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**CONTENT OF ASSIMILATION DYES
AND WATER BALANCE IN COMMON DANDELION
FOUND NEARLY CHEMICAL WORKS "POLICE"**

**ZAWARTOŚĆ BARWNIKÓW ASYMILACYJNYCH
ORAZ BILANS WODNY U MNISZKA POSPOLITEGO
WYSTĘPUJĄCEGO BLISKO ZAŁADÓW CHEMICZNYCH „POLICE”**

Abstract: The aim of the present studies was to assess air pollution around Chemical Works "Police" by means of selected physiological parameters (chlorophyll *a*, *b*, carotenoids and water balance) of common dandelion. Accumulation of sulfur in leaves of common dandelion was clearly larger at the distance of up to 0.7 km from the emitter than its content in control plants. On the basis of the coefficient of correlation, it was observed that the amount of sulfur in leaves had a significant effect on the content of assimilation dyes in common dandelion. Concentration of chlorophyll *a+b* and carotenoids in the assimilation apparatus and the value of the relative water content index of the plants gathered in the area of the Chemical Works "Police" was respectively lower by 31 %, 23 % and 14 % in comparison with these parameters in control leaves.

Keywords: water balance, assimilation dyes, sulfur, *Taraxacum officinale*

Chemical Works "Police" belong to the world leading manufacturers of complex fertilizers. Moreover, they are the only producer of titanium white [1, 2]. The high production is bound to produce the emission of sulfur dioxide, sulfur trioxide and mists of sulfuric acid, fluorine, ammonia and dust. The use of indicator plants plays a significant role in monitoring and evaluating the quantity and range of gaseous and dust impurities.

Common dandelion (*Taraxacum officinale* Weber) [3] is widely regarded and used as an indicator plant showing the environment contamination with heavy metals and sulfur [4–9]. The reaction of plants to the environment pollution is manifested, among other things, by changes occurring in the assimilation apparatus and in physiological processes. Physiological processes caused by biochemical reactions in the presence of

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sulfur compounds can result in disturbances of the work of stomatal apparatuses, the photosynthesis and the decrease in the level of assimilation dyes and the water balance in plants [10–13]. The studies showed that the process of photosynthesis as well as the chlorophyll content in the assimilation apparatus of plants constitute good indicators of the air pollution rate [14, 15].

The aim of the present investigation was the evaluation of air pollution around Chemical Works “Police” by means of selected physiological parameters of common dandelion.

Material and methods

The studies were carried out in 2007 at 7 research points set within the distance of 0.5 to 25 km from Chemical Works “Police”. Within the area of the Works five sites were fixed: No. 1 – 0.6 km southwards in front of the company management building, No. 2 – westwards, 0.5 km from the emitter at gate 3; No. 3 – westwards, 0.6 km from the emitter at gate 4; No. 4 – eastwards, 0.6 km from the emitter in the vicinity of the belt conveyor flight; No. 5 – northwards, 0.8 km from the emitter. The two remaining sites were set farther from the emitter of impurities: No. 6 – about 4 km from the emitter, in the centre of Police commune; No. 7 – about 25 km from the emitter, on Pucka Island (the control site). From the fixed research sites, leaves of common dandelion were taken for laboratory analysis, three times during the vegetation (June, July, August) The content of assimilation dyes (chlorophyll *a*, *b*, total and carotenoids) in the leaves was determined by means of Lichtenthaler and Welburn method [16]. The water balance was defined on the basis of two indices: RWC (*relative water content*) and WSD (*water saturation deficit*) [17]. The general content of sulfur in leaves was determined using an elementary analyzer manufactured by Costech (CHNS).

Results and discussion

The average content of sulfur in leaves of common dandelion gathered from the vicinity of Chemical Works “Police” varied from 0.29 to 0.49 %. The largest amount of this element was found in plants from the site situated eastwards near the belt conveyor flight – 0.49 % and southwards at the company management building – 0.47 %. On the control site this species was characterised by a low amount of sulfur – 0.19 % (Fig. 1).

The amounts of this element in leaves of common dandelion range within the values reported by Kabata-Pendias et al [18] and Litynski and Jurkowska [19]. The studies carried out by Kabata-Pendias and Motowicka-Terelak [20] and Motowicka-Terelak [5] show that the leaves of this plant growing in west Pomeranian province contained sulfur within the range of natural background – below 0.3 %. Such values were obtained in leaves of control plants. Referring to the threshold values of sulfur for common dandelion reported by Motowicka-Terelak and Terelak [7], it was observed that the content of this element was exceeded on four research sites. The obtained values of sulfur concentration in leaves of common dandelion growing in the direct neigh-

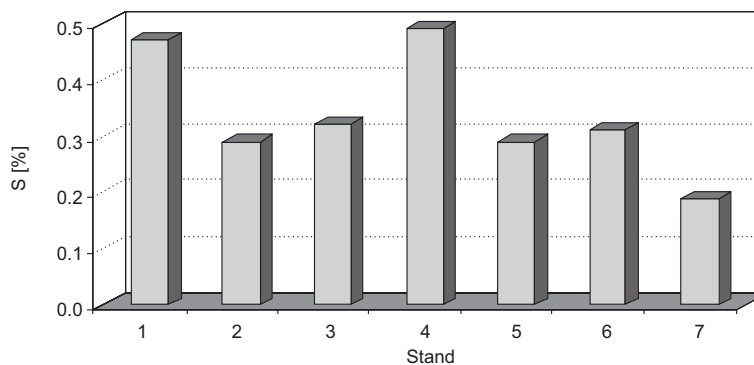


Fig. 1. The average amount of sulfur [%] in leaves of common dandelion found in the area of Chemical Works "Police"

bourhood of Chemical Works "Police" were also higher by 0.19 % southwards, than the amounts of this element in leaves of dandelion from industrial regions of Poland reported by Motowicka-Terelak and Terelak [7]. On the basis of the values of the correlation coefficient, a significant negative correlation relationship was observed between the content of assimilation dyes (chlorophyll *a*, *b*, total and carotenoids) and the concentration of sulfur in leaves of common dandelion (Fig. 2A–D).

The analysis of the two factor variance showed the significance of the influence of the site and time of studies on the content of assimilation dyes in leaves of the examined plant (Table 1).

The lowest content of total chlorophyll was characteristic of common dandelion gathered from the site near the company management building – on average $1.41 \text{ mg} \cdot \text{g}^{-1}$ of fresh matter (Table 1). The average amount of chlorophyll *a* and *b* in leaves from this site was about 48 % and 51 %, respectively, of its average content in control plants. The average content of chlorophyll *a+b* in leaves of the studied species in Police commune amounted to $2.04 \text{ mg} \cdot \text{g}^{-1}$ of fresh matter and this value was lower by $0.80 \text{ mg} \cdot \text{g}^{-1}$ of fresh matter than the concentration of these dyes in control leaves (Table 1).

The amount of carotenoids in the assimilation apparatus of common dandelion growing in the distance of 0.5–0.8 km from the emitter was slightly differentiated ($0.46\text{--}0.76 \text{ mg} \cdot \text{g}^{-1}$ of fresh matter). Leaves gathered from the neighbourhood of Chemical Works contained by about 24 % less of this dye than the control plants (Table 1). A lower amount of chlorophyll in plants growing in the area of contaminated air was obtained by Brej et al [14]. The authors showed that the decrease in the concentration of this dye depended on the species of plant and on the source of emission. Sawicka-Kapusta [10] shows that already low concentration of SO_2 results in the formation of necrosis, which is accompanied by a decrease in the concentration of chlorophyll. Zimny, Zukowska-Wieszczek [15] stated that under the influence of air contamination, the relation of chlorophyll *a* and *b* to pheopytin changes. Wozny [13] thinks that sulfur dioxide causes disturbances in biosynthesis of chlorophyll and decay of carotenoids.

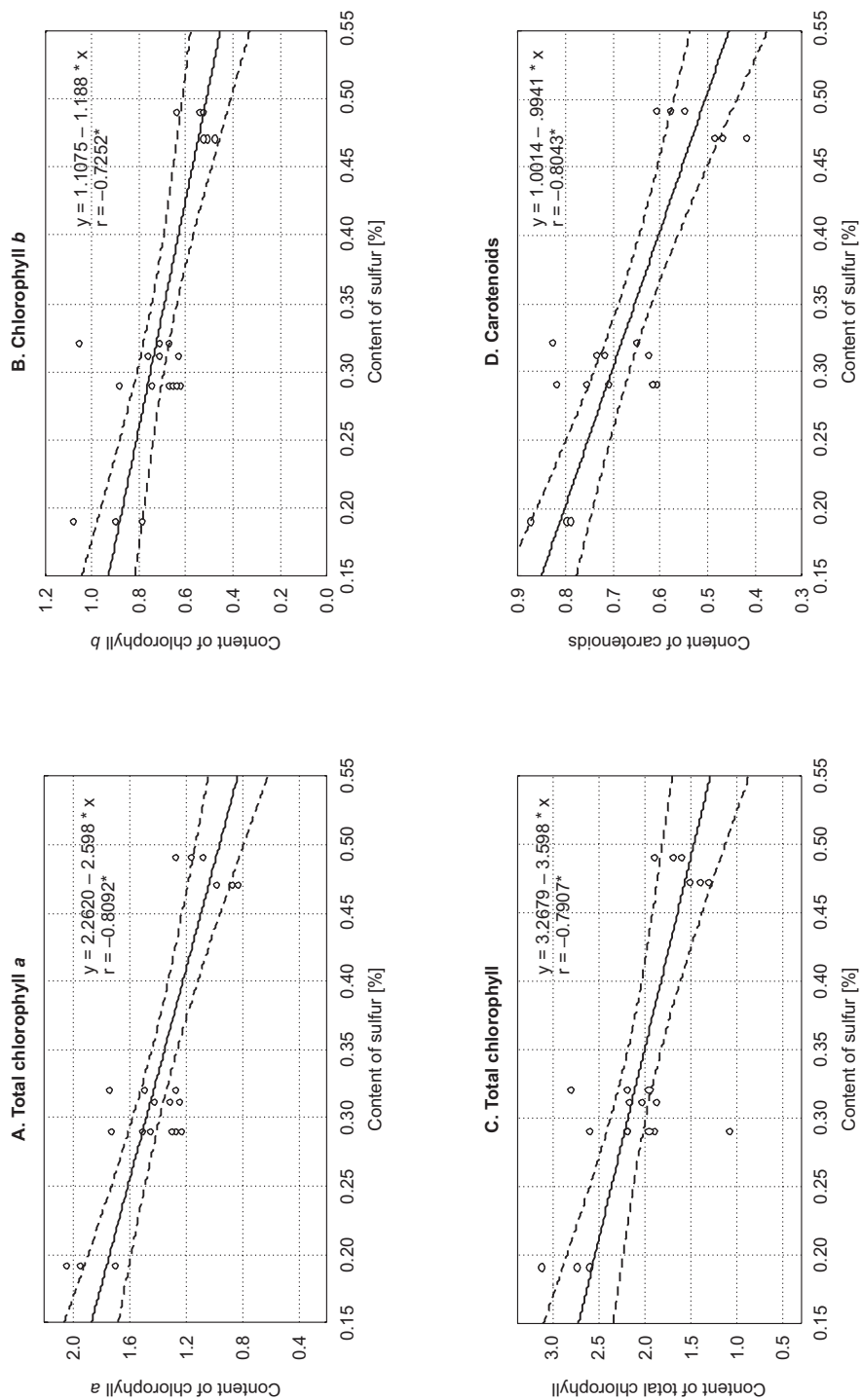


Fig. 2. Correlation between the content of assimilation dyes [$\text{mg} \cdot \text{g}^{-1}$ of fresh matter] and sulfur in leaves of common dandelion found in the area of Chemical Works "Police"

Table 1

The content of assimilation dyes [$\text{mg} \cdot \text{g}^{-1}$ of fresh matter] in leaves of common dandelion found in the area of Chemical Works "Police"

Date – factor II	Stand – factor I							The average of factor II
	1	2	3	4	5	6	7	
Content of chlorophyll <i>a</i> [$\text{mg} \cdot \text{g}^{-1}$ f.m.]								
VI	0.89	1.52	1.50	1.17	1.28	1.33	1.96	1.38
VII	0.84	1.46	1.29	1.09	1.24	1.25	1.71	1.27
VIII	0.99	1.74	1.76	1.28	1.32	1.43	2.06	1.51
The average of factor I	0.91	1.57	1.52	1.18	1.28	1.34	1.91	
LSD _{0.05} for factor I – 0.39; factor II – 0.20; interaction I × II – 0.52; interaction II × I – 0.67								
Content of chlorophyll <i>b</i> [$\text{mg} \cdot \text{g}^{-1}$ f.m.]								
VI	0.51	0.68	0.71	0.55	0.63	0.71	0.79	0.65
VII	0.48	0.75	0.68	0.53	0.66	0.64	0.91	0.66
VIII	0.53	0.89	1.06	0.65	0.65	0.76	1.08	0.80
The average of factor I	0.51	0.77	0.82	0.58	0.65	0.70	0.93	
LSD _{0.05} for factor I – 0.33; factor II – 0.17; interaction I × II – 0.45; interaction II × I – 0.58								
Content of total chlorophyll [$\text{mg} \cdot \text{g}^{-1}$ f.m.]								
VI	1.40	2.20	2.21	1.72	1.91	2.04	2.75	2.03
VII	1.32	2.21	1.97	1.62	1.09	1.89	2.62	1.93
VIII	1.52	2.63	2.82	1.93	1.97	2.19	3.14	2.31
The average of factor I	1.41	2.35	2.33	1.76	1.93	2.04	2.84	
LSD _{0.05} for factor I – 0.47; factor II – 0.24; interaction I × II – 0.63; interaction II × I – 0.81								
Content of carotenoids [$\text{mg} \cdot \text{g}^{-1}$ f.m.]								
VI	0.47	0.71	0.69	0.58	0.61	0.74	0.80	0.66
VII	0.42	0.76	0.65	0.55	0.62	0.63	0.88	0.64
VIII	0.49	0.82	0.83	0.61	0.62	0.72	0.79	0.70
The average of factor I	0.46	0.76	0.72	0.58	0.62	0.70	0.82	
LSD _{0.05} for factor I – 0.72; factor II – 0.31; interaction I × II – 0.97; interaction II × I – 1.25								

A significant factor deciding about gaseous pollution of air is the wind. In the west Pomeranian province west winds dominate from March to September [21]. The present studies showed that leaves of common dandelion growing leeward of the source of impurities contained significantly higher amounts of sulfur and a lower content of total chlorophyll than control plants and plants growing windward of the source of the

emission of impurities. The average amount of total chlorophyll in dandelion gathered leeward constituted 75 % of its concentration in plants growing windward and 62 % in relation to control plants. In each term of studies the observed content of chlorophyll was lower in leaves of the examined plant growing leeward.

The studies showed distinct diversity of water relations in dandelion found in the area of Chemical Works "Police". The index of the relative water content (RWC) in tissues of this plant varied from 70 to 93 %. The value of this index of the species gathered at the distance of 0.5–0.8 km from the source of the emission was lower by about 14 % in relation to control plants (Fig. 3).

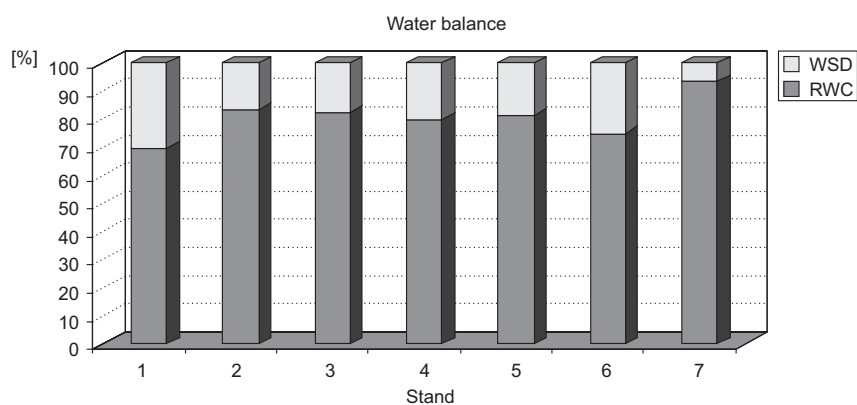


Fig. 3. Water indices [%] of common dandelion found in the area of Chemical Works "Police"

Conclusions

1. Accumulation of sulfur in leaves of common dandelion was clearly larger at the distance of up to 0.7 km from the emitter than its content in control plants.

2. On the basis of the coefficient of correlation, it was observed that the amount of sulfur in leaves had a significant effect on the content of assimilation dyes in common dandelion.

3. The amount of chlorophyll *a+b* and carotenoids in the assimilation apparatus of the examined plant gathered in the area of Chemical Works "Police" was respectively lower by 31 % and 23 % in relation to their concentration in control leaves.

4. Common dandelion gathered in the direct neighbourhood of Chemical Works "Police" was characterised by a lower index of the relative water content by 14 % as compared with control plants.

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ORAZ BILANS WODNY U MNISZKA POSPOLITEGO
WYSTĘPUJĄCEGO BLISKO ZAKŁADÓW CHEMICZNYCH „POLICE”**

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Abstrakt: Celem badań była ocena zanieczyszczenia powietrza wokół Zakładów Chemicznych „Police” za pomocą wybranych parametrów fizjologicznych (chlorofilu *a*, *b*, całkowitego, karotenoidów, bilansu wodnego) mniszka pospolitego. Przeprowadzone badania wykazały, że akumulacja siarki w liściach badanego gatunku była wyraźnie większa w odległości do 0,7 km od emitora od jej zawartości w roślinach kontrolnych. Na podstawie współczynnika korelacji stwierdzono, że ilość siarki w liściach miała istotny wpływ na zawartość barwników asymilacyjnych u mniszka pospolitego. Koncentracja chlorofilu *a+b* i karotenoidów w aparacie asymilacyjnym oraz wartość wskaźnika względnej zawartości wody rośliny zebranej w obrębie ZCh „Police” była odpowiednio niższa o 31 %, 23 % i 14 % w porównaniu do tych parametrów w liściach kontrolnych.

Słowa kluczowe: bilans wodny, barwniki asymilacyjne, siarka, *Taraxacum officinale*