculentum* Mill. crops.

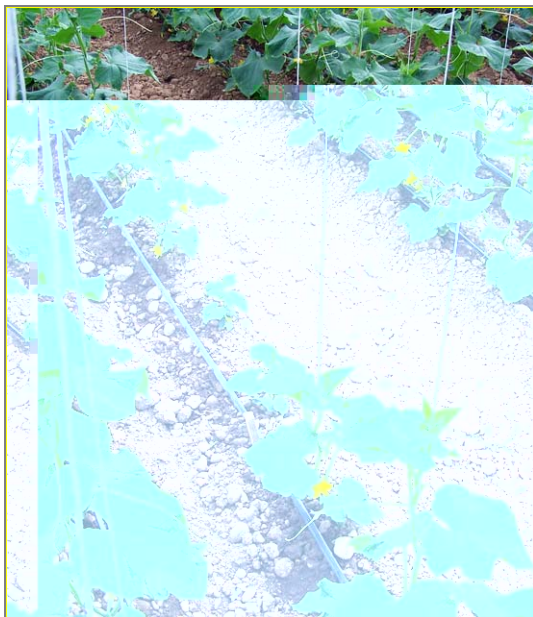


Figure 4: Symptoms on *Cucumis sativus* L. crops.

Isolated males and second juvenile stages were heat killed and fixed in trietanolamin-formalin (T AF) solution while analyzes of female parameters and perineal patterns were made on fresh isolated females. Nematodes were analyzed under microscope, for different life stages different morphological parameters were measured and compared with species characteristic parameters (Karssen, 2002).

ENZYMATIC CHARACTERISATION

Many enzymatic studies have demonstrated that species within *Meloidogyne* genus can be differentiated using polyacriamide-gel electrophoresis (PAGE). PhastSistem (Amersham Biosciences) enables biochemical approach for isozyme phenotyping using very thin (0.4 mm) polyacrylamide slab gel electrophoresis where relatively small amounts of enzyme (single female content) can be analyzed. Combining malate dehydrogenase (MDH) and esterase (EST) phenotypes analyses is possible to distinguish between *Meloidogyne* species (Dalmasso & Berge, 1987; Esbenshade & Triantaphyllou, 1985; Karssen et al., 1995; Širca et al., 2004).

Six young females were isolated from roots samples taken in greenhouses, using scalpel and nematological needles, under dissecting microscope. Roots were placed in a Petry dish and poured over with 0.9% NaCl to prevent female bursting. After isolation females were rinsed with reagent-grade water and transferred to 12 sample-well stamp placed on ice bath. Each female was placed in sample well containing 0.5 μ l of extraction buffer (20% sucrose, 2% Triton X-100, 0.01% Bromphenol Blue) (Esbenshade & Triantaphyllou, 1985) and squashed with needle to release body content. Samples were loaded on two 12/0.3 sample applicator which were placed into applicator arms of the PhastSystem device. For reference species we used *Meloidogyne javanica* (lines 6 and 7).

Electrophoresis took place onto PhastGel gradient (8-25) gel with buffer system according to manufacture instructions. The following adapted program was used (Karssen et al., 1995):

Sample appl. down at	3.2 Vh			
Sample appl. up	at 3.3 Vh			
Sep 3.1400 V	10 mA	2.5 W	10°C	10Vh
Sep 3.1400 V	1 mA	2.5 W	10°C	2Vh
Sep 3.1400 V	10 mA	2.5 W	10°C	125Vh

After electrophoresis gel was stained for enzymatic activity in a Petry dish at 37°C with different staining solutions. MDH staining solution contained 0.05 g β -NAD, 0.03 g Nitro Blue Tetrazoliurn, 0.02 g Phenazine Methosulfate, 5.0 ml 0.5 M Tris pH 7.1, and 7.5 ml stock (10.6 g Na₂C₀3 + 1.34 g L-rnalic acid in 100 ml water) dissolved in 70 ml of reagent-grade water. For EST activity we used staining solution contained 100 ml 0.1 M Phosphate buffer pH 7.3, 0.06 g Fast Blue RR salt, 0.03 g EDTA and 0.04 g α -Naphthyl acetate dissolved in 2 ml acetone (Karssen et al., 1995). Incubation for MDH lasted 5 minutes, after that gel was twice washed with

distilled water and further stained for EST activity for 30 minutes. After isozyme phenotypes patterns were clearly visible the enzymatic reaction was stopped by rinsing gels with distilled water and fixed for 5 minutes in a solution of 10% acetic acid, 10% glycerol and 80% distilled water.

Isozyme phenotype patterns were analyzed by calculating relative migration rates (R_m). Identification of the species was made by combining morphometries and isozyme phenotype patterns. Species specific isozyme pattern supported morphological identification of species done on female perineal patterns and measurements of nematode different life stages.

RESULTS

Meloidogyne species, were recovered in 19 of the 20 vegetable greenhouses sampled (Table 02). *M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla* and *M. ardeniensis* were recovered from one or more of 12 greenhouses. Populations of *Meloidogyne* from an additional seven locations were not identified to species.

Meloidogyne incognita (Fig. 05) was the most common plant-parasitic nematode species detected in Montenegro vegetable greenhouses, being recovered from 11 of the 19 greenhouses infested with root-knot nematodes. *Meloidogyne arenaria* (Fig. 06) was recovered from three of the locations, while *M. javanica* (Fig. 07), *M. hapla* (Fig. 08) and *M. ardeniensis* (Fig. 09) were only detected in one location each. Multiple species of *Meloidogyne* were recovered from three locations, one site having three species and the other two species. Greenhouse 11 having, *M. incognita*, *M. javanica* and *M. arenaria*; Greenhouse 14. having *M. incognita* and *M. javanica* and Greenhouse 15. having *M. arenaria* and *M. ardeniensis*. For all species R_m 's were: *Meloidogyne incognita* 0,36 for MDH and 0,59 for EST. *Meloidogyne arenaria* 0,33 for MDH and 0,6 for EST. *Meloidogyne javanica* 0,34 for MDH and 0,56, 0,6, 0,62 for EST. *Meloidogyne hapla* for MDH 0,57 and 0,65 for EST. *Meloidogyne ardeniensis* 0,37 for MDH and no band for EST (Tab. 03).

The mean root-knot nematode gall indices across all sampling dates and greenhouses ranged from 0.0 to 3.4 (Table 02). Twelve of the greenhouses had gall indices equal to or greater than 3.0 on one or more sampling date, ranging from 25 to 89% occurrence. Greenhouses 2, 14 and 15 had the most serious problems, having gall indices equal to or greater than 3.0 on 67, 56 and 89% of the sampling dates. These greenhouses were sampled 3, 7 and 9 times, respectively. Only *M. incognita* was recovered from Greenhouse 2.; whereas, both *M. incognita* and *M. arenaria* were found in Greenhouse 14. Both *M. arenaria* and *M. ardeniensis* were recovered Greenhouse 15. the location with the greatest number of gall indices equal to or greater than 3.0. *Meloidogyne* spp. were never detected only in Greenhouse 17.

Table 2.: Root-knot nematodes associated with 20 Montenegro vegetable greenhouses.

Site ¹	Type ²	Location ³	Age ⁴	Meloidogyne spp.						Root-knot Gall Index ⁵			Samples with gall index >3.0 (%)
				<i>M. incognita</i>	<i>M. javanica</i>	<i>M. arenaria</i>	<i>M. hapla</i>	<i>M. ardeniensis</i>	<i>M. sp</i>	Mean Index	n ⁶	S.E.	
1	G	Golubovci	28	X						2	3	0,47	33
2	T-L	Golubovačko Polje	3	X						3,3	3	0,58	67
3	T-L	Trešnjica	1	X						1,5	4	1,02	25
4	I	Tološi	5						X	1,7	7	0,77	28
5	I	Trešnjica	2	X						1	4	0,75	0
6	T-S	Trešnjica	4						X	1	3	0,67	0
7	T-S	Trešnjica	6	X						1,5	4	0,66	25
8	T-S	Trešnjica	4	X						2,3	3	0,67	33
9	T-S	Trešnjica	3	X						2	8	0,77	38
10	T-S	Trešnjica	2	X						1,8	4	0,6	25
11	I	Trešnjica	3	X	X	X				2,2	5	0,61	40
12	T-L	Golubovačko Polje	1						X	1	1	0	0
13	T-S	Balabani	2						X	2	3	0,58	33
14	T-S	Trešnjica	2	X		X				2,8	7	0,62	56
15	T-S	Mataguži	4			X		X		3,4	9	0,63	89
16	T-S	Berislavci	3				X			1	1	0	0
17	T-S	Mataguži	3						X	1	1	0	0
18	T-S	Mataguži	3							0	1	0	0
19	T-L	Jelenak DG	18						X	1	1	0	0
20	O	Velja Paprat DG	8						X	1	1	0	0
Site ¹	Vegetable greenhouse												
Type ²	Greenhouse type (G=glass, I=Israeli, T-S=traditional small, T-L=traditional large, O=organic)												
Location ³	Montenegro town												
Age ⁴	Greenhouse age (years)												
Root-knot Gall Index ⁵	0-5 root-knot gall index (0=no galls observed, 5=maximum galling)												
n ⁶	Number of sampling dates used to calculate root-gall index mean												
Species	Detections										%		
<i>M. incognita</i>	10										50		
<i>M. ardeniensis</i>	1										5		
<i>M. arenaria</i>	3										15		
<i>M. javanica</i>	1										5		
<i>M. hapla</i>	1										5		
<i>Meloidogyne</i> spp	7										35		

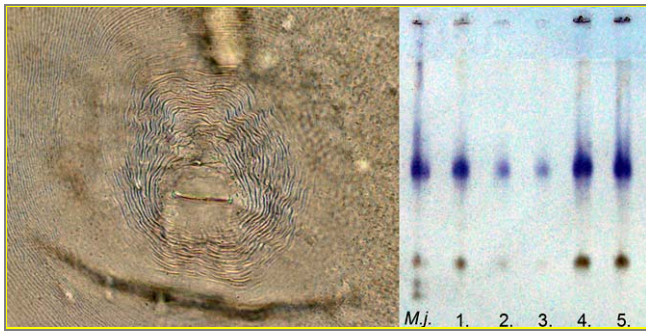


Figure 5: *Meloidogyne incognita* perennial pattern and Isozyme (EST and MDH) phenotype patterns of individual female (lanes 1,2,3,4 and 5).

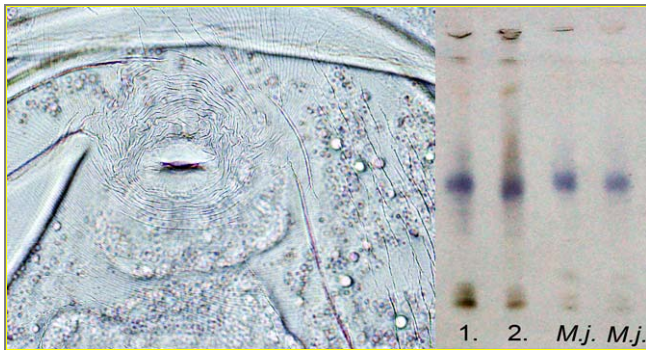


Figure 6: *Meloidogyne arenaria* perennial pattern and Isozyme (EST and MDH) phenotype patterns of individual female (lanes 1, 2).

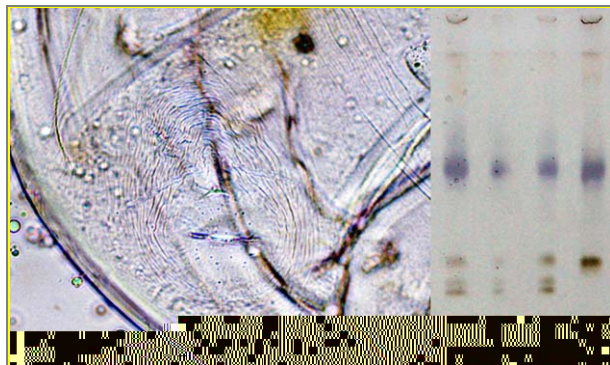


Figure 7: *Meloidogyne javanica* perennial pattern and Isozyme (EST and MDH) phenotype patterns of individual female (lane 1).

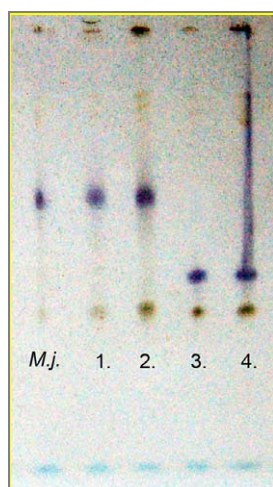


Figure 8: *Meloidogyne hapla* Isozyme (EST and MDH) phenotype patterns of individual female (lanes 3, 4).

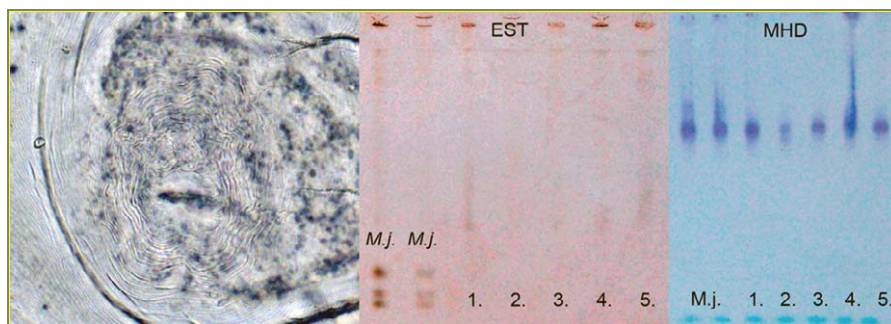


Figure 9: *Meloidogyne ardeniensis* perennial pattern and Isozyme (EST and MDH) phenotype patterns of individual female (lanes 1, 2, 3, 4 and 5).

Table 3: Relative migration rates of *Meloidogyne* species from greenhouses from Zeta-Bjelopavličići valley.

Rm	MDH	EST 1	EST 2	EST 3
<i>M. ardeniensis</i>	0,35			
<i>M. ardeniensis</i>	0,38			
Σ	0,37			
<i>M. incognita</i>	0,35	0,57		
<i>M. incognita</i>	0,39	0,64		
<i>M. incognita</i>	0,34	0,56		
Σ	0,36	0,59		
<i>M. arenaria</i>	0,33	0,6		
Σ	0,33	0,6		
<i>M. javanica</i>	0,34	0,55	0,59	0,62
<i>M. javanica</i>	0,34	0,56	0,6	0,62
Σ	0,34	0,56	0,6	0,62
<i>M. hapla</i>	0,56	0,65		
<i>M. hapla</i>	0,57	0,65		
Σ	0,57	0,65		

DISCUSSION

The results of the nematode survey indicate that *Meloidogyne* spp. are common in Montenegro vegetable greenhouses and can result in major losses in crop productivity.

M. incognita can cause major losses of tomato, cucumber, pepper and lettuce under greenhouse conditions. Although it was the most common root-knot nematode species detected. The greenhouse with the most consistent root gall index equal to or above value of 3.0 was infested with both *M. arenaria* and *M. ardeniensis*. *M. javanica*, *M. hapla* and *M. ardeniensis* were only recovered from a single location. Because root-knot nematode species-specific resistant varieties are available to Montenegro farmers for some vegetable crops, it is imperative that the cause of site-specific root-knot nematode problems be identified to species.

During the survey, it was detected that some Montenegro vegetable farms are planting nematode resistant varieties and using both pre-plant broadcast and post-plant drip applications of nematicides. Since it was not possible to obtain site-specific records about these practices, their use in cooperators' greenhouses may have resulted in an underestimation of the root-knot nematode problem associated with the production of vegetables.

Based on the results of these findings, plans are underway to facilitate accurate nematode problem identification, production and use of nematode-free transplants, proper use of resistant varieties and nematicides and enhancement of the overall soil quality in greenhouse environments. Both on-farm research/nematode management demonstrations and on-farm education programs will be used in these initiatives.

ACKNOWLEDGEMENTS

Special thanks to Marisol Quintanilla.

REFERENCES:

- ALPHEY, T.J.W. & IVEZIĆ, M. 1985: Atlas of Plant Parasitic Nematodes of Yugoslavia. - Scottish Crop Research Institute, Dundee; Agricultural Faculty of the Osijek, pp: 56.
- DALMASSO, A. & BERGE, J.B. 1987: Molecular polymorphism and phylogenetic relationship in some *Meloidogyne* spp.: Application to the taxonomy of *Meloidogyne*. - *Journal of Nematology*, 10: 323 - 332.
- EISENBACK, J.D. & HIRSCHMAN, H.T. 1991: Root Knot Nematodes: *Meloidogyne* Species and Races. In: Nickle, W. R. (Eds), Manual of Agricultural Nematology. - *Marcel Dekker, Inc.*, New York, Basel, Hong Kong, pp: 191-274.

- ESBENSHADE, P.R. & TRIANTAPHYLLOU, A.C. 1985: Use of Enzyme Phenotypes for Identification of *Meloidogyne* Species. - *Journal of Nematology*, 17(1): 6-20.
- GRUJIČIĆ, G. 1959: Efikasnost nekih nematocida kod suzbijanja korenove nematode u staklarama. - *Zaštita bilja*, 55: 63-68.
- GRUJIČIĆ, G. 1967: Korenova nematode (*Meloidogyne* naasi Franklin) u Srbiji, Prethodno saopštenje. - *Zaštita bilja*, 18: 193-197.
- GRUJIČIĆ, G. 1971: Korenove nematode (*Meloidogyne* spp.) na povrtarskim biljkama i mogućnosti suzbijanja preparatima koji nisu fitotoksični. - *Zaštita bilja*, 112-113: 23 - 34.
- GRUJIČIĆ, G. & PAUNOVIĆ, M. 1971: Prilog proučavanju korenove nematode (*Meloidogyne hapla* Chitwood). - *Zaštita bilja*, 112-113: 147-152.
- HRŽIĆ, A. 1973: Izdvajanje nematoda iz zemlje pomoću vrtložnog gibanja. - *Zaštita bilja*, 24(122): 53-60.
- KARSEN, G., VAN HOENSELAAR, T., VERKERK-BAKKER, B. & JANSSEN R. 1995: Species identification of cyst and root-knot nematodes from potato by electrophoresis of individual females. - *Electrophoresis*, 16: 105-109.
- KARSEN, G., VAN HOENSELAAR, T. 1998: Revision of the genus *Meloidogyne* Goldi, 1892 (Nematoda: Heteroderidae) in Europe. - *Nematologica*, 44: 713-788.
- KARSEN, G. 2002: The plant-parasitic nematode genus *Meloidogyne* Goldi, 1892 (Tylenchida) in Europe. - *Koninklijke Brill N.V.*, Leiden, pp. 157.
- KLINDIĆ, O. 1955: Korjenova nematoda (*Heterodera marioni* Cornu) i problem propadanja paprike područja Trebižata. - *Zaštita bilja*, 31: 31-42.
- KLINDIĆ, O. & BUMBIĆ, K. 1969: Rasprostranjenost *Meloidogyne* vrsta na području južne Hercegovine. - *Zaštita bilja*, 106: 355-359.
- KRNJAJIĆ, DJ. 1977: Fitofagne nematode u staklenicima SR Makedonije. - *Zaštita bilja*, 28(4): 429-433.
- KRNJAJIĆ, DJ. & KRNJAJIĆ, S. 1981: Nematologija, praktikum. - Univerzitet u Beogradu, Poljoprivredni fakultet Beograd-Zemun, Beograd, pp. 139.
- MACELJSKI, M. 1967: Problem korijenovih nematoda u Hrvatskoj. - *Biljna zaštita*, 12: 285-288.
- O'BANNON, J.H., SANTO, G.S. & NYCZEPIR A.P. 1982: Host range of the Columbia root-knot nematode. - *Plant Disease*, 66: 1045-1048.
- PAJOVIĆ, I. 2010: Fitoparazitne nematode u plastenicima Zetske ravnice. Doktorska disertacija. - Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad, pp. 97.
- SANTO, G.S., O'BANNON J.H., FINLEY, A.M. & GOLDEN, A.M. 1980: Occurrence and host range of a new root-knot nematode (*Meloidogyne chitwoodi*) in the Pacific Northwest. - *Plant Disease*, 64: 951-952.
- ŠIRCA, S., UREK, G. & KARSEN, G. 2003: Occurrence of the Root-Knot Nematodes *Meloidogyne incognita* and *M. hapla* in Slovenia. - *Plant Disease*, 87(9): 1150.

ŠIRCA, S., UREK, G. & KARSSSEN G. 2004: The incidence of the root-knot nematode *Meloidogyne incognita* and *Meloidogyne hapla* in Slovenia. - *Acta agriculturae slovenica*, 83(1): 15-22.

MELOIDOGYNE (Nematoda: Heteroderidae) UTVRĐENE U PLASTENICIMA U ZETSKO-BJELOPAVLIČKOJ RAVNICI

Igor PAJOVIĆ, Georg W. BIRD, Saša ŠIRCA, Gregor UREK, Dragana RAJKOVIĆ, László BARSÍ i Milan RADIVOJEVIĆ

SINOPSIS

Proizvodnja povrća se značajno povećala u Crnoj Gori poslednjih godina, posebno proizvodnja u zaštićenom prostoru. Monitoring je sproveden u dvadeset objekata zaštićenog prostora koji su izabrani kao reprezentativni za određene tipove i sisteme uzgoja, uz volju vlasnika da sarađuju na duže vrijeme.

Vrste roda *Meloidogyne* mogu se identifikovati koristeći elektroforezu. Identifikacija vrsta je urađena kombinacijom morfometrijskih karakteristika i korišćenjem proračunatih relativnih migracionih koeficijenata (Rm) za malat dehidrogenazu (MDH) i esterazu (EST).

Identifikovane su: *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949; *M. arenaria* (Neal, 1889) Chitwood, 1949; *M. javanica* (Treub, 1885) Chitwood, 1949; *M. hapla* Chitwood, 1949 i *M. ardenensis* de Santos, 1968.

Ključne riječi: vrste roda *Meloidogyne*, objekti zaštićenog prostora, elektroforeza.

Original research article
Received: 6 August 2010.

