THE INFLUENCE OF FERTILIZATION AND EROSION ON MAIZE CROP, GROWN ON ERODED SOIL, AND ON SOIL AGROCHEMICAL AND BIOLOGICAL CHARACTERISTICS

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ABSTRACT *- Investigations conducted during 1997 - 2006 on a cambic chernozem at the Agricultural Research and Development Station of Podu – Iloaiei have studied the influence of different fertilizer systems on yield in wheat and maize crops, and placed in a three-year rotation (pea – wheat – maize). The erosion process has determined the differentiation of average maize yield, according to slope and erosion. The mean annual losses of yield registered in wheat in the last 10 years, caused by erosion, were of 1296 kg/ha (22.1%). On weakly eroded lands, mean maize yields obtained during 1997-2006, were comprised between 3227 kg/ha at the unfertilized control, and 7678 kg/ha at rates of $N_{70}P_{70}$+ 60 t/ha manure. On highly eroded lands, the mean yield obtained under unfertilized was of 2346 kg/ha. Average yield increases obtained by applying 60 t/ha manure, every two years, were of 41.3 kg grains per t of manure applied. Mineral fertilizers ($N_{100}P_{100}$) resulted in obtaining mean yield increases of 13.6 kg grains/kg a.i. of applied fertilizer. On slightly eroded lands, maintaining a good supply level in soil nutritive elements was done by the annual use of fertilizer rates of at least $N_{100}P_{100}$ or $N_{70}P_{70}$+ 40 t/ha manure, applied once in two years, or $N_{70}P_{70}$ + 6 t/ha straw. On highly eroded lands, maintaining a good plant supply in mineral elements was done at rates of N_{140} $P_{100}K_{70}$ or $N_{70}P_{70}$ + 40 t/ha manure. The total number of microarthropods from soil, at the depth of 0-30 cm had values between 22.4 samples/100 cm^2 in the fertilized plot with $N_{70}P_{70}$ + 6 t/ha straw, and 78.5 samples/cm^2 in the fertilized plot with $N_{70}P_{70}$+40 t/ha manure. In most of the fertilization variants, the highest values were registered in Collembole. In case of*

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manure fertilization and on the plot cultivated with perennial grasses and legumes, oribatide became prevalent.

Key words: fertilization, erosion, maize, microarthropods

REZUMAT – Influența fertilizării şi eroziunii asupra porumbului, cultivat pe sol erodat, şi a unor caracteristici biologice şi agrochimice. *Cercetările realizate în perioada 1997 – 2006, pe un cernoziom cambic, la Staţiunea de Cercetare-Dezvoltare Podu-Iloaiei, au urmărit influența diferitelor sisteme de fertilizare asupra producției de grâu şi porumb, într-o rotație de trei ani (mazăre-grâu-porumb). Procesul de eroziune a dus la diferențierea producției medii de porumb, în funcție de pantă şi eroziune. Pierderile medii anuale de producție la grâu , în ultimii 10 ani, datorate eroziunii, au fost de 1296 kg/ha (22,1 %). Pe solurile slab erodate, producțiile medii de porumb, obținute în perioada 1997-2006, au fost cuprinse între 3227 kg/ha la varianta martor nefertilizată şi 7678 kg/ha, la doze de $N_{70}P_{70}$+ 60 t/ha gunoi de grajd. Pe solurile puternic erodate, producția medie obținută în condiții de nefertilizare a fost de 2346 kg/ha. Creşterile medii de producție, obținute prin aplicarea a 60 t/ha gunoi de grajd, la fiecare doi ani, au fost de 41,3 kg /t de gunoi aplicat. Aplicarea îngrăşămintelor minerale ($N_{100}P_{100}$) a dus la creşteri medii de producție de 13,6 kg boabe/kg s.a. îngrăşământ aplicat. Pe solurile slab erodate, menținerea unui nivel bun de alimentare a solului cu elemente nutritive a fost realizat prin aplicarea anuală a dozelor de cel puțin $N_{100}P_{100}$ sau $N_{70}P_{70}$+ 40 t/ha gunoi de grajd, aplicat la fiecare doi ani, sau $N_{70}P_{70}$ + t/ha paie. Pe terenurile puternic erodate, menținerea unei bune alimentări a plantelor cu elemente minerale a fost realizată prin doze de N_{140} $P_{100}K_{70}$ sau $N_{70}P_{70}$ + 40 t/ha gunoi de grajd. Numărul total de microartropode din sol, la adâncimea de 0-30 cm, a fost cuprins între 22,4 indivizi/100 cm^2 , la parcela fertilizată cu $N_{70}P_{70}$ + 6 t/ha paie şi 78,5 indivizi /cm^2 la parcela fertilizată cu $N_{70}P_{70}$+40 t/ha gunoi de grajd. La majoritatea variantelor de fertilizare, valorile cele mai mari au fost înregistrate la Collembole. In cazul fertilizării cu gunoi de grajd, şi pe parcela cultivată cu leguminoase şi ierburi perene, cele mai întîlnite au fost Oribatide.*

Cuvinte cheie: fertilizare, eroziune, porumb, microartropode

INTRODUCTION

The recent concerns of researchers have in view the efficient use of nitrogen fertilizers, in order not to pollute the environment with nitrates and to control soil reaction under allowable limits (Frink et al., 2001, Jităreanu et al., 2006).

FAO projects on the use of fertilizers show that in 2030, this increase will reach 37%, resulting in the augmentation of N_2O emissions by nitrogen fertilization. The results of investigation show that in many countries, nitrogen is not efficiently used, especially in China, where half of nitrogen is lost by volatilization, and 5-10% by leaching. J. Bruisma assesses that in 2030, the amount of nutrients applied on arable lands will reach 71 kg/ha in the industrialized countries and 58 kg /ha in the transition countries. The world consumption of nutrients will increase from 137.7 million t (1999) to 188 million t in 2030 (Bruinsma, 2003, FAO, 2000).

For controlling N_2O and nitrate emissions from farming, the experts propose the development of research by estimating the combined effect of fertilizers, derived from soil stock (P and K), and current fertilization, in order to increase the efficiency of using fertilizers and to study other nutrient sources. These sources are sewage sludge, manure, legumes, etc. (Norse, 2003).

The allowable arable land at the world level, per inhabitant, is decreasing and will be diminished from 0.24 ha, as today, to 0.17 ha in 2020. In Asia, the allowable area for growing will reach in 2020, 800 m^2. At world level, only 12% of the arable area has no restraints for cropping. High areas are affected by aluminum toxicity (23%), 15% of areas is weakly supplied with mobile phosphorus, and 26% has low stocks of mobile potassium. However, the cereals demand for 2020 will reach 3.4 billion t., involving an increase in average cereals yield from 2.9 t/ha, as nowadays, to 4.9 t/ha, in 2020 (Krauss, 2000). The world consumption of mineral fertilizers per inhabitant has increased since 1950 from 5 kg NPK/inhabitant/year to 17 kg (16 kg NPK is the minimum necessary limit for producing food for one human during a year) in 1970, 26 kg in 1988 and maintained to 22.2 kg since 1996 until today (FAO, 2000).

High energetic consumption for the synthesis of one t of nitrogen requires the equivalent energy of 532 l oil or 850 m^3 natural gas. Under conditions when world oil resources are estimated to 1.7 trillion barrels (one barrel = 76.01 l), the investigations of the last period have tried to find other sources of nutrients, which substitute a part of the world nitrogen demand of 80 million t/ha. World stocks of phosphorus (16.1 billion t, of which 80% is in Africa), and potassium (69.1 billion t) ensure plant supply at an annual consumption of 30 million t of phosphorus and 20 million t of potassium, for at least 400 years.

For 2050, a population increase by 50% was estimated, requiring double food consumption. Therefore, the nitrogen demand may increase by four times (FAO, 2000).

Data from Statistical Yearbooks of Romania (1975, 1990, and 2000) and of the Ministry of Agriculture, Waters, and Forests show that the area of arable lands has decreased by 6%, compared to 1975, while the area occupied with grasslands, yards, and buildings has increased by 10%, respectively, 4%.

The arable area per inhabitant in Romania has decreased from 0.707 ha (1930) to 0.42 ha in 2000. Of the total arable land in Romania (9.379331 ha), only 3.8 million ha meet the minimum requirements for developing a competitive agriculture. Data given by the Ministry of Agriculture, Waters, and Forests in 2000 show that the area of suitable arable lands (3.8%, 354880 ha) and with low restraints (35.8%, 3.352683 ha) was of 39.6% (3707563 ha). The weight of arable lands with mean restraints (the third class of suitability) is 25.2 % (2364014 ha), while the arable area with high and very high restraints (the fourth and the fifth class - lands with low and very low suitability) is 35.2% (3307754 ha). In Romania, total fertilizer consumption (N, P_2O_5, K_2O) has continuously decreased since 1986, from 1295 thousands t to 305 thousands t in 1999. Total fertilizer consumption has decreased in that period from 86 kg/ha to 21 kg/ha. This diminution is reflected by soil agrochemical parameters, by decreasing areas with very low contents of NPK.

Data from the Ministry of Agriculture, Waters, and Forests show that at the end of 2000, 4.525 million ha of arable land had a low or extremely low humus stock, 1.867 million ha had a moderate and high acidity (pH under 5.6), 3.401 million ha, a low and very low supply in mobile phosphorus, 3.061 million ha were weakly supplied with nitrogen, 0.312 million ha were weakly and very weakly supplied with mobile potassium, and 1.5 million ha lacked microelements, especially zinc. The areas are also affected by other limitative factors of productive capacity, such as the deterioration of soil structure and compaction, caused by improper soil tillage (6.5 million ha), primary soil compaction (2.06 million ha) and tendency to crust formation (2.3 million ha).

MATERIALS AND METHODS

Investigations conducted during 1997 - 2006 on a cambic chernozem at the Agricultural Research and Development Station of Podu - Iloaiei, Iasi County, have studied the influence of different fertilizers systems on yield in wheat and maize crops, and placed in a three-year rotation (pea – wheat – maize). For each crop, three fertilization systems were experienced: mineral fertilization with nitrogen and phosphorus rates until $N_{140}P_{100}$, manure fertilization (20, 40, and 60 t/ha), with and without mineral fertilization and mineral fertilizers + hashed residue applied in autumn under the base ploughing.

The typical cambic chernozem from Podu - Iloaiei was formed on a loess loam, has a mean humus content (3.1 - 3.4%), is well supplied with mobile potassium (215 - 235 ppm) and moderately with phosphorus (24-58 ppm) and nitrogen (0,160 - 0,185%). In maize, the Oana hybrid was used.

Mobile forms of mineral nitrogen ($N\text{-}NO_3$ and $N\text{-}NH_4$) have been determined spectrophotometrically, and the total nitrogen content has been determined by the Kjeldahl method. Determination of elements content was done by the following methods: spectrophotometrical (P), and flamphotometrical (K, and Ca). Mg and heavy metals content was determined by spectrometry with atomic absorption.

Fauna material was studied at microscope, for each station, the global average abundance of systematic groups/ 100 cm^2 being noticed for each sample.

RESULTS AND DISCUSSION

The climatic conditions during 1997-2006 were favorable to maize growing and development in seven years, and unfavorable, due to low rainfall amount, in the other three years. In the last 10 years, the deficit of rainfall registered during January - August (382.8 mm), compared to the multiannual mean of the area, was between 33.1 and 90.9 mm in three years.

On weakly eroded lands, the average maize yield obtained during 1997-2006, under unfertilized, was of 3227 kg/ha, and on highly eroded lands, it decreased to 2346 kg/ha (*Table 1*). At the rate of $N_{100}P_{100}$, the average maize yield obtained at the same period was of 6419 kg/ha on weakly eroded soil, and of 5058 kg/ha on highly eroded soils. Under climatic conditions of 1997- 2006, mineral fertilizers applied at high rates ($N_{140}P_{100}$) determined yield increases of 3862 kg/ha (120%) on weakly eroded soils, and of 3254 kg/ha (139%) on highly eroded soils. The use of moderate rates of mineral fertilizers ($N_{70}P_{70}$) with 60 t/ha manure resulted in yield increases between 4451 (138%) and 3767 (161%) kg/ha, according to soil erosion condition. Very close yield results were also obtained by applying, for 42 years, rates of $N_{70}P_{70}$ + 3 t/ha stalks of pea or soybean. Yield increases have varied, according to soil erosion, between 3005- 3067 kg/ha (93-95%), on weakly eroded lands, and between 2579-2640 kg/ha (110-113%) on highly eroded lands. The analysis of results obtained has shown that the erosion process, by decreasing soil fertility, has determined the differentiation of mean maize yield, according to slope and erosion, from 5869 (100%) to 4573 (77.9%) kg/ha. Mean annual losses of yields, registered in maize in the last 10 years, caused by erosion, were of 1296 kg/ha (22.1%). The yield differences caused by erosion on slope lands were very high if we had in view that yields were registered at a drier period, when erosion and nutrient losses from soil were lower. The analysis of results on the influence of combined nitrogen and phosphorus fertilization in maize yield has shown that the best economic mean rate was of $N_{100}P_{100}$, where yield increase was between 3192 and 2712 kg/ha, representing 16.0-13.6 kg grains for each kg a.i. of applied fertilizer, according to erosion degree. Very good results were obtained in the case of using a mean rate of chemical fertilizers with manure or residues from fore crops rich in nitrogen, phosphorus, and potassium. Soil nutrient losses were very high on slope lands, due to leaching, runoff, and element fixing. Establishing rates and time of fertilizer application must be done in a differentiate way, according to soil characteristics, cultural practices and climatic conditions.

On slope lands, poor in humus and mineral elements, the use of residues had a special importance for improving soil fertility indicators. The long-term use of residues determined a better soil conservation by increasing humus and mineral

element stock from soil, resulting in a decrease with time, in the necessary of nitrogen and phosphorus fertilizers for crops.

Table 1

Influence of mineral and organic fertilizers on maize yields on eroded lands, after 42 years of experiments (Oana hybrid)

No.	Fertilizer rate	Weakly eroded soil				Highly eroded soil			
		Mean maize yields		Difer. kg/ha	Sign.	Mean maize yields		Difer. kg/ha	Sign.
		kg/ha	%			kg/ha	%		
1	N_0P_0	**3227**	100			**2346**	100		
2	$N_{40}P_{40}$	**4116**	128	889	***	**3155**	134	809	***
3	$N_{70}P_{70}$	**5526**	171	2299	***	**4241**	181	1895	***
4	$N_{100}P_{100}$	**6419**	199	3192	***	**5058**	216	2712	***
5	$N_{140}P_{100}$	**7089**	220	3862	***	**5600**	239	3254	***
6	$N_0P_{70}K_{70}$	**3622**	112	395	*	**2675**	114	329	*
7	$N_{40}P_{40}K_{40}$	**4372**	135	1145	***	**3491**	149	1145	***
8	$N_{70}P_{70}K_{70}$	**5645**	175	2418	***	**4548**	194	2202	***
9	$N_{100}P_{100}K_{100}$	**6735**	209	3508	***	**5346**	228	3000	***
10	$N_{140}P_{100}K_{100}$	**7259**	225	4032	***	**5827**	248	3481	***
11	20 t/ha manure	**4439**	138	1212	***	**3464**	148	1118	***
12	40 t/ha manure	**5567**	173	2340	***	**4181**	178	1835	***
13	60 t/ha manure	**6374**	198	3147	***	**4823**	206	2477	***
14	$N_{40}P_{40}$ +20 t/ha manure	**5722**	177	2495	***	**4172**	178	1826	***
15	$N_{40}P_{40}$+40 t/ha manure	**6558**	203	3331	***	**4832**	206	2486	***
16	$N_{40}P_{40}$+60 t/ha manure	**6992**	217	3765	***	**5477**	233	3131	***
17	$N_{70}P_{70}$+20 t/ha manure	**6543**	203	3316	***	**5042**	215	2696	***
18	$N_{70}P_{70}$+40 t/ha manure	**6998**	217	3771	***	**5625**	240	3279	***
19	$N_{70}P_{70}$+60 t/ha manure	**7678**	238	4451	***	**6113**	261	3767	***
20	$N_{70}P_{70}$+6 t/ha hashed straw	**6119**	190	2892	***	**4963**	212	2617	***
21	$N_{70}P_{70}$+6 t/ha stalks of maize	**6041**	187	2814	***	**4808**	205	2462	***
22	$N_{70}P_{70}$+3 t/ha stalks of pea	**6294**	195	3067	***	**4986**	213	2640	***
23	$N_{70}P_{70}$+3 t/ha stalks of soybean	**6232**	193	3005	***	**4925**	210	2579	***
24	$N_{70}P_0K_0$	**5298**	164	2071	***	**4044**	172	1698	***
	Mean	**5869**	100	-		**4573**	**77.9**	**1296**	
	LSD 5%			340				320	
	LSD 1%			460				440	
	LSD 0.1%			610				590	

Analysis of agrochemical data has shown that nitrogen fertilizers (ammonium nitrate) had determined pH decrease. A significant diminution was registered in ploughed layer, at rates of 140 kg/ha N, where pH value has reached 5.6 after 42 years (*Table 2*).

The results of chemical analyses have shown that in pea-wheat-maize rotation, by annual application of rate of $N_{100}P_{100}$, the decrease in humus content from soil could not be prevented, its level increasing only in variants where

mineral fertilizers were applied with manure or crop residues (*Table 2*). In that case, the values registered by other macronutrients (K, Ca, Mg) have shown that soil supply was normal, compared to crop demands. Maintaining main soil chemical characteristics under favourable limits for plant growing and development was done only in case of organo-mineral fertilization.

Table 2

Change of main agrochemical indices of soil as influenced by fertilizers, after 42 years of experiments

Fertilizer rate	pH (H_2O)	Humus (%)	N_t (%)	P-AL (ppm)	K-AL (ppm)	Ca	Mg
						mg/100 g soil	
Weakly eroded cambic chernozem							
N_0P_0	7.0	3.10	0.141	18	172	11	3.1
$N_{70}P_{70}$	6.5	2.94	0.159	47	170	13	3.7
$N_{100}P_{100}$	6.2	3.10	0.179	78	168	13	4.2
$N_{140}P_{100}$	5.8	3.12	0.198	88	156	14	4.9
60 t/ha manure	7.2	3.96	0.178	64	246	16	5.5
$N_{70}P_{70}$ + 60 t/ha manure	7.0	4.18	0.192	94	234	18	6.0
$N_{70}P_{70}$ + 6 t/ha hashed of wheat	6.8	3.46	0.182	62	238	14	3.9
Average	**6.6**	**3.41**	**0.176**	**64**	**198**	**14**	**4.5**
Highly eroded cambic chernozem							
N_0P_0	6.9	2.76	0.121	11	162	9	2.2
$N_{70}P_{70}$	6.3	2.64	0.143	36	159	11	3.1
$N_{100}P_{100}$	5.9	2.82	0.154	64	154	12	3.6
$N_{140}P_{100}$	5.6	2.98	0.186	76	139	12	4.6
60 t/ha manure	7.0	3.54	0.163	52	224	15	5.2
$N_{70}P_{70}$ + 60 t/ha manure	6.8	3.76	0.179	78	198	16	5.5
$N_{70}P_{70}$ + 6 t/ha hashed of wheat	6.6	3.37	0.175	56	206	13	3.6
Average	**6.4**	**3.12**	**0.160**	**53**	**177**	**13**	**4.0**

On slightly eroded lands, maintaining a good supply in soil nutritive elements was done by the annual use of fertilizer rates of at least $N_{100}P_{100}$ or $N_{70}P_{70}$+ 40 t/ha manure, applied once in two years, or $N_{70}P_{70}$ + 6 t/ha straw. On highly eroded lands, maintaining a good plant supply in mineral elements was done at rates of N_{140} $P_{100}K_{70}$ or $N_{70}P_{70}$ + 40 t/ha manure (*Table 2*). Under these conditions, the humus content from soil, after 42 years of experiencing, was maintained at the initial value.

The investigations have shown that crop rotation and fertilization resulted in the change of microbial associations from soil, which contributed to the mineralization of the organic matter and formation of humus from soil.

The results concerning the effect of technological links on the association structure of edaphic fauna from slope lands pointed out differences of high values, caused by the variation of climatic factors and the degree of man' s interference in the studied agro-ecosystem (*Figure 1*). The high dependence of microorganisms

on the crop structure and soil nutrients resulted in differentiating composition and number of microorganisms from soil, which were higher in case of organo-mineral fertilization. The nature and intensity of soil biological activity were established by microorganism's structure and abundance that developed in connection with cultivated plants, soil and climatic conditions, and technological factors.

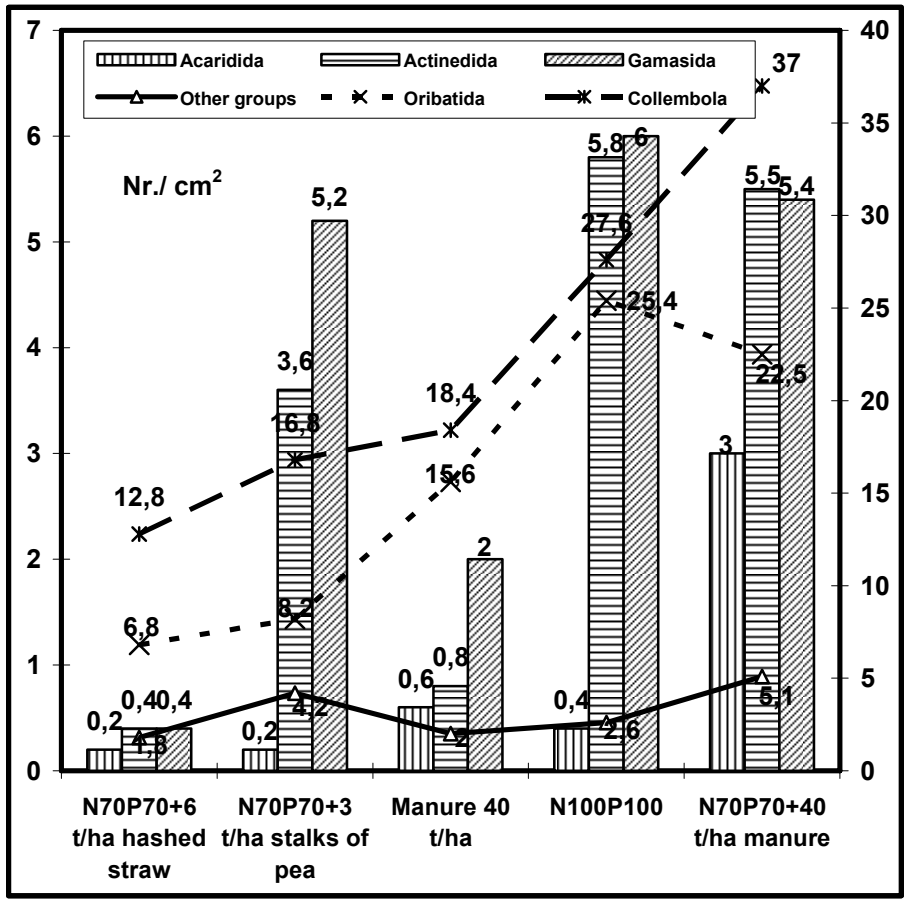

Figure 1 - Influence of mineral and organic fertilizers on of edaphic fauna on slope lands

Applying manure has resulted in stimulating soil mesofauna by the increased amount of nutrients and organic matter. Microarthropods took part to the division into fragments of organic matter, to the process of microbial catalysis and chemical degradation of carbonic compounds, releasing and recycling nutrients from soil. Oribatide/ collembola ratio had values below one at mineral fertilized variants and values above one at variants, where crop residues and

60 t/ha manure were administered. The prevalence of collembola indicates an intense mineralization and release of nutrients, with good effect on crops, and a rapid soil depletion of mineral elements and organic matter. The highest value of arthropods denseness was registered in manure treated soil, where groups of micro-phytophagues were introduced in soil. The average denseness of edaphic arthropods was of 67.8 /100 cm^2 samples in the plot fertilized with $N_{100}P_{100}$ and 78.5 in the plot fertilized with $N_{70}P_{70}$ + 40 t/ha manure.

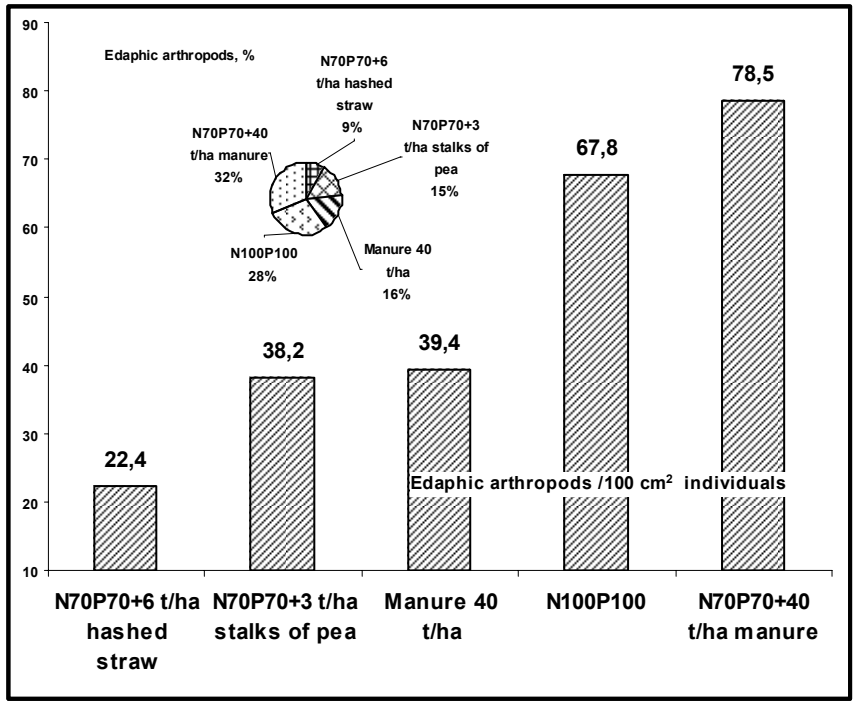

Figure 2 - Total number of microarthropods (samples/100 cm^2) and their weight (%) under different fertilization conditions

Among insects, the representatives of order *Collembola*, with detritomicro-phytophagous feeding regime had the highest denseness at the variant fertilized with manure. The lowest denseness was found in the plot where $N_{70}P_{70}$+6 t/ha straw was applied. The ratio between the main groups of detritomicro-phytophague – oribatid microarthropods and collembola, with values below one at all the mineral fertilization variants, indicates an intense mineralization of chemical products and a rapid nutrient recycling. Oribatide/collembola ratio with values over one from the plot treated with manure is an indicator of quality and of humification stage of organic substratum, which shows the prevalence of humification process of organic matter. Soil mesofauna was stimulated directly by

manure and indirectly by increased nutrient contribution ($N_{100}P_{100}$), which has stimulated canopy and diminished the negative impact of mineral fertilizers on microorganisms. The lowest value of the density of microarthropods was registered in the plot fertilized with $N_{70}P_{70}$ + 6 t/ha straw (22.4 samples/cm^2), because of slow decomposition of crop residues (*Figure 2*). In the balanced variants, fertilized with nitrogen and phosphorus, and in organo-mineral fertilized plots, the percentage of microarthropods was double, in comparison with the mean of variants. Administering wheat straws has diminished the rate of biodegradation, which was noticed by ratio between Oribatide/ collembola (Figure 3). The field without canopy has negatively influenced the number and structure of microarthropods from soil. Of the total number of microarthropods registered in the plot without canopy, oribatide had a weight of 40%, followed by collembola with 29%. In the plot with perennial grasses and legumes, the ratio was modified to the advantage of collembolla (38%), followed by oribatide, which had a weight of 35% (*Figure 3*).

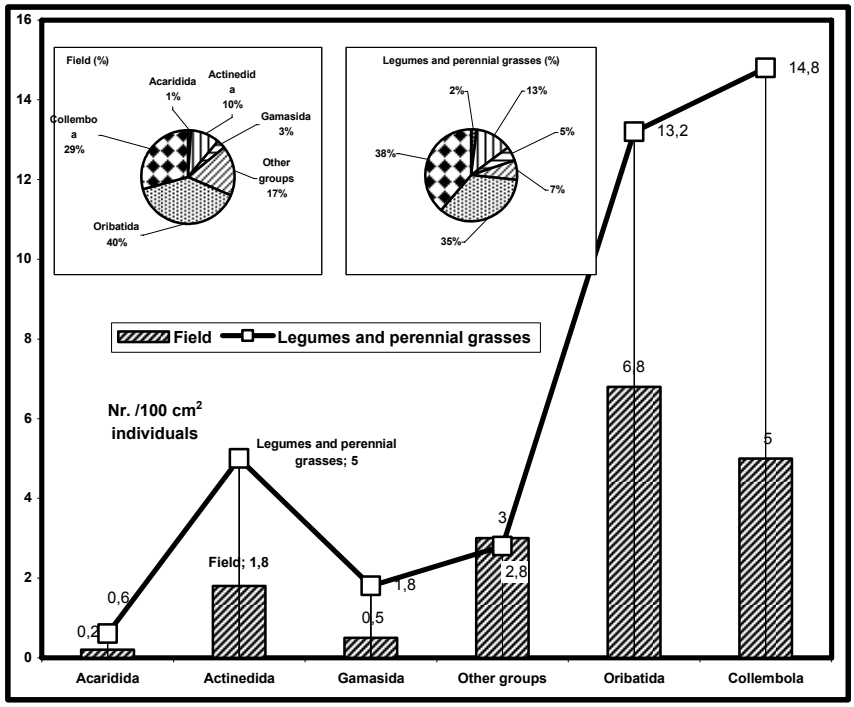

Figure 3 - Number of microarthropods (samples/100 cm^2) and their rate (%) on cambic chernozem cultivated with perennial grasses and legumes

CONCLUSIONS

The erosion process, by decreasing soil fertility, determined the differentiation of average maize yield, according to slope and erosion, from 5869 (100%) to 4573 kg/ha (77.9%). Mean annual losses of yield registered in wheat, in the last 10 years, due to erosion, were of 1296 kg/ha (22.1%).

On weakly eroded lands, mean maize yields obtained during 1997-2006, were comprised between 3227 kg/ha at the unfertilized control and 7678 kg/ha at rates of $N_{70}P_{70}$+ 60 t/ha manure.

On highly eroded lands, in a three-year rotation (maize after wheat), the mean yield obtained under unfertilized was of 2346 kg/ha. Average yield increases obtained by applying 60 t/ha manure, every two years, were of 41.3 kg grains per t of manure applied. Mineral fertilizers ($N_{100}P_{100}$) resulted in obtaining mean yield increases of 13.6 kg grains/kg a.i. of applied fertilizer.

On slightly eroded lands, maintaining a good supply level in soil nutritive elements was done by the annual use of fertilizer rates of at least $N_{100}P_{100}$ or $N_{70}P_{70}$+ 40 t/ha manure, applied once in two years or $N_{70}P_{70}$ + 6 t/ha straw. On highly eroded lands, maintaining a good plant supply in mineral elements was done at rates of N_{140} $P_{100}K_{70}$ or $N_{70}P_{70}$ + 40 t/ha manure.

The total number of microarthropods from soil, at the depth of 0-30 cm had values between 22.4 samples/100 cm^2 in the fertilized plot with $N_{70}P_{70}$ + 6 t/ha straw, and 78.5 samples/cm^2 in the fertilized plot with $N_{70}P_{70}$+40 t/ha manure. In most of the fertilization variants, the highest values were registered in Collembole. In case of manure fertilization and on the plot cultivated with perennial grasses and legumes, oribatide became prevalent.

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