ORIGINAL PAPER

THE EFFECT OF CATTLE LIQUID MANURE FERTILIZATION ON THE SOIL MITES (ACARI) OF PERMANENT MEADOW IN POLAND

WPŁYW NAWOŻENIA GNOJOWICĄ BYDLĘCĄ NA ROZTOCZE GLEBOWE (ACARI) ŁĄKI TRWAŁEJ W POLSCE

RADOMIR GRACZYK, STANISŁAW SENICZAK, BEATA WASIŃSKA - GRACZYK

Department of Ecology, University of Technology and Life Sciences, ul. Kordeckiego 20, 85-225 Bydgoszcz, Poland,
Phone: (+) 48 52 374 9383, Fax: (+) 52 374 9327, e-mail: graczyk@utp.edu.pl

Manuscript received: May 13, 2008; Reviewed: December 6, 2008; Accepted for publication: January 13, 2009

ABSTRACT

The effect of different doses of cattle liquid manure, with or without the VIT-TRA agent, on the mites of permanent meadow, with species analysis of oribatid mites (Acari, Oribatida) was investigated. Samples were taken from 13 plots, fertilized with cattle liquid manure in doses 40, 60 and 80 $m^3 \cdot ha^{-1}$ and VIT-TRA agent. The dose 40 $m^3 \cdot ha^{-1}$ increased the abundance of mites, comparing to the control plot, while doses 60 and 80 $m^3 \cdot ha^{-1}$ decreased it. The fungicidal agent, with medium and high dose of fertilizer, significantly decreased the density of Oribatida, Gamasida and Actinedida in relation to small dose of fertilizer with this agent. The mites reacted in a similar way to the bactericidal agent, but acting of virocidal agent was indistinct. The Oribatida dominated among the mites, while the Actinedida and Gamasida were less abundant. Among the Oribatida the most abundant were: Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata and Scheloribates laevigatus. The Oribatida preferred the lower part of grasses, and their density distinctly decreased with the soil depth.

KEY WORDS: cattle liquid manure, permanent grassland, Acari, Oribatida.

STRESZCZENIE

Zbadano wpływ nawożenia gnojowicą bydlęcą, z oraz bez dodatku środka VIT-TRA, na roztocze glebowe łąki trwałej, z gatunkową analizą mechowców (Acari, Oribatida). Próby do badań pobrano z 13 poletek doświadczalnych, nawożonych gnojowicą bydlęcą w dawkach 40, 60 i 80 $m^3 \cdot ha^{-1}$ oraz z dodatkiem preparatu dezynfekującego. Dawka 40 $m^3 \cdot ha^{-1}$ zwiększyła liczebność roztoczy, w tym dominujących mechowców w porównaniu z powierzchnią kontrolną, natomiast dawki 60 i 80 $m^3 \cdot ha^{-1}$ wpłynęły na nie ograniczająco. Dodatek środka grzybobójczego, przy średniej i wysokiej dawce nawozu, spowodował zmniejszenie liczebności Oribatida, Gamasida i Actinedida względem niskiej dawki nawozu z tym środkiem, co potwierdzono statystycznie. Podobną reakcję wywołał dodatek środka bakteriobójczego, natomiast preparat wirusobójczy działał niewyraźne. Wśród roztoczy dominowały Oribatida, natomiast Actinedida i Gamasida były mniej liczne. Wśród mechowców najliczniejsze były: Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata i Scheloribates laevigatus. Mechowce preferowały dolny poziom traw, a ich zagęszczenie zmniejszało się wraz z głębokością.

SŁOWA KLUCZOWE: gnojowica bydlęca, trwały użytek zielony, Acari, Oribatida.

DETAILED ABSTRACT

W pracy zbadano wpływ nawożenia gnojowicą bydlęcą, z oraz bez dodatku środka VIT-TRA, na roztocze łąki trwałej w Polsce, z gatunkową analizą mechowców (Acari, Oribatida). Próby pobrano z trwałego użytku zielonego, należącego do RZD Minikowo, będącego jednostką doświadczalną Uniwersytetu Technologiczno-Przyrodniczego w Bydgoszczy, z 13 poletek doświadczalnych, nawożonych gnojowicą bydlęcą w dawkach 40, 60 i 80 $m^{3}\cdot ha^{-1}$ oraz z dodatkiem preparatu dezynfekującego. Próby do badań o powierzchni 17cm^2 i wysokości 9cm pobrano w 10 powtórzeniach jesienią 2006 roku i podzielono na 3 poziomy: dolną część traw (Tr, 3-0cm) oraz 2 podpoziomy glebowe, P_1 (1-3cm) i P_2 (4-6cm). Roztocze wypłaszano w zmodyfikowanych aparatach Tullgrena, konserwowano i oznaczano. Łącznie uzyskano 6 319 roztoczy. Dawka gnojowicy 40 $m^{3}\cdot ha^{-1}$ zwiększyła liczebność roztoczy, w tym dominujących mechowców w porównaniu z powierzchnią kontrolną, natomiast dawki 60 i 80 $m^{3}\cdot ha^{-1}$ wpłynęły na nie ograniczająco. Dodatek środka grzybobójczego przy średniej i wysokiej dawce nawozu ograniczył liczebność Oribatida, Gamasida i Actinedida względem niskiej dawki nawozu z tym środkiem, co potwierdzono statystycznie. Podobną reakcję wywołał dodatek środka bakteriobójczego, natomiast preparat wirusobójczy działał niewyraźne. Wśród roztoczy dominowały mechowce, natomiast Actinedida i Gamasida były mniej liczne. Wśród mechowców najliczniejsze były: Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata i Scheloribates laevigatus. Mechowce preferowały dolny poziom traw, a ich zagęszczenie zmniejszało się wraz z głębokością.

INTRODUCTION

Meadows are very important parts of natural, agricultural environment and human surroundings. They provide the fodder for cattle breeding and the other farm animals, have extremely high nutrition value and are relatively cheap [7,17]. Permanent grasslands contribute to the air treatment, soften extremes of temperature and air humidity, and by water retention reduce the water erosion and danger from floods [9,10,11].

One of the best way of increasing production of meadows is fertilization, which quickly improves soil fertility and ionic management in plants [1]. Among organic fertilizers cheap is a cattle liquid manure, which stimulates plants growth and enriches the soil in organic matter, having intermediate value between mineral fertilizers and dung. However, high doses of this fertilizer can limit the plant growth and soil, especially during vegetation. Besides, a liquid manure contains a large number of pathogenic bacteria, which can be dangerous for domestic animals and people. Therefore, we should improve the hygienic state of liquid manure by using disinfectant agents.

The fertilization of meadows with cattle liquid manure enriches the soil in organic matter and humus, what is profitable for soil mites, especially for the Oribatida, which are important decomposers of organic matter. By decomposition of organic matter, these mites take a part in nutrient cycling in the soil, with a great participation of microorganisms [19]. Therefore, the abundance and species diversity of Oribatida in meadows can indicate the condition of soil biology after treated it with cattle liquid manure [13].

The aim of this study was to assess the influence of cattle liquid manure, with or without the VIT-TRA agent, on the abundance of soil mites, and species composition and domination structure of oribatid species.

STUDY AREAS

The investigated meadow is situated in the Valley of Bydgoszcz Canal, about 25 km from Bydgoszcz (northern Poland), and belongs to the Agricultural Experimental Station, University of Technology and Life Sciences in Minikowo. It is a postglacial valley that extends between Bydgoszcz and Naklo, which has about 2 km width and 27 km in length. The floor of the valley is flat, with small longitudinal and transverse downfalls [8].

The investigated meadow is a part of large Notec moor complex area, which were used as a meadow from the end of 18th century. At present this permanent grassland is two-hay-growing, used rather extensive, so the soil has a low content of macroelements, what makes this meadow

Table 1. The content of components in the soil (%).
Tabela 1. Zawartość składników w glebie (%).

Components	Value (%)
Nitrogen	0,68 – 3,0
Phosphorus	0,15 – 0,6
Potassium	0,06 – 1,4
Organic matter	45,87
pH	7,3 – 7,7

sensitive to the cattle liquid manure fertilization. The soil belongs to the peat-muck soils, with about 20 cm peat layer on average. According to Roguski [18] this soil has low content of macroelements (tab. 1).

The climate of investigated area is a transitional one, effected both by continental climate from the East and maritime climate from the West. The temperature is about 7,5°C on average, precipitation is about 491 mm on average. The highest precipitation is usually in July, and the lowest in February or March [24].

The plant association belongs to the herbal-gramineous plant community, with dominance of reed canarygrass (Phalaris arundinacea L.) and redtop (Agrostis gigantean Roth.) (table 2). Locally dominated red fescue (Festuca rubra L.), annual bluegrass (Poa annua L.), rough bluegrass (Poa trivialis L.), with participation of weeds [8].

METHODS

In the investigated grassland 13 plots (3,5 x 5,5 m each) were chosen, with 5,5 m buffer zones between them. The cattle liquid manure were used in doses 40 $m^3 \cdot ha^{-1}$ (plots 1-4), 60 $m^3 \cdot ha^{-1}$ (plots 5-8) and 80 $m^3 \cdot ha^{-1}$ (plots 9-12). Plots 2, 6 and 10 were treated with cattle liquid manure with fungicidal agent, plots 3, 7 and11 with bactericidal agent and plots 4, 8 and12 with virocidal agent. The control plot (0) was also chosen. Soil samples of 17 cm^2 and 9 cm deep were taken from each plot in 10 replicates in autumn 2006. The samples were next divided into the lower part of plants (Tr, 3-0 cm) and the upper P_1 (0-3 cm) and lower P_2 (3-6 cm) soil layers. Mites were extracted in high gradient Tullgren funnels, conserved and determined: the Gamasida and Actinedida to the order, and the Oribatida to species, including the juvenile stages. Totally 6 319 of mites were investigated, including 4 383 Oribatida. The species were analysed using the abundance (A), dominance (D), constancy (C) and Shannon (H) indices [14]. In statistical calculations we used the TUKEY HSD test (1-way ANOVA program of Statistica 6). Names of oribatid species follow Weigmann [23].

RESULTS

A small dose (40 $m^3 \cdot ha^{-1}$) of cattle liquid manure increased the abundance of mites, while the higher doses significantly decreased it, in relation to the control plot (tab. 3). In the mites associations dominated Oribatida, which create also the reaction of whole mites to cattle liquid manure fertilization. Generally, the Oribatida tolerated a small dose of liquid manure, and its density

Table 2. Flora diversity of meadow plants in the plots investigated .
Tabela 2. Zróżnicowanie florystyczne roślinności łąkowej na badanych powierzchniach.

Species	Percentage by species (%)
Poa pratensis (Wiechlina łąkowa), *P. trivialis* (Wiechlina zwyczajna)	17
Agrostis gigantea (Mietlica olbrzymia)	13
Phalaris arundinacea (Mozga trzcinowata)	12
Deschampsia caespitosa (Śmiałek darniowy), *Cirsium oleraceum* (Ostrożeń warzywny)	7
Festuca rubra (Kostrzewa czerwona), *Trifolium pratense* (Koniczyna łąkowa)	5
Trifolium repens (Koniczyna biała), *Carex nigra* (Turzyca pospolita)	4
Holcus lanatus (Kłosówka wełnista)	3
Dactylis glomerata (Kupkówka pospolita), *Poa annua* (Wiechlina roczna), *Lolium perenne* (Życica trwała), *Stellaria media* (Gwiazdnica pospolita), *Polygonum bistorta* (Rdest wężownik), *Urtica dioica* (Pokrzywa zwyczajna),	2
Agropyron repens (Perz właściwy), *Cirsium arvense* (Ostrożeń polny), *Polygonum hydropiper* (Rdest ostrogorzki), *Achillea millefolium* (Krwawnik pospolity), *Potentilla anserina* (Pięciornik gęsi), *Sanguisorba officinalis* (Krwiściąg lekarski), *Filipendula ulmaria* (wiązówka błotna)	1
Alopecurus pratensis (Wyczyniec łąkowy), *Cardaminopsis arenosa* (Rzeżusznik piaskowy), *Cerastium holosteoides* (Rogownica pospolita), *Polygonum nodosum* (Rdest kolankowaty), *Ranunculus acer* (Jaskier ostry), *Ranunculus repens* (Jaskier rozłogowy), *Juncus articulates* (Sit członowaty), *Rumex acetosella* (Szczaw polny), *Rumex crispus* (Szczaw kędzierzawy), *Mutellina purpurea* (Marchwica pospolita), *Heracleum sphondylium* (Barszcz zwyczajny), *Inula britannica* (Oman łąkowy)	+
Other herbs and weeds	2
Empty places	1

Table 3. Abundance of meadow mites (*A* in thousand individuals·m^{-2}), number of species (*S*) and Shannon *H* index for *Oribatida* in the plots investigated. Agents: F-fungicidal, B-bactericidal, V-virocidal

Tabela 3. Liczebność roztoczy łąkowych (*A* w tys.·m^{-2}), liczba gatunków (*S*) i wskaźnik Shannona *H* dla *Oribatida* na badanych powierzchniach. Preparaty: G- grzybobójczy, B-bakteriobójczy, W-wirusobójczy

Dose		40 m³/ha					60 m³/ha				80 m³/ha			
Agent				F	B	V		F	B	V		F	B	V
Plots		0	1	2	3	4	5	6	7	8	9	10	11	12
Acari	*A*	43,6	48,7	99,6	49,0	15,2*^	14,0*^{A}	14,9*^{F}	15,9	15,3	19,2	14,2*^{F}	14,0*	13,6*
Gamasida	*A*	1,8	3,2	11,6*^	5,1	0,7	1,2	1,1^{F}	1,3	1,4	2,1	0,9^{F}	0,4^{B}	1,7
Actinedida	*A*	6,9	3,5	20,0*^	8,8	3,6	2,0	1,7^{F}	3,8	2,8	4,3	2,7^{F}	4,8	4,6
Other	*A*	1,0	2,6	4,5	5,2	0	0,2	0,1	0	0	1,2	0	0	0
Oribatida	*A*	33,9	39,4	63,6	29,9	11,0*^	10,5*^{A}	12,0^{F}	10,8*	11,0*	11,6*^{A}	10,6^{F}	8,8*	7,3*
	S	12	13	15	15	10	11	12	10	12	12	14	12	13
	H	1,842	1,831	1,940	1,978	1,952	1,870	1,866	1,994	1,951	1,986	2,067	2,038	2,063

* - statistically significant difference between experimental plot, and control plot ($p \leq 0,05$)

^ - statistically significant difference between plot fertilized with the cattle liquid manure with the agent, and plot fertilized without the agent in the same dose (1-2, 1-3, 1-4, 5-6, 5-7, 5-8, 9-10, 9-11, 9-12)

$^{A, A'}$ - statistically significant difference between plots fertilized without agent (A: 1-5, 1-9, A′: 5-9)

$^{F, F'}$ - statistically significant difference between plots fertilized with fungicidal agent (F: 2-6, 2-10, F′: 6-10)

$^{B, B'}$ - statistically significant difference between plots fertilized with bactericidal agent (B: 3-7, 3-11, B′: 7-11)

$^{V, V'}$ - statistically significant difference between plots fertilized with virocidal agent (V: 4-8, 4-12, V′: 8-12)

decreased along with increasing doses of fertilizer, independently from the kind of applied agent. Similarly reacted Actinedida and Gamasida.

The statistic analysis confirmed, that the application of fungicidal agent by medium and high doses of fertilizer decreased the abundance of Oribatida, Gamasida and Actinedida, in relation to a small dose of fertilizer with this agent. In a similar way mites reacted to bactericidal agent, but acting of virocidal agent was indistinct. The species number of Oribatida in the investigated plots was similar. Shannon index reached the highest values in the plots treated with a dose of 80 $m^3 \cdot ha^{-1}$ (tab. 3).

In the investigated plots the most abundant were: Parachipteria bella (Sellnick), Liebstadia humerata (Sellnick), Achipteria coleoptrata (L.) and Scheloribates laevigatus (C.L.Koch) (tab. 4). The main dominant species was Parachipteria bella, which reached the highest dominance index in the plots fertilized with a small dose of cattle liquid manure. Species Liebstadia humerata tolerated all doses of fertilizer and disinfectant agents, and achieved high constancy indices. Species Achipteria coleoptrata was sensitive on medium and high doses of fertilizer and disinfectant agents, what was statistically confirmed. Species Scheloribates laevigatus reacted indistinct to fertilization.

The Oribatida preferred the lower parts of grasses, and their density distinctly decreased with the soil depth. Adults also concentrated in the lower part of grass, while the juvenile stages preferred the upper soil level, except plots 2 and 3, where they occurred more abundant in the low parts of grasses. That distribution was characteristic exclusively for two dominating species, P. bella and A. coleoptrata (tab.5).

Table 4. Abundance (*A* in thousand individuals·m^{-2}), dominance (*D*) and constancy (*C*) of some *Oribatida* species in the plots investigated with the regard of age structure. ad-adults, tot-total, Agents: F-fungicidal, B-bactericidal, V-virocidal

Tabela 4. Wskaźnik abundancji (*A* w tys. osobn.·m^{-2}), dominacji *(D)* i stałości występowania (*C*) niektórych gatunków *Oribatida* na badanych powierzchniach z uwzględnieniem struktury wiekowej. ad-okazy dorosłe, tot – razem, Preparaty: G- grzybobójczy, B-bakteriobójczy, W- wirusobójczy

Dose			40 m^3/ha					60 m^3/ha					80 m^3/ha		
Agent					F	B	V		F	B	V		F	B	V
Plots			0	1	2	3	4	5	6	7	8	9	10	11	12
A.coleoptrata (Linnaeus, 1758)	ad	*A*	7,5	4,3	4,9	1,9	1,9	1,4	0,9	1,3	1,5	1,6	1,1	1,1	1,0
	tot	*A*	10,2	9,7	13,7	4,4	2,1*^	1,4*^{A}	1,1*^{F}	1,3*	1,5*	3,0*^{A}	1,4*^{F}	1,3*	1,0*
		D	29,8	24,6	21,0	14,2	18,6	13,7	9,5	12,2	13,7	26,0	13,1	14,3	13,2
		C	100	100	100	80	70	60	50	50	80	80	80	60	40
P. bella (Sellnick, 1928)	ad	*A*	7,2	6,4	9,2	3,6	1,0	0,3	1,2	2,0	1,0	1,5	0,8	1,5	2,0
	tot	*A*	10,1	14,8	22,3	10,3	1,0*^	0,3*^{A}	1,2*^{F}	2,4	1,0*	2,2*^{A}	0,8*^{F}	2,0	2,0
		D	29,8	37,4	34,1	32,8	9,3	2,9	10	22,2	8,7	19,3	7,4	23,1	27,3
		C	90	100	90	80	60	20	60	80	50	40	70	70	90
S. laevigatus (C.L.Koch,1835)	ad	*A*	2,8	2,2	3,4	2,2	2,2	1,9	0,8	1,2	1,8	1,6	1,4	1,5	1,1
	tot	*A*	3,5	3,5	4,5	5,5	2,6	2,0	1,1	1,6	1,8	2,3	1,9	2,2	1,3
		D	10,3	9,0	6,8	17,7	23,5	18,9	9,5	14,4	16,4	20,3	18,2	24,5	18,2
		C	90	100	100	100	90	90	80	80	80	70	90	80	70
L. humerata (Sellnick, 1928)	ad	*A*	2,6	2,3	9,2	3,1	2,3	2,9	4,1	2,1	3,5	0,6	3,1	1,0	0,8
	tot	*A*	2,6	2,6	9,9*	3,8	2,5	3,0	4,5	2,4	3,7	0,7	3,4	1,1	0,9
		D	7,8	6,6	15,2	12,3	23,0	28,0	37	22,2	33,3	6,2	31,8	12,9	12,4
		C	90	90	100	90	60	90	90	90	100	50	100	60	40
L. similis (Michael, 1888)	ad	*A*	0,8	1,3	1,6	1,0	1,1	1,0	1,7	1,5	0,8	0,8	0,5	0,2	0,1
	tot	*A*	0,8	1,9	1,8	1,3	1,1	1,0	1,8	1,5	1,0	1,1	0,7	0,2	0,1
		D	2,3	4,7	2,8	4,0	10,4	9,1	15	13,9	9,3	9,4	6,3	2,0	0,8
		C	40	80	90	50	80	40	80	50	60	50	50	30	10
E. occultus (C.L.Koch,1835)	ad	*A*	1,1	1,6	0,9	0,2	0,4	1,8	1,4	0,2	0,7	0,1	0,4	0,2	0,1
	tot	*A*	3,1	3,4	4,5	0,4*^	0,5*^	2,2	1,6	0,5*	1,0	0,3*^{A}	0,5*^{F}	0,2*	0,1*
		D	9,0	8,7	6,8	1,3	4,4	20,6	13	4,4	8,7	2,6	5,1	2,7	1,7
		C	90	100	100	20	30	80	90	40	70	30	50	30	10
O. castanea (Willmann,1931)	ad	*A*	1,0	1,4	1,8	0,5	0,4	0,2	0,2	0,4	0,0	0,1	0,1	0,2	0,2
	tot	*A*	1,0	1,6	2,2	0,5	0,4	0,2^{A}	0,2^{F}	0,4	0,0	0,1^{A}	0,1^{F}	0,2	0,2
		D	3,0	4,0	3,3	1,7	3,8	1,7	1,5	3,3	0,0	0,5	0,6	2,7	2,5
		C	60	80	70	30	60	30	10	30	0,0	10	10	30	20
C. gracilis (Michael, 1884)	ad	*A*	1,9	0,5	1,0	0,3	0,5	0,1	0,1	0,3	0,5	1,1	0,8	0,5	0,7
	tot	*A*	1,9	0,5	1,0	0,3	0,5	0,1	0,1	0,3	0,5	1,1	0,8	0,5	0,7
		D	5,7	1,2	1,6	1,0	4,9	1,1	1,0	2,8	4,4	9,4	7,4	16,1	9,9
		C	40	20	50	20	40	20	20	30	50	50	60	50	80
Oribatida	ad	*A*	25,6	20,9	34,9	16,0	9,9	9,8	10,7	9,2	10,4	7,8	9,0	7,1	6,9
	tot	*A*	33,9	39,4	63,6	29,9	11,0*^	10,5*^{A}	12,0^{F}	10,8*	11,0*	11,6*^{A}	10,6^{F}	8,8*	7,3*
		D	100	100	100	100	100	100	100	100	100	100	100	100	100
		C	690	820	980	620	530	480	540	500	570	450	640	520	490

* - statistically significant difference between experimental plot, and control plot ($p \leq 0,05$)

^ - statistically significant difference between plot fertilized with the cattle liquid manure with the agent, and plot fertilized without the agent in the same dose (1-2, 1-3, 1-4, 5-6, 5-7, 5-8, 9-10, 9-11, 9-12)

$^{A, A'}$ - statistically significant difference between plots fertilized without agent (A: 1-5, 1-9, A′: 5-9)

$^{F, F'}$ - statistically significant difference between plots fertilized with fungicidal agent (F: 2-6, 2-10, F′: 6-10)

$^{B, B'}$ - statistically significant difference between plots fertilized with bactericidal agent (B: 3-7, 3-11, B′: 7-11)

$^{V, V'}$ - statistically significant difference between plots fertilized with virocidal agent (V: 4-8, 4-12, V′: 8-12)

Table 5. Vertical distribution of *Oribatida* (individuals for every 50 cm^{-3}) in the plots investigated with the regard of age structure. ad-adults, tot-total,

Tabela 5. Pionowe rozmieszczenie *Oribatida* (osobn. na 50 cm^{-3}) na badanych powierzchniach z uwzględnieniem struktury wiekowej. ad-okazy dorosłe, tot – razem,

Dose						40 m³/ha										60 m³/ha										80 m³/ha			
Agent						F		B		V				F		B		V				F		B		V	
Plots		0		1		2		3		4		5		6		7		8		9		10		11		12	
		ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot	ad	tot
A. coleoptrata	Tr	9	11	5	9	7	21	2	5	3	3	2	2	1	2	1	1	2	2	2	2	1	1	1	1	1	1
	P_1	2	5	2	6	1	2	1	2	+	+	+	+	+	+	1	1	+	+	1	2	1	1	+	+	+	+
	P_2	1	1	+	1			+	+		+					+	+	+	+	+	1	+	1	+	+		
P. bella	Tr	9	11	9	16	10	30	4	12	1	1	+	+	+	+	1	1	1	1	2	2	+	+	2	2	3	3
	P_1	2	5	1	8	4	6	2	4	1	1			1	1	2	3	+	+	+	1	1	1	+	1	+	+
	P_2	+	1	+	1	1	1	+	+			+	+			+	+	1	1			+	+	+	+	+	+
S. laevigatus	Tr	3	4	3	4	5	6	2	6	1	2	2	3	1	1	1	2	3	3	2	3	1	2	1	2	1	1
	P_1	1	2	+	1	1	1	1	3	1	1	1	1	+	+	+	+			1	1	+	+	+	1		
	P_2	+	+	+	+		+	+	1	1	1					+	+	+	+	+	+	+	+	1	+	1	1
L. humerata	Tr	4	4	3	4	12	13	4	5	2	2	4	4	5	5	1	2	4	5	1	1	3	4	1	1	1	1
	P_1	1	1	+	+	3	3	1	1	1	1	1	1	1	2	1	2	1	1			1	1	1	1		
	P_2	+	+	+	+	+	+			1	1	+	+	1	1	+	+	+	+			+	+			+	+
L. similis	Tr	1	1	1	2	1	2	1	2	1	1	1	1	2	2	1	1	1	2	1	1	1	1			+	+
	P_1	+	+	1	1	1	1			+	+	+	+	+	+	1	1			+	+	+	+	+	+		
	P_2	+	+			+	+	+	+	+	+							+	+	+	+						
E. occultus	Tr	1	3	2	4	1	6	+	+	+	1	2	3	2	2	+	+	1	1		+	+	+	+	+	+	+
	P_1	+	2	+	1		1	+	+	+	+	1	1	+	+	+	+	+	+	+	+	+	+	+	+		
	P_2	+	+	+	+	+	1					+	+	+	+			+	+								
O. castanea	Tr	1	1	1	1	3	3	1	1	1	1	+	+			+	+							+	+	+	+
	P_1	+	+	1	1	+	+							+	+		+			+	+			+	+		
	P_2	0,0								+	+	+	+											+	+		
C. gracilis	Tr	3	3	1	1	1	1	+	+	1	1	+	+	+	+	+	+	1	1	2	2	1	1	+	+	1	1
	P_1	+	+			+	+			+	+	+	+							+	+	+	+	+	+		
	P_2																									+	+

DISCUSSION AND CONCLUSIONS

Fertilization of soil with a cattle liquid manure changes physical and chemical properties of soil and influence the soil organisms. In this paper a small dose of fertilizer increased the abundance of mites, but higher doses decreased it, comparing to the control plot. Similar reaction of mites to this fertilizer noted in alternating grassland in Poland [6], with predominating Oribatida, which also reacted positively to a small dose of fertilizer. These results are also consistent with the other investigation in Poland, performed on 3-year permanent grasslands growing on peat soils [3].

In this paper the Oribatida were sensitive to a high dose of fertilizer, what confirms the earlier investigations by Bolger & Curry [4]. Also Trojanowski & Baluk observed that the dose of nitrogen over 180 kg N/ha reduced the abundance of mites [22]. In the investigated permanent meadow, the species diversity of Oribatida was rather small and decreased under a big dose of cattle liquid manure, what is consistent with the other investigations [2]. In all plots predominated typical meadow species like Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata and Scheloribates laevigatus. All these species reacted negatively to higher doses of fertilizer. Parachipteria bella and Achipteria coleoptrata were sensitive to fungicidal agent, what confirmed that they are mycophagic species [16]. Achipteria coleoptrata also reacted negatively to increasing doses of fertilizer, however in the investigations of the Seniczak et al., this species tolerated higher doses of ammonia water [20].

In this experiment Oribatida clearly preferred the lower parts of grasses, what is consistent with other data [6,21]. Presence of abundant typical meadow species, like Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata and Scheloribates laevigatus on lower parts of grasses can create economic problems. These mites are intermediate hosts of tapeworms [5, 15], which parasite on some domestic animals.

The obtained results led to the following conclusions:

1. The dose of cattle liquid manure 40 $m^3 \cdot ha^{-1}$ increased the abundance of mites, including predominating Oribatida, comparing to the control plot, while the dose 60 and 80 $m^3 \cdot ha^{-1}$ significantly decreased it.
2. Among Oribatida predominated typical meadow species, like Parachipteria bella, Liebstadia humerata, Achipteria coleoptrata and Scheloribates laevigatus.
3. Oribatida preferred the low parts of grasses, and their density distinctly decreased with the soil depth.

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