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INFLUENCE OF DISTANCE FROM BLACK LOCUST (*Robinia pseudoacacia*) SHELTERBELTS ON DEHYDROGENASE ACTIVITY IN ARABLE SOILS

WPŁYW ODLEGŁOŚCI OD ZADRZEWIEŃ ROBINII AKACJOWEJ (*Robinia pseudoacacia*) NA AKTYWNOŚĆ DEHYDROGENAZY W GLEBACH UPRAWNYCH

Abstract: Biological activity of soils can be measured on the base of their dehydrogenase activity, mainly influenced by soil organic carbon content. The aim of the paper was to evaluate the effect of distance from shelterbelts plantet with black locust trees on level of dehydrogenase activity in arable soils of Proszowice Plateau derived from loess. Soil samples were taken from area of 20 × 24 m with different soil type (brown soil proper, from layer of 0–25 cm of arable soil. Sixty mixed soil samples were collected from area in growing distance (up to 24 m) from shelterbelt. The highest dehydrogenase activity was measured in samples taken up to 2 m from black locust trees. Dehydrogenase activity amounted 12.48 $cm^3H \cdot kg^{-1} \cdot 20\ h^{-1}$ in these zone. Level of measured activity was the lowest in zone 12–14 m (2.91 $cm^3H \cdot kg^{-1} \cdot 20\ h^{-1}$). It were state statistical differences between dehydrogenase activity in zone 0–2 m and in the rest zones. Level of dehydrogenase activity was strongly influence by organic carbon content and C/N ratio.

Keywords: dehydrogenase activity, black locust, arable soils

The source of enzymes in soil are soil organisms, plant roots and their residue and specific soil flora [1]. Dehydrogenases, which can be regarded the most frequently determined soil enzymes, according to Brzezinska [2] and Wlodarczyk [3] may be also used for assessing total soil biological activity. As results from the investigations, there is a strict relationship between dehydrogenase activity and organic matter content, organisms number and the soil fertility [4].

The aim of the paper was an assessment of the influence of the distance from shelterbelts composed of black locust on dehydrogenase activity in arable soils developed from loess in the Proszowicki Plateau.

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Material and methods

The soil material was collected from an arable field situated in Krolewice village in the Proszowicki Plateau. From the north the arable field adjoins the shelterbelt composed mainly of black locust. The trees are 8–10 m high and about 30 years old. The soil cover of the analyzed field consists of typical brown soils developed from loess.

12 zones, 2 m wide were marked out at the increasing distance from the trees in order to collect soil samples. In each zone 5 plots (2 × 4 m) were designed. 5 soil samples were collected from the surface layer of each plot and a single collective sample was formed of them. There were a total of 60 collective samples taken from the whole tested area, representing the 12 zones.

The soil samples were dried and then sieved through a sieve with 2 mm mesh. In the material prepared in this way basic soil physico-chemical properties were determined by means of standard methods applied in soil science. Dehydrogenase enzymatic activity was determined with Casida et al [5] method, which involves the soil incubation with TTC (2,3,5-triphenyltetrazolium chloride) on DU 640 Beckman spectrophotometer.

The results were elaborated geostatistically using Surfer 8.0 programme. The data were subjected to statistical analysis using the Tukey's RIR test in Statistica 7.0 programme.

Results and discussion

The highest dehydrogenase activity was noted in samples collected within the 0–2 m zone, ie at the distance of 2 m from the shelterbelts (Figs. 1, 2). In this zone mean dehydrogenase activity was 12.48 cm^3 H · kg^{-1} · 24 h^{-1}. In the soil samples taken between 2 and 8 m from the trees, the activity of the analyzed enzyme assumed lower values, however not below 4.95 cm^3 H · kg^{-1} · 24h^{-1}. In the subsequent zones

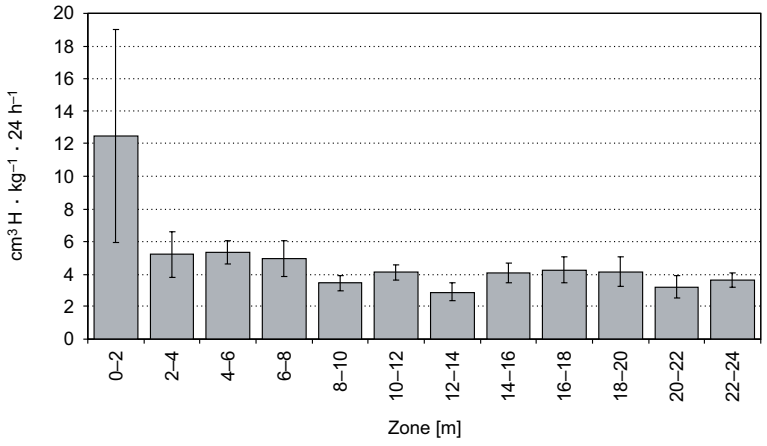

Fig. 1. Dehydrogenase activity in particular zones

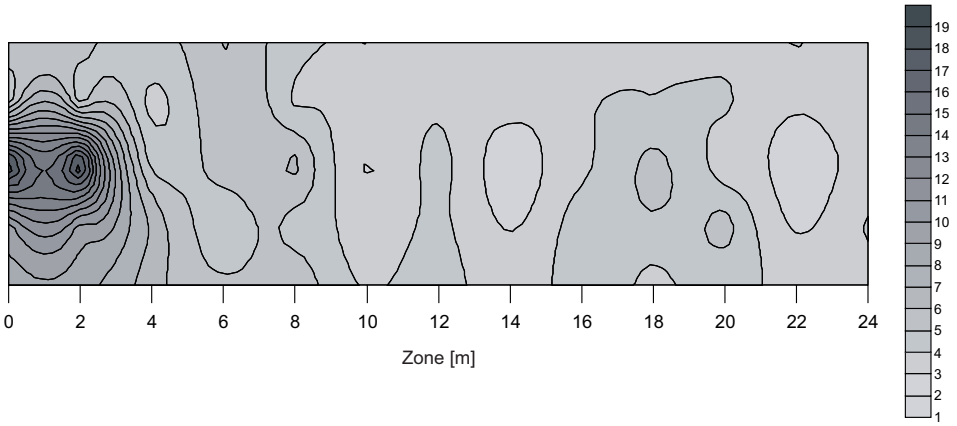

Fig. 2. Spatial distribution of dehydrogenase activity (in cm^3 H · kg^{-1} · 24 h^{-1}) in studied area

dehydrogenase activity was decreasing until 12–14 m where it reached the minimum value of 2.91 cm^3 H · kg^{-1} · 24 h^{-1}. Increased soil enzymatic activity under the influence shelterbelts composed of various species was also registered in former investigations [6, 7]. The research conducted in the Lublin neighbourhood on the effect of 8-year shelterbelts of black locust revealed a similar relationship between dehydrogenase activity and distance from the trees [8]. In the light of these investigations dehydrogenase activity was greater in the soils immediately under the trees as compared with the samples collected 2 m from the black locust, assuming the values respectively 6.67–9.28 and 4.39–5.21 cm^3 H · kg^{-1} · 24 h^{-1}. These slightly lower values of enzymatic activity in the soil close to the trees in comparison with the results presented in this paper are due to the younger tree age. The concentration of soluble carbon in soil and therefore increase in dehydrogenase activity are affected among others by the age and size of plants. It has been evidenced by the activity increasing with the age and size of seedlings in forest nurseries [9].

On the basis of Tukey test it was determined that the difference between the enzyme activity in the 0–2 m zone, as compared with dehydrogenase activity assessed in the other zones, was statistically significant at the level 0.05 (Table 1).

High value of dehydrogenase activity in the "contact" zone with arable fields and shelterbelts evidences a high total activity of soil microorganisms and at the same time is an indicator of the soil fertility and fecundity [10].

A positive influence of black locust shelterbelts on dehydrogenase activity is also connected with increasing content of main nutrients in the zones reached by the inflow of leaves, pods and branches of the black locust. Advantageous effect of black locust on dehydrogenase activity is also connected with the fact that this tree as a plant belonging to legume family enriches the soil in nitrogen. The research aimed at determining the influence of fertilization on dehydrogenase activity demonstrated that it was nitrogen which particularly beneficently affected microorganism activity through its positive influence on their biomass increment [11].

Table 1

Significance level (p) of differences in dehydrogenase activity between particular zones calculated using Tukey test (significant are differences if $p < 0.05$)

Zone [m]	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24
0–2		0.04	0.05	0.02	0.00	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2–4	0.04		1.00	1.00	0.94	1.00	0.73	1.00	1.00	1.00	0.86	0.97
4–6	0.05	1.00		1.00	0.91	1.00	0.65	1.00	1.00	1.00	0.81	0.95
6–8	0.02	1.00	1.00		0.98	1.00	0.85	1.00	1.00	1.00	0.94	0.99
8–10	<0.01	0.94	0.91	0.98		1.00	1.00	1.00	1.00	1.00	1.00	1.00
10–12	<0.01	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
12–14	<0.01	0.73	0.65	0.85	1.00	1.00		1.00	0.99	1.00	1.00	1.00
14–16	<0.01	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00
16–18	<0.01	1.00	1.00	1.00	1.00	1.00	0.99	1.00		1.00	1.00	1.00
18–20	<0.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
20–22	<0.01	0.86	0.81	0.94	1.00	1.00	1.00	1.00	1.00	1.00		1.00
22–24	<0.01	0.97	0.95	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

The level of dehydrogenase activity in the analyzed soils was strictly connected with organic carbon content ($0.57^{***)}$) and the degree of organic matter decomposition expressed by C/N ratio (0.51^{***}) and to a lesser extent also with soil sorption complex capacity (0.31^{*}) (Table 2, Fig. 3). Inflow of fresh organic matter stimulates micro-organism activity in the soils situated in the immediate vicinity of black locust. Januszek [12] noted a similar relationship between organic carbon content in the forest soils and their enzymatic activity.

Table 2

Linear correlation coefficients for the relationship between chosen soil properties and dehydrogenase activity

Soil properties	Linear correlation coefficients
pH H_2O	0.13
pH KCl	0.24
C organic [$g \cdot kg^{-1}$]	0.57^{***}
N total [$g \cdot kg^{-1}$]	0.19
C/N	0.51^{***}
TEB [$mmol(+) \cdot kg^{-1}$]	0.22
CEC [$mmol(+) \cdot kg^{-1}$]	0.31^{*}
Hh [$mmol(+) \cdot kg^{-1}$]	0.08
BS [%]	0.10

TEB – *base cations concentration*, CEC – *cation exchange capacity*, Hh – *hydrolytic acidity*, BS – *base saturation*.

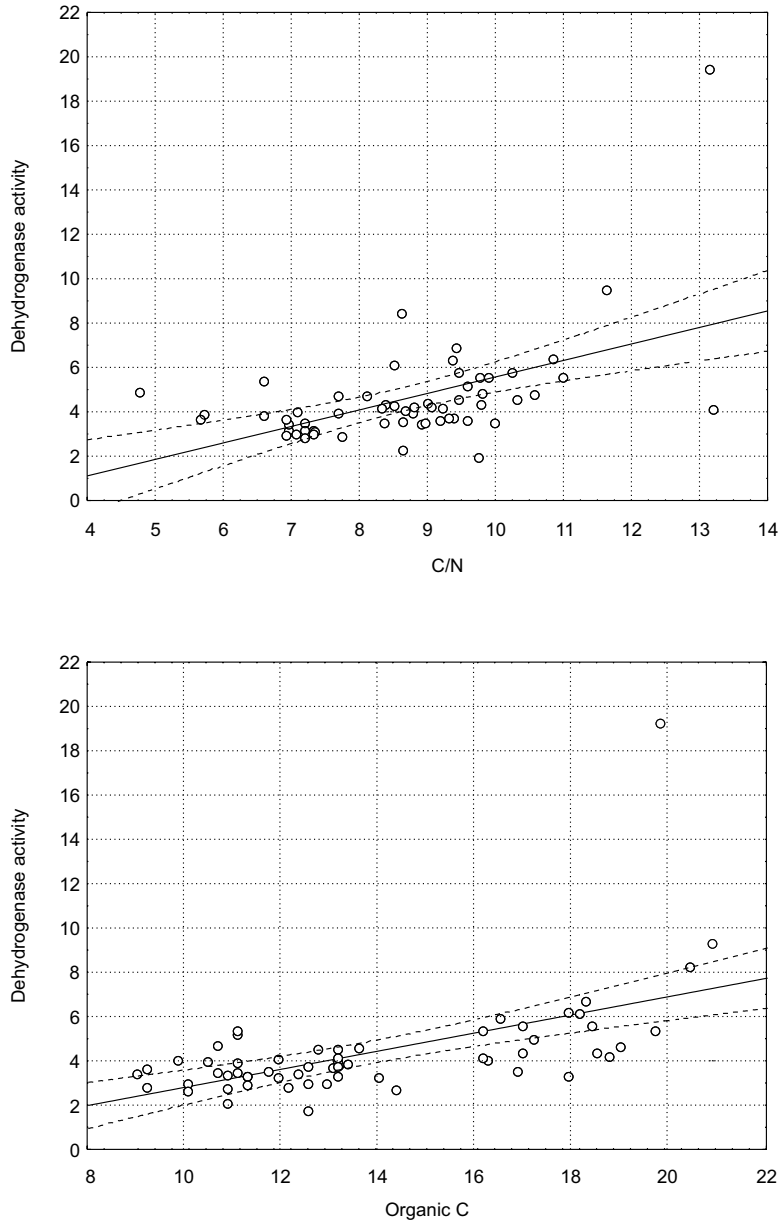

Fig. 3. Dependence between soil carbon content, C/N ratio and dehydrogenase activity

Biomass and microbial soil activity become reduced with increasing temperature and decreasing soil moisture [12]. Shelterbelts which protect the adjoining field against the extreme atmospheric conditions, create more advantageous conditions for soil microflora development and therefore enhance dehydrogenase activity [13].

Conclusions

1. The highest dehydrogenase activity was assessed in the soils collected below 2 m from black locust trees.

2. Dehydrogenase activity in the 0–2 m zone was statistically higher than in all other zones.

3. Organic carbon content, C/N ratio and soil sorption capacity most influenced dehydrogenase activity in the analysed soils.

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Abstrakt: Celem pracy było określenie wpływu odległości od zadrzewień złożonych z robinii akacjowej na poziom aktywności dehydrogenazy w glebach uprawnych Płaskowyżu Proszowickiego wytworzonych z lessu. Próbki glebowe zostały pobrane z mikropoletka o wymiarach 20 × 24 m, z warstwy 0–25 cm z gleby brunatnej właściwej użytkowanej jako grunt orny. Ogółem pobrano 60 próbek zbiorczych w rosnącej odległości (do 24 m) od zadrzewień. Najwyższą aktywnością dehydrogenazy charakteryzowały się gleby pobrane w odległości do 2 m od zadrzewień. W strefie tej aktywność dehydrogenazy wynosiła 12,48 cm^3 H · kg^{-1} · 24 h^{-1}. W strefach położonych dalej od zadrzewień aktywność dehydrogenzy stopniowo malała, przyjmując wartości najniższe w strefie 12–14 m od zadrzewień – 2,91 cm^3 H · kg^{-1} · 24 h^{-1}. Stwierdzono statystycznie istotne różnice pomiędzy aktywnością dehydrogenazy w strefie 0–2 m a aktywnością oznaczoną w pozostałych strefach. Poziom aktywności dehydrogenazy był ściśle związany z zawartością węgla organicznego oraz stosunkiem C/N.

Słowa kluczowe: aktywność dehydrogenazy, robinia akacjowa, gleby uprawne