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RESIDUAL EFFECT OF SOIL POLLUTION WITH OIL DERIVATIVES ON THE OCCURRENCE OF ACARINA

NASTĘPCZY WPŁYW ZANIECZYSZCZENIA GLEBY ROPOPOCHODNYMI NA WYSTĘPOWANIE ROZTOCZY

Abstract: The aim of the work was to determine the residual effect (*ie* after one year and two years) of soil contamination with various oil derivatives (petrol, diesel fuel and used engine oil) on the activity of terrestrial Acarina. Assessed was also the effect of assisted bioremediation process on the abovementioned invertebrates. Soil, placed in the containers (1 m^3), was polluted with 6000 mg of fuel kg^{-1} d.m. of soil in June 2010. A week later half of the containers was subjected to bioremediation with the use of ZB-01 biopreparation, specially prepared for this purpose. Epigeal fauna including Acarina was trapped using pitfall traps in the years 2011 and 2012. Two years after the moment of soil contamination with petrol, diesel fuel and engine oil on the level corresponding to the most frequently registered content in the soil medium polluted with oil derivatives, their negative effect on Acarina activity on the soil surface is still evident. Application of bioremediation supported with ZB-01 preparation significantly reduces the negative effect in case of the soil contaminated with petrol and to a lesser extend also in soil polluted with diesel fuel, whereas it contributes to a considerable intensification of Acarina activeness in the soil contaminated with used engine oil. The number of Acarina caught using pitfall traps may be strongly modified by the course of the weather conditions during respective vegetative seasons.

Keywords: oil derivatives, soil, bioremediation, Acarina

Due to their growing consumption, oil derivatives constitute increasingly more frequently identified environmental hazards [1]. Harmful effect of oil derivatives on the soil environment may persist for various periods of time, depending on the pollutant kind and dose. Both the conditions under which the contaminated soil self-purification occurs and possible applications of various methods of assisted bioremediation are important [2-5]. Although the effect of oil derivatives on soil invertebrates has been researched, particularly from the perspective of their use as bioindicators [6, 7], only scant information is available about the effect of assisted bioremediation process on these organisms [8]. As has been proved, bioremediation using specially selected microorganisms brings beneficial results in purification of soils contaminated with oil derivatives [9].

Soil Acarina play a significant role in metabolic processes [10]. They are also often indicated as bioindicators of environmental changes resulting from human activity [11, 12].

The paper aimed at determining the residual effect (*ie* after one year and two years) of soil contamination with various oil derivatives (petrol, diesel fuel and used engine oil) on the activity of terrestrial Acarina. Assessed was also the effect of assisted bioremediation process on the abovementioned invertebrates.

Materials and methods

The research was conducted in 2009-2012 at the Experimental Station of the University of Agriculture in Mydlniki near Krakow. In the experiment containers with

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a capacity of 1 m^3 were used. The containers were dug into the soil, so that their upper area was on the same level with the surrounding soil. In June 2010 the soil in containers was polluted with the following oil derivatives: petrol, diesel oil and used engine oil (dose 6000 mg of fuel · kg^{-1} d.m. of soil). A week later half of the containers was subjected to bioremediation with the use of ZB-01 biopreparation, specially prepared for this purpose. This treatment was repeated in the spring 2011. The experiment was performed in four replications. Four objects were created in two series (natural and supported bioremediation): 1. Control - unpolluted soil, 2. Soil contaminated with petrol, 3. Soil contaminated with diesel oil and 4. Soil contaminated with used engine oil. Epigeal fauna including Acarina was trapped using pitfall traps (0.9 dm^3 jars dug even with the soil level and protected against atmospheric precipitation with a plastic roof) placed in the central point of each container. The traps were emptied once a week during the periods from May to October 2011 and 2012. Statistical computations were made using Statistica 10.0 PL computer programme. Means were diversified using LSD test at significance level $\alpha = 0.05$.

Results and discussion

The dynamics of Acarina occurrence in 2011 and in 2012 was similar, but the number of individuals was higher in 2012 (Figs. 1, 2). The dynamics in 2011, *ie* one year after the soil contamination, pointed to their most intensive activeness in May and at the beginning of June (Fig. 1). In the later period they were caught only sporadically. Similar dynamics of their occurrence, with peak abundance in June was registered also in previous investigations [13].

Table 1

Occurrence of Acarina trapped using pitfall traps in individual months after soil contamination. The symbols as in Figure 1

Number of months from the moment of soil contamination	**Acarina [No. of individuals / trap / month]**							
	Control		**Petrol**		**Diesel fuel**		**Engine oil**	
	0R	**R**	**0R**	**R**	**0R**	**R**	**0R**	**R**
11	2.50 ab*	3.00 ab	0.50 a	1.75 ab	4.25 ab	2.50 ab	3.75 b	2.46 ab
12	0.00 a	0.25 a	0.50 a	0.50 a	0.25 a	0.50 a	0.50 a	0.00 a
13	0.00 a	0.00 a	0.25 a	0.25 a	0.00 a	0.00 a	0.00 a	0.00 a
14	0.25 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
15	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a	0.00 a	0.00 a
16	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
23	87.25 ab	86.50 ab	6.25 a	73.50 ab	9.42 a	27.25 a	3.75 a	154. 25 b
24	57.50 ab	63.25 ab	13.17 a	84.25 ab	15.50 a	42.00 a	13.00 a	121.25 b
25	12.25 a	23.17 ab	13.25 a	26.25 ab	16.25 a	12.75 a	12.67 a	40.33 b
26	4.00 a	8.00 a	14.50 a	10.74 a	13.25 a	9.25 a	5.25 a	18.08 a
27	3.50 a	11.58 a	12.08 a	7.25 a	9.75 a	10.00 a	7.50 a	17.75 a
28	3.75 ab	4.17 ab	4.50 ab	8.00 b	1.00 a	1.75 a	3.75 ab	7.25 b

* Means in lines marked with the same letters do not differ significantly according to LSD test at $\alpha = 0.05$; factors contamination x remediation

In the 11th month, from the moment of the soil contamination, the most numerous Acarina were caught in the soil contaminated with engine oil (Table 1), on the other hand significantly fewer of these animals were caught into the traps placed in the soil polluted with petrol. However, none of the registered values differed markedly from these noticed under conditions of control soil. The bioremediation process did not influence significantly the Acarina activeness on the soil surface either. The number of Acarina caught in the months from 12 to 16 was very low and no visible differences were noted between the investigated objects. Also, the data analysis for the 2011 season did not reveal any effect of the soil pollution with oil derivatives or bioremediation supported with ZB-01 preparation on the occurrence of Acarina on the soil surface (Fig. 3).

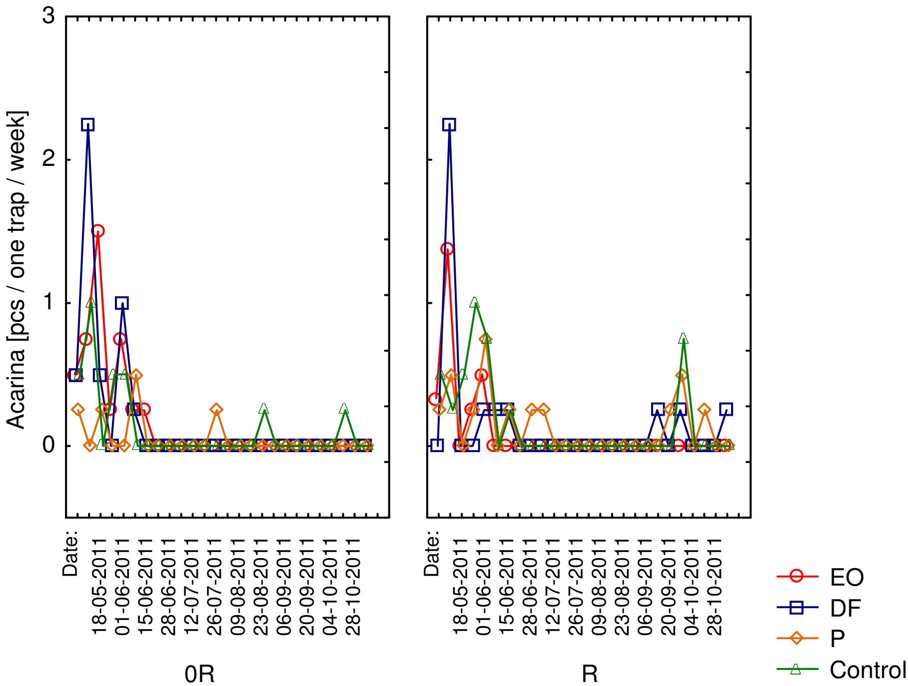

Fig. 1. Course of dynamics of Acarina occurrence trapped using pitfall traps in 2011. EO - soil contaminated with used engine oil, DF - soil contaminated with diesel fuel, P - soil contaminated with petrol, Control - unpolluted soil, 0R - series without assisted bioremediation, R - series with assisted bioremediation

Analysis of the dynamics of Acarina abundance in the 2012 season indicated their intensive activeness during the whole vegetation season (Fig. 2), with more intensive occurrence in May and June. According to Eyre et al [14], the meteorological conditions in a given season may have a considerable influence on the number of specimens caught using pitfall traps. In the months from 23rd to 25th from the moment of soil pollution, the highest numbers of Acarina were caught in the soil polluted with engine oil, but at simultaneously applied supported bioremediation (Table 1). Significantly fewer of these invertebrates were registered in all other objects with polluted soil, except the petrol contaminated soil subjected to bioremediation, whereas in the 25th month also in the control soil. In August and September 2012 (*ie* in the 26th and 27th month after contamination) Acarina number was much lower and no significant differences were noted at that time depending on the pollutant substance or the bioremediation. Heightened Acarina activity in the soil contaminated with petrol and engine oil after the application of biopreparation was registered also in October 2012 (the 28th month after the soil contamination).

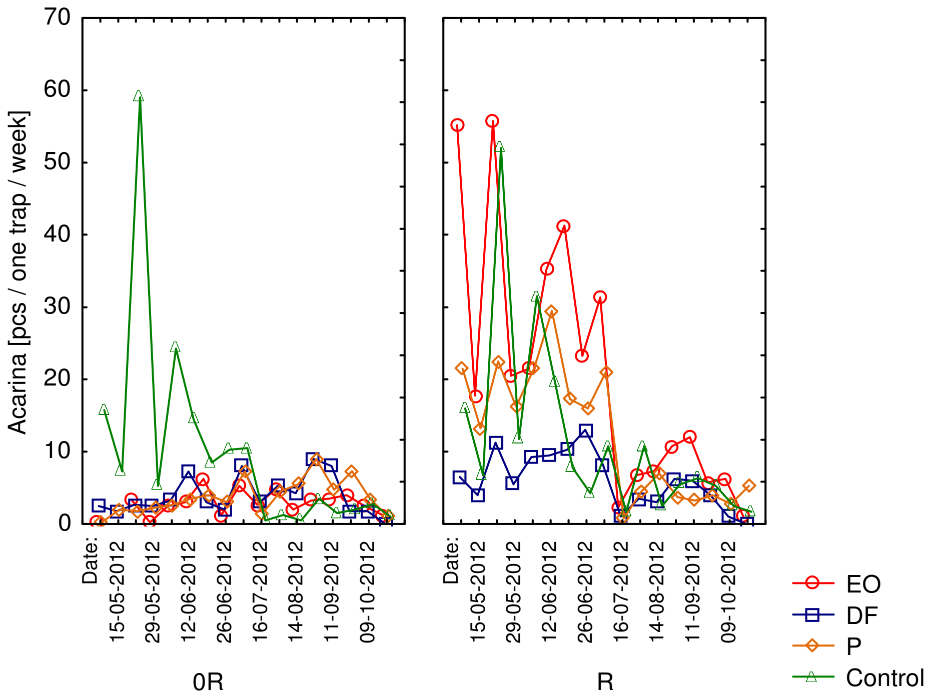

Fig. 2. Course of dynamics of Acarina occurrence trapped using pitfall traps in 2012. The symbols as in Figure 1

Joint analysis of the results obtained during the 2012 season revealed the persistent negative effect of the soil contamination with engine oil, diesel fuel and petrol regarding Acarina activeness on the soil surface. The applied supported bioremediation removed this negative effect in case of petrol as the pollutant substance. In case of diesel fuel, also increased number of caught Acarina was noted, so statistically it did not differ from the number registered in the control soil, where the biopreparation was not applied. In the soil contaminated with engine oil, the applied biopreparation led to a marked increase in the number of caught Acarina to the level almost twice higher than observed in the unpolluted soil without the biopreparation.

The research on the occurrence of terrestrial Acarina conducted in the presented experiment immediately after the soil pollution with oil derivatives (*ie* in the 2010 season) did not show any significant effect of the pollutants on the invertebrate activity on the soil surface [13]. On the other hand the applied biopreparation contributed to increased number of specimens caught in the soil contaminated with petrol 3 months after the contamination.

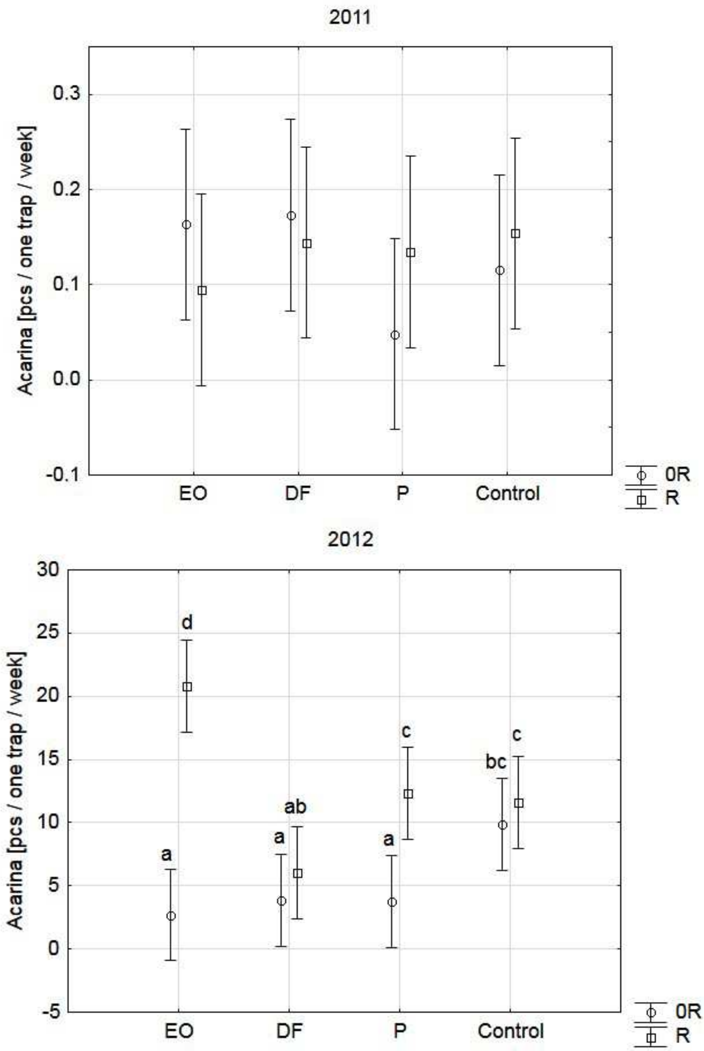

Fig. 3. Occurrence of Acarina trapped using pitfall traps mean in the years 2011, 2012. The symbols as in Figure 1. Means marked with the same letters do not differ significantly according to LSD test at $\alpha = 0.05$; factors contamination x remediation. ⌶ Mean ±0.95 confidence interval. In 2011 means do not differ statistically

In previous research, 2 and 3 years after the moment when crude oil was spilled on the roadside in result of a road disaster, slightly more numerous Acarina (Orbatida) were caught in the unpolluted area [15]. Investigations conducted by Blakely et al [16] as well as previous research of Ertsfeld and Snow-Ashbrook [17] also indicated a reduction in abundance of total Acarina with PAH contamination. The authors ascribe it to two possible reasons: fungicidal effect of PAHs, which reduces the amount of microarthropod's fungal or detrital food, or reduction of their habitat space due to increasing bulk density in effect of PAH contamination. On the other hand, Santarufo et al [18] mention the soil Acarina among the microarthropods fairly resistant to the urban environment.

Conclusions

1. Two years after the moment of soil contamination with petrol, diesel fuel and engine oil on the level corresponding to the most frequently registered content in the soil medium polluted with oil derivatives, their negative effect on Acarina activity on the soil surface is still evident.
2. Application of bioremediation supported with ZB-01 preparation significantly reduces the negative effect in case of the soil contaminated with petrol and to a lesser extend also in soil polluted with diesel fuel, whereas it contributes to a considerable intensification of Acarina activeness in the soil contaminated with used engine oil.
3. The number of Acarina caught using pitfall traps may be strongly modified by the course of the weather conditions during respective vegetative seasons.

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NASTĘPCZY WPŁYW ZANIECZYSZCZENIA GLEBY ROPOPOCHODNYMI NA WYSTĘPOWANIE ROZTOCZY

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Abstrakt: Celem pracy było określenie następczego (tj. po upływie roku i 2 lat) oddziaływania skażenia gleby różnymi ropopochodnymi (benzyną, olejem napędowym i zużytym olejem silnikowym) na aktywność naziemnych Acarina. Ocenie poddano również wpływ procesu bioremediacji wspomaganej na wymienione bezkręgowce. Glebę umieszczono w kontenerach o pojemności 1 m^3 i zanieczyszczono 6000 mg substancji ropopochodnej kg^{-1} suchej masy gleby w czerwcu 2010 roku. Po upływie tygodnia połowa kontenerów z zanieczyszczoną glebą poddana została procesowi bioremediacji z użyciem preparatu ZB-01, specjalnie do tego celu przygotowanego. Faunę naziemną, w tym roztocza, chwytano z użyciem pułapek Barbera w latach 2011 i 2012. Po upływie 2 lat od momentu zanieczyszczenia gleby benzyną, olejem napędowym i olejem silnikowym na poziomie odpowiadającym najczęściej stwierdzanej zawartości w glebach średnio skażonych substancjami ropopochodnymi nadal widoczny jest negatywny ich wpływ na aktywność roztoczy glebowych na powierzchni gleby. Zastosowanie bioremediacji wspomaganej istotnie ogranicza ten negatywny wpływ w przypadku skażenia gleby benzyną i w mniejszym stopniu także olejem napędowym, a przyczynia się do znacznego zwiększenia aktywności roztoczy w warunkach gleby zanieczyszczonej zużytym olejem silnikowym. Liczebność roztoczy odławianych z użyciem pułapek Barbera może być silnie modyfikowana przebiegiem warunków pogodowych panujących w danym sezonie wegetacyjnym.

Słowa kluczowe: ropopochodne, gleba, bioremediacja, Acarina