COMPARATIVE EARTHWORM RESEARCH IN VARIOUS ECOSYSTEMS WITH DIFFERENT ANTHROPIC IMPACT

Valentina ANDRIUCĂ[1], Daniela GÎRLA[1], Mădălina IORDACHE[2]

[1]State Agrarian University of Moldova, Chisinau
[2]Universiy of Agricultural Sciences and Veterinary Medicine of Banat, Timisoara
Mirceşti Street, No. 44, Chisinau, Republic of Moldova
E-mail: valandriuca@yahoo.com

Abstract: *Using pedofauna research in the integrated agro-ecological monitoring is a necessary perspective, considering that some populations, such as earthworms, characterize the potential soil fertility, health quality and vitality, providing thus ecological stability. Research of pedofauna with positive role for soil fertility allows to monitor the vitality and activity of soil biota and to avoid the critical levels. The present research was conducted in long term field experiments (41 years), in crop rotation, and in monoculture (55 years) at the Didactic Experimental Station "Chetrosu" of the State Agrarian University of Moldova, from Chisinau, Republic of Moldova. Earthworms' numerical research was performed in six different crop agroecosystems, forest strip and in the Scientific Reserve "Codrii". There were investigated the morphological and physical-chemical features of the soil, which was diagnosed as chernozem (FAO System). Earthworms have been collected in soil samples by 0,25 m2, in 8 repetitions, removing the soil up to 40 cm depth, in layers of 10 cm and further quantitative measurements (number, weight, abundance) were made. Also, the formaldehyde method of earthworm extraction from soil was used (ISO 23611-1/2006). According to research results, the earthworm density in the soil of different field agro-ecosystems can be arranged in the following decreasing range: fallow, alfalfa, wheat, corn, sun-flower, peas. As concerning the distribution by depth horizons, was found a larger earthworm number in the tillage soil, in the horizons with humus, roots and plant debris totally or partially decayed.*

Key words: *earthworms, agroecosystems, Pisum sativum L., Helianthus annuus L., Zea mays L., Triticum aestivum L., Medicago sativa L., fallow land, ecological monitoring, chernozeom.*

INTRODUCTION

Earthworms' comparative research in different ecosystems and the anthropogenic impact level have been achieved within the bilateral international project no. 14/RoA for Republic of Moldova, between State Agrarian University of Moldova Department of Agroecology and Soil Science, and University of Agricultural Sciences and Veterinary Medicine of Banat, Timisoara, Romania (project no. 432/16.06.2010). Among global environmental problems facing civilization today, a special role is assigned by environmental pollution phenomena manifested through misguided agricultural, including application of fertilizers which, in addition to the positive role, might play negative roles, especially the ballast elements, and other effects, sometimes toxic for the biotic part of the soil. Among integrated ecological security and ecological monitoring, the biological monitoring occupies a great space. It is that system of observations, assessments and forecasts of all changes found in the living world, but poorly currently applied in soil research. Research of pedofauna, of species with positive role for soil fertility allow the monitoring of vitality and activity of soil biota and avoid the critical levels. Performing the integrated (pedoecologic and impact) monitoring by different approaches and activities facilitates the continuously complex supervision of soils.

Using pedofauna research in the integrated agroecological monitoring is a necessary perspective, considering that some populations, such as earthworms, characterize the potential

soil fertility, quality of health and vitality, and the activity of pedofauna provides ecological stability [COTOMAN and FILIPOV, 2007; DOBROWOLSKI and NIKITIN, 1986].

The literature data show that it is insufficiently investigated the correlation between biological activity of mezofauna and greenhouse gases emanation, but is evidently recognized their role of soil loosening, structure, pedogenesis and fertility. On the other hand, in the literature it is not elucidated the influence of anthropogenic impact problems (organic and mineral fertilizers, soil cultivation, plant protection products) on the pedofauna quality [COTOMAN and FILIPOV, 2007; DOBROWOLSKI and NIKITIN, 1986; FLOREA, 2003; GHILARIOV, 1956; GHILARIOV, 1963].

Data concerning pedofauna research the Republic of Moldova, especially mezofauna, are few and limited to a small number of publications [DOBROWOLSKI and NIKITIN, 1986; GHILARIOV, 1956; GHILARIOV, 1963; URSU and BARCARI, 2011]. Researches on the influence of fertilizers, soil tillage, physical and mechanical properties, crop rotation, crop type, and other factors on pedofauna are very fragmented and poorly raised.

According to several data, earthworms exert a favourable action on humus formation, especially in temperate regions. Introduced in the compost, they favour the decay of organic matter and determine a C/N ratio lower than that obtained only through the activity of microorganisms. The impact of agricultural technology items on earthworms have been also investigated in numerous studies [DOBROWOLSKI and NIKITIN, 1986; GHILARIOV, 1956; GHILARIOV, 1963; IORDACHE and BORZA, 2009; PUIA and SORAN, 1984; URSU and BARCARI, 2011].

MATERIAL AND METHODS

The research was conducted in long term field experiments (41 years), in crop rotation, and in monoculture (55 years) at the Didactic Experimental Station "Chetrosu" (State Agrarian University of Moldova, Chisinau). Earthworms' research in the ecological background monitoring was performed in fallow ecosystems (55 years), forest strip and in the Scientific Reserve "Codrii". There were investigated the morphological and physical-chemical features of the soil, which was diagnosed as chernozem (FAO System). Earthworms have been collected in soil samples by 0,25 m^2, in 8 repetitions, removing the soil up to 40 cm depth, in layers of 10 cm and further quantitative measurements (number, weight, abundance) were made. Also, the formaldehyde method of earthworm extraction from soil was used (ISO 23611-1/2006).

RESULTS AND DISCUSSION

Within the agricultural year 2010-2011 there have been investigated the physical and chemical indices of soil in six agroecosystems listed in table 1.

The performed study on earthworm population density showed that earthworm number in the fallow and alfalfa agro-ecosystems is higher than in other field crops as wheat, peas, corn and sunflower. A lower density of earthworms (21-29 worms/m2) was recorded in pea culture, which can be explained by less branched root system and a smaller quantity of organic debris, deposited on the surface (figure 1).

Because the soil humidity is an important factor for earthworm abundance, the precipitations regime recorded at the Didactic Experimental Station "Chetrosu", Chisinau, Republic of Moldova, is shown in the figure below (figure 2).

Analyses of results showing the earthworm numerical distribution by soil depth demonstrated that in the soil cultivated with peas and sunflower was found a greater earthworm number for the depth 15-30 cm, and in the soil cultivated with maize and winter wheat for the depth 5-30 cm. In alfalfa and fallow agroecosystems, the earthworm number was higher starting from surface down to 30 cm, so a deeper habitat. The increased number of earthworms

in the surface horizons can be explained by the presence of vegetal debris in course of decomposition or totally decayed during the previous years.

Table 1

Physical and chemical indices of soil in the studied agroecosystems (Didactic Experimental Station "Chetrosu")

Variant (agrocoenoses researched)	Depth (cm)	Hydroscopic water (%)	Humus (%)	Exchangeable cations (me/100 g soil)			$CaCO_3$ (%)	pH_{H2O}	Soil particles (%)	
				Ca^{2+} (me/100g soil)	Mg^{2+} (me/100g soil)	$\sum Ca^{2+} + Mg^{2+}$, (me/100g soil)			>0,01	< 0,01
Plowing, manure, (*Zea mays* L., 41 years)	0-10	3,37	3,03	22,7	3,9	26,6	0	6,8	65,33	34,67
	10-20	3,30	2,98	22,8	4,1	26,9	0	6,9	66,09	33,91
	20-30	3,23	2,87	22,7	4,3	27,0	1,8	7,6	65,98	34,02
	30-40	3,09	2,79	22,5	4,0	26,5	2,4	7,7	65,39	34,61
	40-50	2,95	2,68	22,0	3,9	25,9	3,5	7,8	66,86	33,14
	50-60	2,74	2,61	21,7	3,7	25,4	4,8	7,9	67,02	32,98
Plowing, manure (*Pisum sativum* L.)	0-10	3,23	3,28	23,1	4,1	27,2	1,3	7,5	65,74	34,26
	10-20	3,16	3,19	23,0	3,9	26,9	2,0	7,6	66,12	33,88
	20-30	3,09	2,99	22,8	4,2	27,0	2,9	7,8	66,34	33,66
	30-40	3,02	2,78	22,2	4,4	26,6	3,7	7,9	65,76	34,24
	40-50	2,88	2,41	22,6	3,9	26,5	4,4	7,9	65,09	34,91
	50-60	2,67	1,93	22,2	3,7	25,9	5,3	8,0	66,44	33,56
Plowing, manure (*Helianthus annuus* L.)	0-10	3,52	2,98	23,1	5,1	28,2	1,1	7,6	64,11	35,89
	10-20	3,44	2,87	23,2	5,6	28,8	1,5	7,7	63,98	36,02
	20-30	3,37	2,75	23,0	4,9	27,9	2,0	7,7	64,22	35,78
	30-40	3,30	2,68	22,9	4,7	27,6	3,3	7,8	63,85	36,15
	40-50	2,74	2,57	22,5	4,9	27,4	6,2	8,0	64,19	35,81
	50-60	2,60	2,24	21,9	5,1	27,0	7,7	8,2	64,76	35,24
Plowing, manure (*Triticum aestivum* L.)	0-10	3,59	3,17	22,9	5,3	28,2	1,3	7,6	62,13	37,87
	10-20	3,52	3,02	23,0	4,9	27,9	1,8	7,7	62,31	37,69
	20-30	3,44	2,79	22,8	4,7	27,5	2,0	7,8	63,76	36,24
	30-40	3,30	2,43	22,4	4,4	26,8	2,4	7,8	63,39	36,61
	40-50	3,16	1,96	22,0	3,9	25,9	4,0	7,9	64,04	35,96
	50-60	2,95	1,73	22,2	4,1	26,3	5,7	8,1	63,51	36,49
Plowing, manure (*Medicago sativa* L., 55 years)	0-10	3,66	3,29	22,6	5,1	27,7	1,3	7,5	63,78	36,22
	10-20	3,44	3,18	22,3	4,9	27,2	1,3	7,6	64,11	35,89
	20-30	3,37	2,99	22,2	4,7	26,9	1,8	7,7	63,67	36,33
	30-40	3,30	2,83	22,4	3,9	26,3	3,5	7,8	63,59	36,41
	40-50	3,23	2,69	22,1	3,6	25,7	6,4	8,1	63,14	36,86
	50-60	3,02	2,37	21,7	3,8	25,5	8,1	8,1	63,96	36,04
Fallow land, 55 years	0-10	3,52	3,41	23,7	4,9	28,6	1,3	7,6	64,76	35,24
	10-20	3,44	3,29	22,8	5,1	27,9	1,8	7,7	64,54	35,46
	20-30	3,37	2,99	22,9	4,7	27,6	3,3	7,9	65,16	34,84
	30-40	3,16	2,78	22,1	4,8	26,9	4,2	8,0	64,96	35,04
	40-50	2,81	2,49	21,6	5,0	26,6	7,3	8,1	64,45	35,55
	50-60	2,67	1,87	21,0	4,7	25,7	9,2	8,2	65,23	34,7

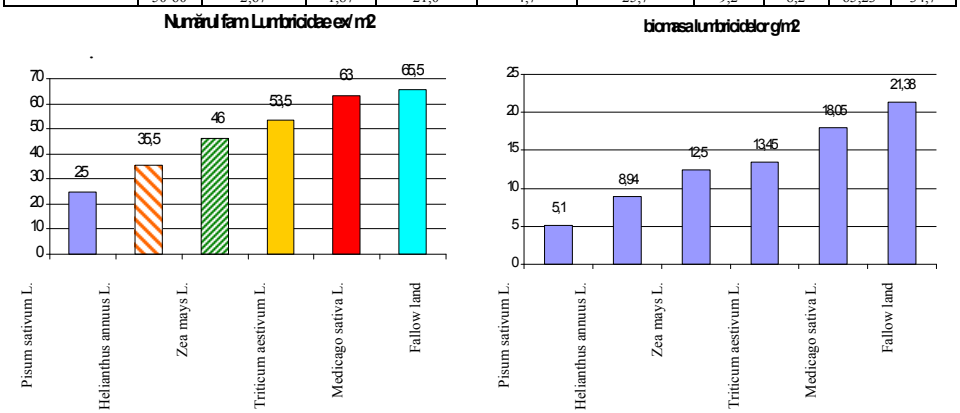

Figure 1. Earthworm number (worms/m2) (left) and biomass (g/m2) (right) in the studied variants (Didactic Experimental Station "Chetrosu")

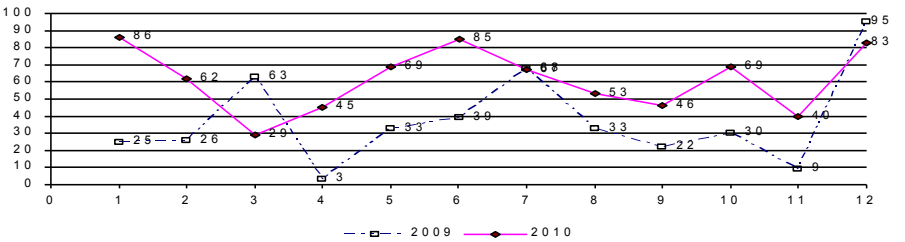

Figure 2. Rainfall regime (mm) at Didactic Experimental Station "Chetrosu", Chisinau, Republic of Moldova

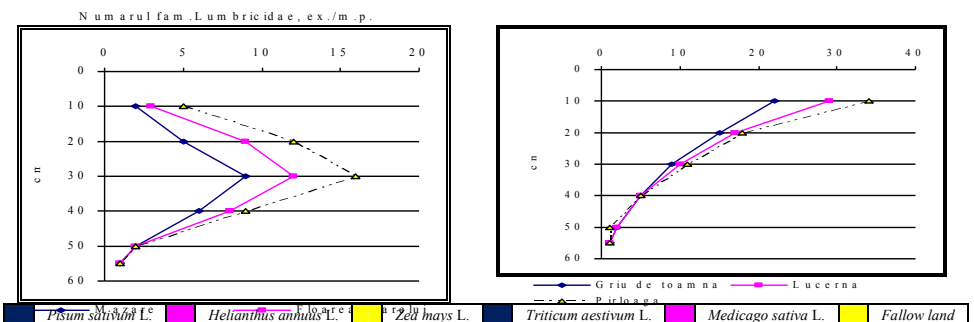

Figure 3. Earthworm numerical distribution (worms/m^2) by depth levels in the studied agroecosystems (Didactic Experimental Station "Chetrosu")

Table 2

Influence of human impact on earthworm number and weight in various ecosystems (2011, May)

Agroecosystems	Basic tillage, fertilizer background	Soil depth (cm)	Earthworm number (worms/0.25 m^2)	Earthworm weight (g/0.25 m^2)
Triticum aestivum L.	Basic tillage, green manure + NPK	0-10	10	17,3
		10-20	8	17,6
		20-30	-	-
		30-40	-	-
	Plowing, cattle manure	0-10	4	14,1
		10-20	6	13,9
		20-30	3	13,1
		30-40	-	-
	Paraplow , green manure + NPK	0-10	23	20,6
		10-20	7	15,3
		20-30	-	-
		30-40	-	-
	Paraplow, cattle manure	0-10	4	19,7
		10-20	4	15,9
		20-30	-	-
		30-40	1	13,6
Buffer land (forest strip)		0-10	8	
		10-20	10	
		20-30	5	
		30-40	-	-
Zea mays L. (monoculture, 41 years)	Paraplow, green manure + NPK	0-10	-	-
		10-20	-	-
		20-30	4	14,4
		30-40	3	13,5
	Paraplow, cattle manure	0-10	3	15,2
		10-20	3	14,4
		20-30	-	-
		30-40	-	-

According to research results, the earthworm density in the soil of different field agro-ecosystems can be arranged in the following decreasing range: fallow, alfalfa, wheat, corn, sun-flower, peas. As concerning the distribution by depth horizons, was found a larger earthworm number in the tillage soil, in the horizons with humus, roots and plant debris totally or partially decayed (figure 3).

In the table 2 there are comparatively exposed the earthworm densities in various ecosystems with different levels of human intervention.

Data obtained for winter wheat (plowing variants and paraplow) fertilized with green manure+NPK and cattle manure demonstrated as previously that soil tillage by paraplow significantly influenced the earthworm number and biomass.

CONCLUSIONS

Earthworms can be used in the biological monitoring, because they are species with a lifespan over two years, large body size enough to allow tissue sampling for analyses, these can be easily extracted from their environment, can live in laboratory conditions, are strong bio-accumulative.

Some factors as tillage, fertilizers, vegetable debris on/from soil directly influence the earthworm populations and their activities.

The paraplow variants associated with cattle manure confirmed a large earthworm number as compared with plowing variants, fertilized with green manure + NPK, which negatively affect the earthworm number and biomass.

The cattle manure is a favourable background for earthworm abundance.

Earthworm density in the soil of different field agro-ecosystems decreased in the following range: fallow, alfalfa, wheat, corn, sun-flower, peas. It was found a larger earthworm number in the tillage soil, in the horizons with humus, roots and plant debris totally or partially decayed.

ACKNOWLEDGEMENTS

Publishing of this paper was financially supported by the following research grants UEFISCDI: PN II-RU-PD no. 109/02.08.2010, code PD-591 and PN II-CAPACITATI module III no. 432/16.06.2010.

BIBLIOGRAPHY

1. COTOMAN, M., FILIPOV, F., 2007 – Ecopedologie. Ion Ionescu de la Brad Publishing House, Iaşi, p. 94;
2. DOBROWOLSKI, G., NIKITIN, E., 1986 – Ecological functions of soil. Moscow: Moscow State University, p. 137;
3. FLOREA, N., 2003 – Degradarea, protectia si ameliorarea solurilor si a terenurilor. Editura Universitara Publishing House, Bucharest, p. 309;
4. GHILARIOV, M.,1956 – Soil fauna investigation as a method in soil diagnostics. Portici, 1956 (b 33). p. 85;
5. GHILAROV, M.S., 1963 – On the interrelations between soil dwelling invertebrates and soil microorganisms. Soil organisms. Amsterdam, North Holland, 1963. p. 255 -259;
6. IORDACHE, MADALINA, BORZA, I., 2009 – Impactul unor elemente de tehnologie agricolă asupra lumbricidelor din sol. Eurobit Publishing House, Timisoara;
7. PUIA, I., SORAN, V., 1984 – Agroecologie: ecosystem si agroecosistem, Agronomia Publishing House, Cluj-Napoca, p. 203;
8. URSU, A., BARCARI, E., 2011 – Solurile Rezervatiei "Codrii", SN Publishing House, Chisinau - Lozova, p 33-36.