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CHANGES IN NUMBER OF FUNGI UNDER CULTIVATION OF AGRICULTURAL PLANTS IN THE VICINITY OF THE MUNICIPAL LANDFILL SITE

ZMIANY LICZEBNOŚCI GRZYBÓW W GLEBACH POD UPRAWĄ ROŚLIN ROLNICZYCH WOKÓŁ SKŁADOWISKA ODPADÓW KOMUNALNYCH

Abstract: Research for the present paper was carried out in field experiment localized in the vicinity of the municipal landfill site in Tarnow. In designated areas 8 plots were established, in which horse bean 'Nadwislanski' var., spring wheat 'Zura' var. and potatoes 'Kuklik' var. were cultivated in 2006 and 2007 using the same agricultural technology. Additional plot was located in restored sector of the landfill.

On the basis of the obtained results it can be concluded that in soil under cultivation of various agricultural plants, microscopic fungi – *Micromycetes* occurred with frequency from 8440 to 179150 cfu $\cdot$ g^{-1} of soil dry mass. The abundance of fungi in soil on the plots with spring wheat was lower than under other agricultural plants (potatoes, horse bean). Based on the analyses it was also found that the occurrence of fungi in tested soils was influenced by plot location in relation to the landfill and type and period of growth of the cultivated plant.

Keywords: fungi, soil, agricultural plants, landfill site

Municipal landfills site pose a threat to the surrounding natural environment and negatively affect the conditions of agricultural production, reducing soil quality and value of crops. In many cases they are located nearby the fields, which often leads to significant deterioration of vegetation conditions of cultivated plants. Therefore, there is a growing need to improve technologies that lead to minimisation of their negative influence not only on atmosphere but also on adjacent soil [1–3].

There is a clear correlation between parameters of soil environment, its micro-organisms and plants. Microorganisms increase efficiency of root exudates, and thus

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they can facilitate the assimilation of minerals and stimulate plant growth. Fungi play a significant role in soil environment, they are common in natural biocenoses and are used for agrocenoses [1, 4].

Therefore, the objective of the research was to measure the changes in abundance of fungi in soils under cultivation of agricultural plants in the vicinity of a municipal landfill site.

Material and methods

The research for present paper was carried out in the vicinity of the municipal landfill site in Tarnow from March 2006 to September 2007. The analyses were carried out in field experiment. On each side of the landfill two zones were set to its borders – zone I from 50 to 250 m, whereas II zone between 250 and 500 m. 8 plots were established in the designed areas, in which horse bean 'Nadwislanski' var., spring wheat 'Zura' var. and potatoes 'Kuklik' var. were cultivated in 2006 and 2007 using the same agricultural technology. Additionally, the 9th plot was located in reclaimed sector of the landfill, which role was to indicate the influence of the deposited waste in this sector on mycological state of soils in the tested plot. Each plot was divided into microplots 20 m^2 each. Characteristics of the plots location are presented in Table 1. Soil samples for analyses were taken once in each season from the plots from 0–20 cm layer. Samples were transported to the laboratory of Department of Microbiology, University of Agriculture in Krakow, where the microbiological analyses of abundance of fungi in one gram of soil dry matter were performed. *Colony forming units* (cfu) of fungi on malt extract agar (Malt Extract Agar, MEA, Oxoid, Basingstoke, Great Britain) were determined using plating dilutions method.

Table 1

Plots situated in the vicinity of municipal landfill site in Tarnow in 2006–2007

Plot	Plot location – zone [m]	Soil
W I	50–250	light loam
W II	250–500	heavy loamy sand
N I	50–250	light loam
N II	250–500	light loam
E I	50–250	slightly loamy sand
E II	250–500	heavy loamy sand
S I	50–250	light loamy sand
S II	250–500	slightly loamy sand
Z	restored sector	light loam

Explanations: letters in plots' marking mean cardinal points.

Results and discussion

On the basis of the results presented in Table 2 it can be concluded that in soil under cultivation of various agricultural plants, microscopic fungi *Micromycetes* occurred in the range between 8440 and 179150 cfu · g^{-1} soil d.m.

Table 2

Abundance of fungi in soils under cultivation of agricultural plants in the vicinity of municipal landfill site in Tarnow

No.	Plot/plant	Abundance [cfu per 1 g of soil d.m.]							
		III 2006	V 2006	VII 2006	IX 2006	III 2007	V 2007	VII 2007	IX 2007
1	W I								
	Spring wheat	10270	42700	113500	90534	27362	14634	33200	19700
	Horse bean	14273	42054	45567	58300	23367	33564	43267	16200
	Potatoes	18730	23360	42267	24300	13380	11634	23200	20300
2	W II								
	Spring wheat	23004	26816	31966	131633	68700	19466	39520	27050
	Horse bean	13804	86816	109500	48200	88700	69045	90526	17000
	Potatoes	10900	16800	68867	34700	26050	11950	58660	44720
3	N I								
	Spring wheat	24590	72560	83000	76540	18700	9667	61090	21300
	Horse bean	16598	112500	157500	98000	28700	139024	126190	10300
	Potatoes	23900	68930	92500	163500	42720	45900	92520	63450
4	N II								
	Spring wheat	43086	47890	37100	100866	34800	45330	59000	22800
	Horse bean	23029	57800	70823	37950	14866	32970	54810	12400
	Potatoes	14360	48400	123500	141000	35800	69434	84170	71240
5	E I								
	Spring wheat	17600	42646	55766	64720	23900	49300	78200	21740
	Horse bean	27628	22695	28900	64366	13966	27600	38000	41734
	Potatoes	29300	50130	84700	24900	67830	41734	82400	34460
6	E II								
	Spring wheat	13200	27440	32066	8440	19600	9500	29360	13200
	Horse bean	13240	17170	30000	63033	15100	24573	39361	17640
	Potatoes	16280	33290	62200	66534	9420	12500	42610	46540
7	S I								
	Spring wheat	21600	59220	90400	130500	17600	31600	46200	14500
	Horse bean	11698	79780	107533	26234	32650	82600	56780	10500
	Potatoes	23620	17600	44260	34567	20600	12600	26240	19500
8	S II								
	Spring wheat	54196	92260	113510	132500	82502	41967	54000	29900
	Horse bean	10196	102248	179150	120000	27567	122863	154562	69943
	Potatoes	44500	32680	64572	74567	17560	16400	66420	49900

Table 2 contd.

No.	Plot/plant	Abundance [cfu per 1 g of soil d.m.]							
		III 2006	V 2006	VII 2006	IX 2006	III 2007	V 2007	VII 2007	IX 2007
9	Z								
	Spring wheat	18600	23290	15350	35567	10200	17350	21560	16800
	Horse bean	14772	32795	31967	25000	10634	31793	43967	66300
	Potatoes	21684	22600	24600	32567	27020	23620	53640	33238

Explanations: location of plots as in Table 1.

The lowest value was recorded on the plot under wheat cultivation, which was located in the zone 250 to 500 m east of the landfill (E II plot), and the highest value was recorded on the plot under horse bean cultivation, which was located behind the trees strip in zone II, on the south side of the landfill (plot S II). Analysing changes in the number of fungi showed that their abundance in the tested soil varied depending on the plot location, type of the cultivated plant and sampling period. It needs to be stressed that soil is excellent substrate for growth and development of various group of microorganisms, because it is usually sufficient with organic and mineral nutrients and has adequate humidity, reaction and favourable aerobic conditions. There is also a strong correlation between soil environment parameters, its microorganisms and plants [2, 5–7].

Analytical data presented in Table 2 indicates that the plot under horse bean cultivation contained from 10196 to 179150 cfu of microscopic fungi in 1 g of soil dry matter. Both the maximum and minimum number was found in the plot situated south of the landfill, in a zone 250–500 m from its area (S II plot). Analysing changes of fungi abundance in soil on the plots under cultivation of each agricultural plant indicated that their number in spring wheat ranged from 8440 to 132500 cfu in 1 g of soil d.m. Their highest number occurred on the plot located south of the landfill (S II plot) whereas the minimal number on the east side of the landfill (E II plot). On the other hand, abundance of microscopic fungi in soil under cultivation of potatoes was from 9420 to 163500 cfu $\cdot$ g^{-1} soil d.m. The study showed that in soil under cultivation of potatoes the highest number of fungi occurred on a plot located on the north side of the landfill in the area distant from 50 to 250 m from its territory (plot N I) and the lowest number was found on the plot located on the east side of the landfill in the area 250–500 m (E II plot) distant. Obtained analytical data indicate that in 1 g of soil d.m. on the plots under horse bean there were from 10196 to 179150 cfu of microscopic fungi. Maximum as well as minimum value was found on the plot situated south of the landfill in the area distant from 250 to 500 m (S II plot). Similarly increase in abundance of fungi in soil layers (20–25 cm) was observed in the measuring point located further from the landfill in Leczyca (400 m) [3].

Comparing the average number of fungi under cultivation of all agricultural plants included in the experiment indicated that the highest average number (98316 cfu $\cdot$ g^{-1} soil d.m.) occurred in soil under cultivation of horse bean, on the plot located on the south side of the landfill (S II plot) which was over 30 % higher than the maximum

average number of fungi in the soil on the control plot located in the zone II on the west side of the landfill, 250 to 500 m from its area (W II plot). On the other hand the lowest value (19101 cfu · g^{-1} d.m. of soil) was found in the soil under cultivation of spring wheat, on the plot situated on the east side of the landfill (E II plot) (Table 3) which was comparable with the minimum average number of fungi (19840 cfu · g^{-1} d.m. of soil) found in the plot located in the restored area. It is worth noting that on the plot located in the area of the landfill (Z plot) under cultivation of all agricultural plants much lower average numbers of fungi was recorded in comparison with other plots. Therefore, it is clear that waste deposited in this sector significantly impacted mycological state of the soils in the tested area.

Table 3

Average number of fungi in soil under cultivation of agricultural plants in the vicinity of municipal landfill site in Tarnow (years 2006–2007)

No.	Plot	Abundance [cfu in 1 g of soil d.m.]		
		Spring wheat 'Zura' variety	Horse bean 'Nadwislanski' variety	Potatoes 'Kuklik' variety
1	W I	43988	34574	22146
2	W II	46019	65449	34081
3	N I	45931	86102	74178
4	N II	48859	38081	73488
5	E I	44234	33111	51932
6	E II	19101	27515	36172
7	S I	51453	50972	24873
8	S II	75104	98316	45825
9	Z	19840	32154	29871

Explanations: location of plots as in Table 1.

Based on the obtained average numbers of fungi it was also shown that in the soil under cultivation of potatoes and beans a significant increase of fungi abundance compared with the control plot (W II) can be noticed on the plots located on the north side of the landfill, whereas under cultivation of spring wheat – on the plots located on the south side.

The above relationship may result from the fact that due to location the plots situated on the east side of the landfill should be the most vulnerable to impact of pollutants emission from the landfill. This results both from predominant winds in this area that blow in an easterly direction and from the fact that the active section is situated on the north-east side of the landfill. It also needs to be remembered that soil microflora is the fastest growing and reacting to changes of environmental parameters part of the biocenosis. This is due to typical of microorganisms variety of biochemical functions and abnormally high physiological activity [2, 5, 8].

The obtained results also showed that abundance of fungi on the plots under cultivation of spring wheat was slightly lower than under the rest of agricultural plants

included in the experiment. The results may therefore indicate that different chemical composition of root exudates of each agricultural plant species in the experiment had modifying influence on the soil microorganisms. Microflora is affected by plant genus, plant species, plant variety as well as plant growth period. Plants by their root exudates can change soil dwelling microflora in various ways [4, 9]. Taking into account the terms of the analyses, significant increase of fungi abundance was noted in soil on the plots during active growth of plants which is in summer and which is probably caused by intensive mineralisation of soil organic matter due to usually preferable humidity and thermal conditions for growth of microflora in this period [4, 10].

Conclusions

1. The carried out research showed varied occurrence of fungi in soil environment on plots located in the vicinity of the municipal landfill site.
2. The abundance of fungi in soil on the plots under cultivation of spring wheat was lower than under other tested agricultural plants (potatoes, horse bean).
3. The plot location in relation to the landfill and type and period of growth of the cultivated plant influenced the abundance of fungi in the tested soils.

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ZMIANY LICZEBNOŚCI GRZYBÓW W GLEBACH POD UPRAWĄ ROŚLIN ROLNICZYCH WOKÓŁ SKŁADOWISKA ODPADÓW KOMUNALNYCH

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Abstrakt: Badania do niniejszej pracy zostały przeprowadzone w doświadczeniu polowym zlokalizowanym wokół składowiska odpadów komunalnych w Tarnowie. W wyznaczonych strefach założono 8 poletek

doświadczalnych, na których uprawiano w latach 2006 i 2007 bobik odmiany 'Nadwiślański', pszenicę jarą odmiany 'Żura' oraz ziemniaki odmiany 'Kuklik' przy zastosowaniu tej samej agrotechniki. Dodatkowe poletko zlokalizowano w sektorze zrekultywowanego składowiska. Na podstawie otrzymanych wyników można stwierdzić, że w glebie na poletkach pod uprawą różnych roślin rolniczych grzyby mikroskopowe – *Micromycetes* występowały od 8440 do 179150 jtk · g^{-1} s.m. gleby. Stwierdzono, że liczebność grzybów w glebie na poletkach w uprawie pszenicy jarej była mniejsza niż pod pozostałymi ujętymi w doświadczeniu roślinami rolniczymi (ziemniaki, bobik). Na podstawie przeprowadzonej analizy stwierdzono także, że występowanie grzybów w badanych glebach było zależało od miejsca położenia poletka doświadczalnego względem składowiska oraz rodzaju i okresu wzrostu uprawianej rośliny rolniczej.

Słowa kluczowe: grzyby, gleba, rośliny uprawne, składowisko odpadów