BIOLOGICAL LETT. 2010, 47(2): 59–64
Available online at: http:/www.versita.com/science/lifesciences/bl/ DOI: 10.2478/v10120-009-0021-1

Effect of cattle liquid manure fertilization and disinfectant on seasonal dynamics of Oribatida (Acari) in a permanent lowland meadow in Poland

RADOMIR GRACZYK, STANISŁAW SENICZAK and BEATA WASIŃSKA-GRACZYK

Department of Ecology, University of Technology and Life Sciences in Bydgoszcz,
Kordeckiego 20, 85-225 Bydgoszcz, Poland
Corresponding author: Radomir Graczyk, graczyk@utp.edu.pl

(*Received on 3 January 2008; Accepted on 11 November 2010*)

Abstract: Oribatid mites have a favourable influence on soil fertility. The effect of cattle liquid manure fertilization (40 and 80 m^3 ha^{-1}) and disinfectant at 3 concentrations: 0.50% (fungicidal), 0.75% (bactericidal), and 3.00% (viricidal) on seasonal dynamics of Oribatida was investigated in a permanent lowland meadow in Poland. Cattle liquid manure without disinfectants reduced the density of oribatid mites, especially in the spring, except for a higher dose of fertilizer in the summer, which increased their density compared to the control plot. This fertilizer treated with the disinfectants differentiated the density of oribatid mites, i.e. reduced or increased it, compared to the control plots. However an increased density was observed only in summer, after application of the higher dose of fertilizer with fungicide or viricide. In the control plot, some species (*Achipteria coleoptrata* and *Parachipteria bella*) were rather abundant in the spring and autumn, and some other species (*Liebstadia humerata* and *Scheloribates laevigatus*) only in the spring. Cattle liquid manure and disinfectants changed the dynamics of density of these species. In the control plot the adults were slightly more abundant than the juveniles in the spring, but the juveniles dominated in the summer, and the adults dominated again in the autumn. Cattle liquid manure and disinfectants changed the age structure of oribatid mites. None of the experimental variants was favourable for Oribatida in all seasons.

Keywords: cattle liquid manure, permanent meadow, seasonal dynamics, Acari, Oribatida

INTRODUCTION

Cattle liquid manure is often used as a fertilizer in lowland meadows. It is a natural fertilizer, which contains all nutrients for plant growth. If it is used in proper doses, it increases the productivity of green forage and the content of nutrients and moisture in the soil. A low dose of this fertilizer usually increases the density of oribatid mites, but medium and high doses decrease it, compared to the control plot (Graczyk et al. 2008). The most abundant oribatid species, like *Achipteria coleoptrata* (Linnaeus, 1758) and *Parachipteria bella* (Sellnick, 1928), are sensitive to cattle liquid manure. This is important because oribatid mites have a positive effect on grass growth (Niedbała 1980; Boczek & Błaszak 2005).

The aim of this study was to assess the effect of low and high doses of cattle liquid manure fertilization, with and without fungicide, bactericide and viricide, on seasonal dynamics of Oribatida and the most abundant species.

MATERIAL AND METHODS

This investigation was performed in March, June, and September 2006, in a permanent lowland meadow situated in the Valley of the Bydgoszcz Canal, between Bydgoszcz and Nakło (northern Poland). The meadow belongs to the Agricultural Experimental Station in Minikowo (University of Technology and Life Sciences in Bydgoszcz). In this meadow, 9 plots (0–8) were chosen, 20 m^2 each, isolated by buffer zones of 5.5 m × 5.5 m. Plot 0 was a control. In March and June, plots 1, 3, 5, 7 were fertilized with cattle liquid manure with a dose of 40 $m^3 \cdot ha^{-1}$, and plots 2, 4, 6, 8 with a dose of 80 $m^3 \cdot ha^{-1}$. Plots 3 and 4 were additionally treated with 0.5% fungicide, plots 5 and 6 with 0.75% bactericide, and plots 7 and 8 with 3% viricide. The disinfectant was produced by Laboratoires Ceetal, France and is composed of aqueous solutions of dimethyl ammonium chloride (100 g l-1), dioxy-12-ethane (32 g l-1), glutardialdehyde (40 g l-1), and formaldehyde (31.5 g l-1).

Soil samples, of 17 cm^2 in area and 9 cm thick (including 3 cm of lower parts of plants and 6 cm of topsoil), were taken in the spring, summer, and autumn of 2006, from each plot in 10 replicates. Oribatid mites were extracted in high-gradient Tullgren funnels, and next conserved and determined to species, including the juvenile stages. In total, 10 787 of oribatid mites were investigated, using the abundance (*A*), dominance (*D*), and Shannon (*H*) indices (Odum 1982). In statistical calculations, we used the HSD Tukey test (one-way ANOVA program of Statistica 6). Names of oribatid species follow Weigmann (2006).

RESULTS AND DISCUSSION

Seasonal dynamics of oribatid mites depends on species biology, climatic conditions, and fertilization (Seniczak et al. 2006). In the control plot, these mites were the most abundant in the spring (Table 1). This is favourable for grasses, which need a lot of mineral components then. The mites were less abundant in the autumn, and the least abundant in the summer, which was statistically confirmed. These results are consistent with Schuster's (1988) findings, but Lebrun (1984) noted the highest density of mites usually in the autumn and winter, and Hammer (1972) in the winter.

Cattle liquid manure without disinfectants reduced the density of Oribatida, especially in the spring, except for the higher dose of fertilizer in the summer, which increased the density, compared to the control plot. The fertilizer treated with disinfectants differentiated the density, compared to the fertilizer alone, so in some plots the density of mites was lower, and in the other plots it was higher (summer – plots 2, 4, 8; autumn – plots 1, 3) than in the control plot. Wasińska–Graczyk et al. (2009) also observed an increase in density of Oribatida under a high dose of pig liquid ma-

Table 1. Abundance (*A*, in 10^3 individuals per m^2) and dominance (*D*, in % of total catch) indices of Oribatida in investigated plots. Spr = spring; Sum = summer; Aut = autumn. Significant differences at $P < 0.05$: (a) between summer and spring, (b) between autumn and spring, (c) between autumn and summer. Disinfectant: F = fungicide; B = bactericide; V = viricide

Plot			0	1	2	3	4	5	6	7	8
Disinfectant			no	no	no	F	F	B	B	V	V
Fertilizer ($m^3 \cdot ha^{-1}$)			0	40	80	40	80	40	80	40	80
Oribatida	Spr	*A*	65.0	32.4	13.4	36.7	25.8	16.0	14.9	21.8	47.4
	Sum	*A*	13.4^{a}	15.2	19.9	9.8^{a}	32.5	6.0	12.5	6.1^{a}	41.1
	Aut	*A*	33.9	39.4	11.6	63.6^{c}	12.8	29.9^{c}	8.8	12.1	7.3^{bc}
Achipteria coleoptrata	Spr	*A*	9.3	2.9	1.3	3.1	1.7	0.7	1.0	1.2	2.1
		D	14.3	8.9	9.9	9.0	7.1	5.0	6.2	5.2	4.4
	Sum	*A*	2.6^{a}	2.3	1.4	1.7	2.9	0.2	0.5	0.7	1.3
		D	19.3	15.0	7.3	17.3	8.2	3.0	5.0	11.8	3.2
	Aut	*A*	10.2^{c}	9.7^{c}	3.0	13.7^{bc}	1.4	4.4^{bc}	1.3	2.1	1.0
		D	29.8	24.6	26.0	21.0	13.1	14.2	14.3	18.6	13.2
Parachipteria bella	Spr	*A*	9.4	8.7	2.8	6.1	3.8	1.7	3.6	2.1	9.2
		D	14.4	26.9	21.2	17.6	15.8	12.0	21.9	9.2	19.4
	Sum	*A*	0.6^{a}	4.0	3.1	0.4^{a}	7.5	0.4^{a}	2.5	0.7	9.6
		D	4.5	26.1	15.4	4.3	20.8	7.0	22.6	11.8	23.5
	Aut	*A*	10.1^{c}	14.8	2.2	22.3^{c}	0.8^{bc}	10.3^{bc}	2.0	1.0	2.0^{bc}
		D	29.8	37.4	19.3	34.1	7.4	32.8	23.1	9.3	27.3
Liebstadia humerata	Spr	*A*	11.6	4.8	2.0	10.5	7.8	4.4	2.2	7.9	6.6
		D	17.8	14.7	14.9	30.0	31.8	30.7	13.5	34.4	13.8
	Sum	*A*	3.2	2.3	2.3	2.6^{a}	6.1	2.0	3.8	1.6^{a}	8.3
		D	23.8	15.4	11.5	26.5	16.8	34.0	34.8	25.5	20.2
	Aut	*A*	2.6^{b}	2.6	0.7	9.9	3.4	3.8	1.1	2.5	0.9^{bc}
		D	7.8	6.6	6.2	15.2	31.8	12.3	12.9	23.0	12.4
Scheloribates laevigatus	Spr	*A*	9.1	4.9	3.4	5.2	4.1	4.0	3.5	5.7	7.3
		D	14.1	15.2	25.2	14.8	17.0	27.8	21.5	24.9	15.5
	Sum	*A*	3.9	2.3	1.9	1.7	6.0	1.4	1.9	1.1^{a}	6.3
		D	29.1	15.4	9.7	17.9	16.5	24.0	17.7	18.6	15.4
	Aut	*A*	3.5	3.5	2.3	4.5	1.9	5.5	2.2	2.6	1.3^{bc}
		D	10.3	9.0	20.3	6.8	18.2	17.7	24.5	23.5	18.2

nure and viricide. Interestingly, in the plots treated with a lower dose of fertilizer with or without disinfectants (plots 1, 3, 5, 7) the density was the lowest in the summer, while in the plots treated with the higher dose of fertilizer with or without disinfect-

Table 2. Age structure of Oribatida (in 10^3 individuals per m^2) in investigated plots. Spr = spring; Sum = summer; Aut = autumn; ad = adults; tot = total. Disinfectant: F = fungicide; B = bactericide; V = viricide

Plot			0	1	2	3	4	5	6	7	8
Disinfectant			no	no	no	F	F	B	B	V	V
Fertilizer ($m^3 \cdot ha^{-1}$)			0	40	80	40	80	40	80	40	80
Oribatida	Spr	ad	35.7	24.4	20.5	8.7	13.6	8.9	16.9	10.3	22.4
		tot	65.0	32.4	36.7	16.0	21.8	13.4	25.8	14.9	47.4
	Sum	ad	9.6	9.3	7.2	3.8	4.3	8.8	17.9	5.7	20.4
		tot	13.4	15.2	9.8	6.0	6.1	19.9	32.5	12.5	41.1
	Aut	ad	25.6	20.9	34.9	16.0	9.9	7.8	9.0	7.1	6.9
		tot	33.9	39.4	63.6	29.9	12.1	11.6	12.8	8.8	7.3
Achipteria coleoptrata	Spr	ad	5.3	2.8	1.9	0.3	0.8	0.7	1.4	0.7	0.3
		tot	9.3	2.9	3.1	0.7	1.2	1.3	1.7	1.0	2.1
	Sum	ad	2.0	1.4	1.7	0.2	0.7	0.7	1.0	0.3	0.7
		tot	2.6	2.3	1.7	0.2	0.7	1.4	2.9	0.5	1.3
	Aut	ad	7.5	4.3	4.9	1.9	1.9	1.6	1.1	1.1	1.0
		tot	10.2	9.7	13.7	4.4	2.1	3.0	1.4	1.3	1.0
Parachipteria bella	Spr	ad	5.5	7.4	3.8	1.4	1.4	2.3	2.3	2.7	4.3
		tot	9.4	8.7	6.1	1.7	2.1	2.8	3.8	3.6	9.2
	Sum	ad	0.6	2.3	0.4	0.4	0.7	1.7	3.8	1.7	6.7
		tot	0.6	4.0	0.4	0.4	0.7	3.1	7.5	2.5	9.6
	Aut	ad	7.2	6.4	9.2	3.6	1.0	1.5	0.8	1.5	2.0
		tot	10.1	14.8	22.3	10.3	1.0	2.2	0.8	2.0	2.0
Scheloribates laevigatus	Spr	ad	5.3	2.9	2.5	1.7	2.3	1.9	2.6	2.4	2.8
		tot	9.1	4.9	5.2	4.0	5.7	3.4	4.1	3.5	7.3
	Sum	ad	2.3	1.4	1.0	0.6	0.5	1.0	1.9	1.0	1.7
		tot	3.9	2.3	1.7	1.4	1.1	1.9	6.0	1.9	6.3
	Aut	ad	2.8	2.2	3.4	2.2	2.2	1.6	1.4	1.5	1.1
		tot	3.5	3.5	4.5	5.5	2.6	2.3	1.9	2.2	1.3
Liebstadia humerata	Spr	ad	6.5	3.1	6.4	2.9	5.7	1.3	5.7	1.5	4.4
		tot	11.6	4.8	10.5	4.4	7.9	2.0	7.8	2.2	6.6
	Sum	ad	2.3	1.1	2.0	1.3	1.0	1.0	3.4	2.0	3.8
		tot	3.2	2.3	2.6	2.0	1.6	2.3	6.1	3.8	8.3
	Aut	ad	2.6	2.3	9.2	3.1	2.3	0.6	3.1	1.0	0.8
		tot	2.6	2.6	9.9	3.8	2.5	0.7	3.4	1.1	0.9

ants (plots 2, 4, 6, 8) the density was the lowest in the autumn. According to Reeves (1967) a low summer density of Oribatida is mainly caused by a low soil moisture, which was also observed in the agroecosystems in Poland (Dziuba 1963) and the USA (Perdue & Crossley 1989). In contrast, Trojanowski & Baluk (1992) observed no distinct effects on seasonal dynamics of mites after a high dose of nitrogen fertilization. Generally, cattle liquid manure and disinfectant reduced the differences in density between seasons, compared to the control plot.

In the control plot, some species of oribatid mites (*Achipteria coleoptrata* and *Parachipteria bella*) were rather abundant in the spring and autumn, with a lower density in the summer, while some other species, like *Liebstadia humerata* (Sellnick, 1928) and *Scheloribates laevigatus* (C. L. Koch, 1835), were rather abundant only in the spring. Cattle liquid manure without disinfectant reduced greatly the density of all species in the spring, but more in *A. coleoptrata* than in the other species. The higher dose of fertilizer reduced the density of mites in this season more than the lower dose. This fertilizer treated with disinfectants differentiated the density of species, and in some plots their density was higher than in the control plot. For example, the lower dose of fertilizer and fungicide greatly increased the density of *A. coleoptrata*, *L. humerata*, *P. bella* and *S. laevigatus* in the autumn, but this dose of fertilizer with bactericide also increased the density of *S. laevigatus* in that season. A higher dose of the fertilizer with viricide increased the density of *L. humerata*, *P. bella* and *S. laevigatus* in the summer, compared to the control plot. Seniczak et al. (2006) observed an increasing density of *Liebstadia similis* (Michael, 1888) and *S. laevigatus* in the summer, after using a high dose of ammonia water, whereas Wasińska-Graczyk et al. (2009) noted the increased density of oribatid mites under a high dose of pig liquid manure and viricide.

In the control plot, participation of juveniles varies between the investigated seasons, which illustrates well the development of species. In the spring the adults usually start to reproduce and slightly outnumber the juveniles, but in the summer the juveniles dominate, whereas in the autumn the adults are more abundant again, because some tritonymphs transform into adults then. Cattle liquid manure without or with disinfectants reduced or increased the density of oribatid mites, affecting also their age structure. Consequently, in some plots the adults dominated, while in the other plots the juveniles were more abundant (spring – plots 2, 8; summer – plots 5, 7, 8). Juveniles also dominated in some species, like *A. coleoptrata* and *P. bella* (autumn – plots 1, 2, 3), or *L. humerata* and *S. laevigatus* (summer – plot 8). This suggests that the populations of oribatid mites coped well with the stress factors after fertilization and were able to increase their density in better living conditions. Seniczak et al. (2006) also observed a high increase in participation of juveniles in the summer populations of *L. similis* after a high dose of ammonia water.

CONCLUSIONS

1. Cattle liquid manure reduced the density of oribatid mites, especially in the spring, except for the higher dose of fertilizer in the summer, which increased their density compared to the control plot.

2. Cattle liquid manure treated with disinfectants differentiated the density of oribatid mites by reducing or increasing it, compared to the control plots. However, an increased density was observed only in summer, after application of the higher dose of fertilizer with fungicide or viricide.
3. In the control plot, some species of oribatid mites (*A. coleoptrata* and *P. bella*) were rather abundant in the spring and autumn, and some others (*L. humerata* and *S. laevigatus*) only in the spring. Cattle liquid manure and disinfectants changed the dynamics of density of these species.
4. In the control plot the adults were slightly more abundant than the juveniles in the spring, but the juveniles dominated in the summer, and the adults dominated again in the autumn. However, cattle liquid manure and disinfectants changed the age structure of oribatid mites.
5. None of the experimental variants was favourable for Orbatida in all seasons.

REFERENCES

Boczek J., Błaszak Cz. 2005. Mites (Acari) – the meaning in life and the human economy. SGGW, Warszawa (in Polish).

Dziuba S. 1963. Studies in the environmental ecology of the mites (Acarina) in the soil of cultivated fields. Part II – The horizontal and vertical distribution and changes in the number of mites in the soil of cultivated fields. SSTor. 7: 3–35.

Graczyk R., Seniczak S., Wasińska B. 2008. The effect of cattle liquid manure fertilization on the mites (Acari) in permanent meadow in Bydgoszcz Canal valley (Poland). J. Cent. Eur. Agric. 9, 4: 651–658.

Hammer M. 1972. Microhabitats of oribatid mites on the Danish woodland floor. Pedobiologia 12: 412–423.

Lebrun Ph. 1984. Determination of the dynamics of an edaphic oribatid population (*Nothrus palustris* C. L. Koch, 1839). In: Acarology VI(2) (Griffiths D. A., Bowman C. E., Eds), pp. 871–877, Ellis Horwood Ltd., Chichester.

Niedbała W. 1980. Oribatida – mites of the terrestial ecosystems. PWN, Warszawa (in Polish).

Odum E. P. 1982. Principles of ecology. PWN, Warszawa (in Polish).

Perdue J. C., Crossley Jr D. A. 1989. Vertical distribution of soil mites (Acari) in conventional and no-tillage agricultural systems. Biol. Fertil. Soils 9: 135–138.

Reeves R. M. 1969. Seasonal distribution of some forest soil Oribatei. In: Proceedings of the 2nd International Congress of Acarology (Evans G. O., Eds), July 19–25, 1967, Sutton Bonington, England, pp. 23–30, Akademiai Kiado, Budapest.

Schuster R. 1988. Untersuchungen zur Epizootiologie der Monieziose des Schafes in der DDR, unter besonderer Berücksichtigung Zwischenwirte. Monatsh. Vet. 43: 233–235.

Seniczak S., Chachaj B., Wasińska B., Graczyk R. 2006. Effect of ammonia water on seasonal dynamics of the density of Oribatida (Acari) in a lowland meadow. Biological Lett. 43: 227–230.

Trojanowski H., Baluk A. 1992. The effect of nitrogen fertilization on small soil invertebrates – Acarina and Collembola. Rocz. Nauk. Roln. Ser. E. 22: 83–90.

Wasińska-Graczyk B., Seniczak S., Graczyk R. 2009. The effect of pig liquid manure fertilization on the density and species structure of Oribatida (Acari) in lowland meadow in Poland. Biological Lett. 46: 57–63.

Weigmann G. 2006. Hornmilben (Oribatida). In: Die Tierwelt Deutschland und der angrenzenden Meeresteile. 76. Teil (Dahl F. Ed), pp. 1−520, Goecke & Evers, Keltern.