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**EFFECT OF THE SOLID WASTE LANDFILL
IN TARNOW ON THE OCCURRENCE
OF BENEFICIAL ENTOMOFAUNA ON HORSE BEAN**

**WPLYW SKŁADOWISKA ODPADÓW STAŁYCH
W TARNOWIE NA WYSTĘPOWANIE
POŻYTECZNEJ ENTOMOFAUNY BOBIKU**

Abstract: The research on the occurrence of beneficial entomofauna on horse bean was conducted in 2006 and 2007 on plots located in the immediate vicinity of the municipal landfill site in Tarnów. The structure of horse bean entomofauna dominance differed depending on plot localisation with respect to the active landfill sector. A larger proportion of harmful entomofauna was observed on the plots located closest to the active sector, whereas the share of beneficial insects on these plots was smaller.

Keywords: municipal landfill sites, beneficial insects, pests

Landfill sites pose an important economic and social problem. Moreover, the areas adjoining landfills are exposed to various hazards, such as microbiological or chemical pollution leading to degradation of surrounding soils, surface and underground waters or vegetation. Dispersal of gaseous, dust and microbial pollutants in the atmosphere may pose a grave hazard to human life and health [1–3].

Landfill sites may disturb the balance in the environment eg through change of habitat conditions. A large accumulation of various types of waste, including organic one may favour the occurrence of one organism but eliminate the others [4]. It refers to both animal and plant organisms. Landfill sites are a place of habitation of organisms which are troublesome or dangerous for humans, eg rats. Numerous occurrences of *Muscidae*, *Calliphoridae* and *Sarcophagidae* dipterans, which may carry many pathogenic organisms, are also often observed in the vicinity of municipal landfill sites.

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Agricultural activity is conducted in the neighbourhood of municipal landfill sites. Due to the character of field crops the balance is frequently disturbed which is visible as a sudden increase in population numbers feeding on cultivated crops. Numerous appearances of pest are often prevented among others by their natural enemies, which are often called beneficial insects. Changes of insect numbers in arable crops may be caused by eg application of chemical plant protection [5–7]. As an effect of pesticide application the number of beneficial insects usually declines, however, not only pesticide application poses a hazard for balance in agrocenoses. Also other factors, such as fertilization, industrial or traffic pollution bring about changes in the numbers of entomofauna. Municipal landfill sites also emit numerous pollutants which may affect organisms settling arable crops but this effect has not been fully investigated yet. Maintaining biodiversity is one of the most important challenges which humans face in the nearest future.

The present research aimed to investigate the occurrence of beneficial entomofauna on horse bean plants in the area immediately adjoining a municipal landfill site.

Material and methods

The research was conducted in 2006 and 2007 in Tarnow. The solid waste landfill site in Tarnow, around which the studies were carried out, is located in the northern city quarter called Krzyz. The landfill site area is surrounded by arable lands, wasteland and forest. Observations were conducted on experimental plots located in the immediate vicinity of the landfill. The experimental points were set up on each side of the landfill in two zones: below 250 m and 250–500 m from its boundaries. Labelling of experimental plots is presented in Table 1. Spring wheat, potatoes and horse bean were cultivated on each 20 m² plot. The experiment was set up in four replications. Identical cultivation measures were applied on all plots.

Table 1

Soil sampling sites in the vicinity of the municipal landfill site in Tarnow

Point	Localization of points with respect to landfill site	
	Direction	Zone [m]
W I	West	below 250
W II	West	250–500
N I	North	below 250
N II	North	250–500
E I	East	below 250
E II	East	250–500
S I	South	below 250
S II	South	250–500

Wind from the west dominate in the area of Tarnow city, the mean wind speed is 2.2 m/s, which points to light wind. Detailed wind distribution data are as follows: north

winds – 6 %, north-east winds – 7.1 %, east winds – 16.7 %, south-east winds – 4.8 %, south winds – 14.8 %, south-west winds – 7.4 %, west winds – 22.6 %, north-west winds – 8.8 % and calm air – 11.8 %

Measurements of emission and composition of biogas were conducted in the immediate vicinity of active municipal landfill site in Tarnow in places where plants were cultivated. The measurements were carried out from April 2006 to October 2007 using a device for measuring landfill gas composition – Polytektor II G 750 (Germany). The contents of biogas components in the air surrounding the landfill are presented in Table 2. The highest methane concentrations occurred in zone I on the eastern, northern and southern side of the landfill.

Table 2

Mean value of biogas components in the air surrounding the municipal landfill site in Tarnow (from April 2006 to October 2007)

Indicator	Unit	Measuring point							
		S I	S II	E I	E II	N I	N II	W I	W II
Methane (CH ₄)	ppm	0.9	0.4	0.7	0.5	0.5	0.0	0.0	0.0
Hydrogen sulfide (H ₂ S)	ppm	Not registered							
Carbon dioxide (CO ₂)	%	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04
Oxygen (O ₂)	%	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9

Immediate observations of entomofauna presence on horse bean plants were conducted every week during vegetation period. Insects were captured on each plot using bucket traps making 10 strokes diagonally on each plot. The insects were captured at the same time on subsequent dates. The collected insects were brought to the laboratory and identified. The Peus scale was used for an assessment of dominance structure of individual insect groups: D-dominants > 5 %, S-subdominants 2.1–5.0 % and A-accessory < 2.1 %.

The results were verified statistically using Statistica programme. Three factor ANOVA was conducted, Newman-Keuls critical intervals were computed and the value of the final step was used for means differentiation at significance level $p < 0.05$.

Results and discussion

Numerous entomofauna occurred in the surrounding of the solid waste landfill site in Tarnow-Krzyz (Table 3). Several thousand specimens were captured on individual plots during the observation period. The most numerous entomofauna was observed on the plots located on the eastern and northern landfill side. The most numerous group of trapped insects consisted of neutral ones, ie species which do not directly affect horse bean plant healthiness. Horse bean pest were also numerous, whereas the least numerous were the so-called beneficial insects, ie these which are the natural enemies of horse bean pests.

Among the beneficial entomofauna the most numerous were the representatives of *Heteroptera* and *Coccinellidae* beetles (Table 4). The representatives of *Chrysomelidae* and *Syrphidae* family were less numerous. Also single specimens from *Cantharidae* family were trapped. The greatest number of *Heteroptera* was captured on the plots on the western side of the landfill in zone II and the smallest on plots localized in zone I on the eastern side in the immediate vicinity of the active landfill sector.

Neutral insects prevailed on all plots, irrespective of their location with respect to the landfill (Table 5). They had the greatest share in the dominance structure on horse bean plots located on the southern and western side of the landfill. Harmful insects were almost as numerous as the neutral ones on the horse bean plots on the eastern and northern side of the landfill. Obviously a lower share of harmful insects in the dominance structure was observed on horse bean plots situated at a long distance from the active landfill sector. Beneficial insects had the smallest share in the dominance structure, usually between 10 and 14 %. They had the greatest share on the plots on the southern and western side of the landfill.

The analysis of the dominance structure of beneficial entomofauna groups (Table 6) points to a prevalence of two groups, ie *Coccinellidae* beetles and *Heteroptera*. The latter dominated in horse bean cultivation on the northern side of the landfill in the first zone. A considerable proportion of *Coccinellidae* beetles was undoubtedly connected with numerous aphids settling horse bean plants. Also for *Chrysomelidae* or *Syrphidae* aphids are the basic source of food [8]. The *Cantharidae* and *Chrysomelidae* population numbers did not differ significantly between the analyzed plots. On the other hand, the numbers of *Coccinellidae* beetles, *Syrphidae* or *Heteroptera* were significantly smaller on the plots situated closest to the active landfill sector. This evidences a stronger sensitivity of this group of beneficial entomofauna to pollution emitted by the municipal landfill site.

Municipal landfills are not only the places of waste accumulation but also, as indicated by Chan et al [4] they may provide comfortable living conditions for many insect species. Gaseous and microbial pollutants which are emitted from the landfill may affect the adjoining area, as in [3]. Because of the localisation, the plots situated on the eastern and northern side of the landfill are the most exposed to the emission effect. It is connected both with east wind prevailing in this area and with the fact that the active sector is located in the north-eastern part of the landfill. The highest methane concentrations were registered on these plots. The gas originates on municipal waste landfill sites and moves to the adjoining terrains with air currents. A greater proportion of harmful entomofauna was registered on the plots located in these places. Also other authors point to a negative effect of air pollution on the composition of entomofauna of cultivated crops [8–11]. On the other hand the share of beneficial insects was smaller despite the fact that the number of beneficial insects captured on all plots was similar. This evidences a lower efficacy of pest natural enemies in reducing their population numbers.

Table 4

Occurrence of entomofauna on horse bean plants depending on plot localization with respect to the landfill site

Taxon	Year	Number of captured plants [pcs]												LSD _{p < 0.05}				
		S						E							N		W	
		I		II		I		II		I		II			I	II	I	II
		I	II	I	II	I	II	I	II	I	II	I	II		I	II	I	II
<i>Heteroptera</i>	2006	169	151	135	147	153	144	156	190									
	2007	175	169	175	176	186	172	192	206									
	Mean	172	160	155	161.5	169.5	158	174	198	23.2								
<i>Coccinellidae</i>	2006	190	196	146	155	133	154	183	171									
	2007	167	174	174	171	150	176	181	173									
	Mean	178.5	185	160	163	141.5	165	182	172	20.1								
<i>Cantharidae</i>	2006	21	27	15	17	16	16	17	20									
	2007	23	23	21	23	22	20	24	25									
	Mean	22	25	18	20	19	18	20.5	22.5	n.s.								
<i>Chrysomelidae</i>	2006	32	36	17	29	25	25	29	31									
	2007	38	38	36	42	34	37	41	36									
	Mean	35	37	26.5	35.5	29.5	31	35	33.5	n.s.								
<i>Syrphidae</i>	2006	59	62	34	44	31	39	38	48									
	2007	57	56	41	46	37	54	46	55									
	Mean	58	59	37.5	45	34	46.5	42	51.5	13.2								
Other	2006	175	167	135	140	144	136	153	170									
	2007	146	167	157	179	165	162	174	187									
	Mean	160.5	167	146	159.5	154.5	149	163.5	178.5	n.s.								

n.s. – non-significant differences.

Table 5
Structure of entomofauna dominance [%]

Insects captured on horse bean plants	Year	Proportions of individual insect groups												<i>LSD_{p < 0.05}</i>				
		S						E							N		W	
		I		II		I		II		I		II			I	II	I	II
		I	II	I	II	I	II	I	II	I	II	I	II		I	II	I	II
Neutral insects	2006	54.6	53.5	45.8	45.1	46.5	46.5	45.1	46.5	46.5	46.5	46.5	50.2	51.6				
	2007	52.2	51.7	45.3	47.7	46.8	47.3	47.7	47.3	46.8	47.3	47.3	49.6	50.8				
	Mean	53.4	52.6	45.6	46.4	46.7	46.9	46.4	46.7	46.7	46.9	46.9	49.9	51.2	3.33			
Harmful insects	2006	31.0	32.8	43.7	43.2	42.8	42.2	43.2	42.8	42.8	42.2	42.2	36.4	34.4				
	2007	34.1	34.5	42.8	39.3	41.7	40.0	39.3	41.7	41.7	40.0	40.0	37.2	35.0				
	Mean	32.6	33.7	43.3	41.3	42.3	41.1	41.3	42.3	42.3	41.1	41.1	36.8	34.7	2.60			
Beneficial insects	2006	14.2	13.6	10.4	11.5	10.6	11.2	11.5	10.6	10.6	11.2	11.2	13.3	13.8				
	2007	13.5	13.7	11.8	12.8	11.3	12.6	12.8	11.3	11.3	12.6	12.6	13.0	14.1				
	Mean	13.9	13.7	11.1	12.2	11.0	11.9	12.2	11.0	11.0	11.9	11.9	13.2	14.0	1.22			

Table 6

Structure of beneficial entomofauna group dominance [%]

Taxon	Year	Proportion of insects from individual taxons												LSD _{p<0.05}
		S						Points						
		I		II		E		N		W				
		I	II	I	II	I	II	I	II	I	II			
<i>Heteroptera</i>	2006	26.2	23.6	28.0	27.6	30.5	28.0	27.1	30.2					
	2007	28.9	27.0	29.0	27.6	31.3	27.7	29.2	30.2					
	Mean	27.5	25.3	28.5	27.6	30.9	27.9	28.1	30.2	3.66				
<i>Coccinellidae</i>	2006	29.4	30.7	30.3	29.1	26.5	30.0	31.8	27.1					
	2007	27.6	27.8	28.8	26.8	25.3	28.3	27.5	25.4					
	Mean	28.5	29.2	29.5	28.0	25.9	29.2	29.6	26.3	3.01				
<i>Cantharidae</i>	2006	3.3	4.2	3.1	3.2	3.2	3.1	3.0	3.2					
	2007	3.8	3.7	3.5	3.6	3.7	3.2	3.6	3.7					
	Mean	3.5	3.9	3.3	3.4	3.4	3.2	3.3	3.4	n.s.				
<i>Chrysomelidae</i>	2006	5.0	5.6	3.5	5.5	5.0	4.9	5.0	4.9					
	2007	6.3	6.1	6.0	6.6	5.7	6.0	6.2	5.3					
	Mean	5.6	5.8	4.7	6.0	5.4	5.4	5.6	5.1	n.s.				
<i>Syrphidae</i>	2006	9.1	9.7	7.1	8.3	6.2	7.6	6.6	7.6					
	2007	9.4	8.9	6.8	7.2	6.2	8.7	8.1	4.6					
	Mean	9.3	9.3	6.9	7.7	6.2	8.1	7.3	6.1	2.20				
Other	2006	27.1	26.1	28.0	26.3	28.7	26.5	26.6	27.0					
	2007	24.1	26.6	26.0	28.0	27.8	26.1	26.4	27.4					
	Mean	25.6	26.4	27.0	27.2	28.2	26.3	26.5	27.2	n.s.				

n.s. – non-significant differences.

Conclusions

1. Horse bean plants growing in the immediate vicinity of the active landfill sector are settled to a greater degree by harmful entomofauna.
2. Numbers of beneficial insect populations on plots were similar irrespective of their localisation with respect to the landfill.
3. In the area most exposed to the effect of active landfill sector the share of beneficial and negative insects was declining.
4. Beneficial representatives of *Coccinellidae*, *Heteroptera* and *Syrphidae* were more sensitive to the negative effect of pollutants originating from the landfill.

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WPLYW SKŁADOWISKA ODPADÓW STAŁYCH W TARNOWIE NA WYSTĘPOWANIE POŻYTECZNEJ ENTOMOFAUNY BOBIKU

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Abstract: Badania nad występowaniem entomofauny pożytecznej bobiku przeprowadzono na poletkach zlokalizowanych w bezpośrednim sąsiedztwie składowiska odpadów komunalnych w Tarnowie w 2006 i 2007

roku. Struktura dominacji entomofany bobiku różniła się w zależności od lokalizacji poletek względem czynnego sektora składowiska. Na poletkach zlokalizowanych najbliżej czynnego sektora zaobserwowano większy udział szkodliwej entomofauny. Natomiast udział owadów pożytecznych w tych lokalizacjach był mniejszy.

Słowa kluczowe: składowiska odpadów komunalnych, owady pożyteczne, szkodniki