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**INFLUENCE OF BLACK LOCUST  
(*Robinia pseudoacacia* L.) MIDFIELD SHELTERBELTS  
ON THE CONTENT OF BIOAVAILABLE FORMS OF PHOSPHORUS  
AND POTASSIUM IN ARABLE SOIL DEVELOPED FROM LOESS**

**WPLYW ZADRZEWIŃ ŚRÓDPOLNYCH ROBINII AKACJOWEJ  
(*Robinia pseudoacacia* L.) NA ZAWARTOŚĆ PRYZYWAJALNYCH FORM  
FOSFORU I POTASU W GLEBIE UPRAWNEJ WYTWORZONEJ Z LESSU**

**Abstract:** The aim of the paper was evaluation of influence of the black locust trees afforestation on loess soil available forms content of phosphorus and potassium. Samples were collected from arable land located in the area of the Proszowice Plateau. Investigated field was divided to 12 (2 m wide) zones in growing distance from black locust. It was found significant influence of afforestation of trees on available potassium content. Its content was the highest in zones located in neighborhood of afforestation. Phosphorus content showed not so strong correlation with the distance from trees, but it was found visible higher concentration of this element in zones distanced to 12 m from robinia.

**Keywords:** available elements, black locust, loess soil

Midfield shelterbelts are an element of agricultural landscape created by man. They can be remains of forest vegetation, a result of spontaneous colonization by arborescent vegetation and bushes or an effect of plantings [1].

Shelterbelts are treated as a forest substitute, which ought to be commonly used in the areas where, due to good quality of soils, afforestation should be discouraged. Planting shelterbelts is treated as an equivalent to afforestation factor of protection and use of the environmental space.

In our climatic zone shelterbelts are an element of landscape weakening the effect of destabilizing factors [2]. Midfield shelterbelts, in agricultural landscape composed of false acacia or other species, under specific conditions of relief may function as barrier

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ecosystems, which owing to their high sorption capacity resulting from the presence of litter and nutrient uptake by growing trees, are a buffer for biogenic elements [3].

There is no detailed data on the influence of midfield shelterbelts on soil environment, particularly the ploughlands adjoining the shelterbelts. An interesting object of investigations are midfield shelterbelts composed of black locust (*Robinia pseudoacacia* L.), the plant from the papilionaceous family, whose presence causes an increase in nitrogen content in soil [4, 5]. The influence of robinia on the contents of other elements in arable soils has not been investigated so far. Therefore, the presented work aimed at determining the effect of black locust on the content of bioavailable forms of potassium and phosphorus in arable soil formed from loess adjoining the robinia shelterbelts and establishing the range of its influence.

## Material and methods

A microplot situated in Krolewice village on the Proszowice Plateau was selected for the research. The microplot was delineated in an arable field in the vicinity of midfield shelterbelts composed of false acacia plantings. The trees forming the shelterbelt are between 20 and 30 year old, the stripe of the shelterbelt is narrow, about 2–3 m in width, the trees are about 8–10 m high with crown width about 6–8 m. The selected arable field is flat, which excludes a potential effect of surface wash and runoffs on soil properties.

An area of 20 m × 24 m was marked out on the microplot and further divided into rectangular surfaces of 2 m × 4m. In this way 12 zones were identified (in five replications) at increasing distance from the black locust. Collective soil samples were taken from the depth of 0–20 cm using Egner's stick. The samples were collected in the early-spring season, before fertilization was applied to the fields.

In 60 collective samples collected in this way the content of bioavailable potassium and phosphorus forms were assessed using the Egner-Riehm method.

Spatial maps of bioavailable component content in the soil were created using Surfer 8.0 programme. Statistical analysis of results was conducted using Tukey test (at the significance level 0.05) in Statistica 6.0 programme.

The soil cover of the microplot consists of typical brown soil formed from loess, which is a dominant type of soil on the Proszowice Plateau. Brown soils, like soils lessivés, are considered an optimal site for black locust [4].

## Results

The highest concentrations of bioavailable phosphorus were assessed in the samples collected in zones located between 22 m and 24 m from the robinia shelterbelts (Fig. 1). Elevated content of the element in some samples collected from the zones situated at between 2 and 12 m from the shelterbelts is visible on the presented spatial map of bioavailable phosphorus content (Fig. 2). Mean content of bioavailable phosphorus in these zones ranges from 52.6 to 57.3 mg · kg<sup>-1</sup>. The lowest phosphorus concentration was assessed in the zone immediately adjoining the shelterbelts (42.3 mg · kg<sup>-1</sup>). The highest phosphorus content in the zones at 20–22 and 22–24 m is most probably connected not with the shelterbelt effect but with some soil variability.

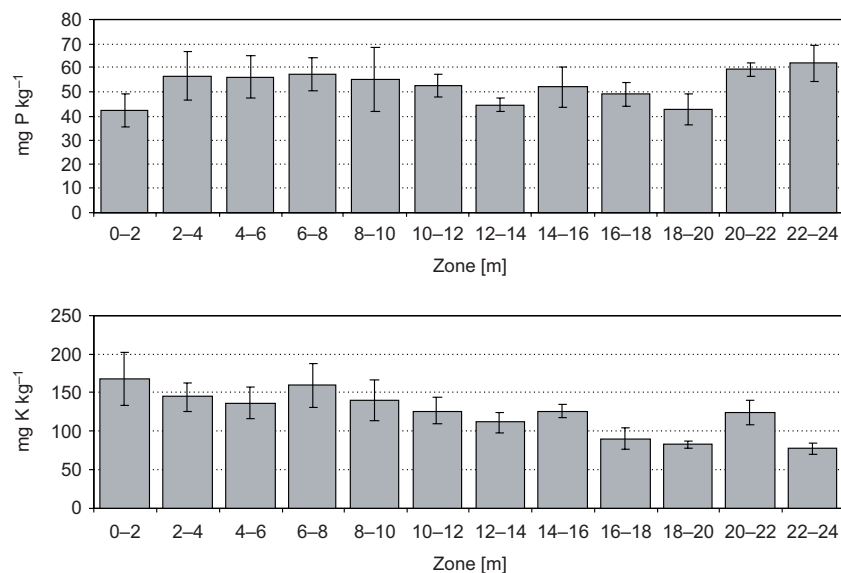


Fig. 1. Available phosphorus and potassium content in particular zones

Statistical analysis revealed significant differences in phosphorus content between the zones in which the content of the analyzed element was the lowest (zones 0–2, 12–14 and 18–20 m) and the highest (zones 20–22 and 22–24 m) (Table 1). The significance level of differences between the other zones was higher than 0.05, which denotes a lack of statistical dependence.

Table 1

Significance level of differences between average phosphorus content in soils of particular zones distanced from black locust trees (differences are statistically significant if significant level < 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		0.92	0.69	1.00	0.81	0.26	0.03	0.26	.01	.01	0.21	0.12
2-4	0.92		1.00	1.00	1.00	0.99	0.62	0.99	0.05	0.01	0.98	0.92
4-6	0.69	1.00		0.94	1.00	1.00	0.88	1.00	0.15	0.05	1.00	0.99
6-8	1.00	1.00	0.94		0.98	0.58	0.11	0.59	.01	.01	0.51	0.33
8-10	0.81	1.00	1.00	0.98		1.00	0.79	1.00	0.09	0.03	1.00	0.98
10-12	0.26	0.99	1.00	0.58	1.00		1.00	1.00	0.50	0.22	1.00	1.00
12-14	0.03	0.62	0.88	0.11	0.79	1.00		1.00	0.97	0.80	1.00	1.00
14-16	0.26	0.99	1.00	0.59	1.00	1.00	1.00		0.49	0.22	1.00	1.00
16-18	.01	0.05	0.15	.01	0.09	0.50	0.97	0.49		1.00	0.57	0.75
18-20	.01	0.01	0.05	.01	0.03	0.22	0.80	0.22	1.00		0.27	0.44
20-22	0.21	0.98	1.00	0.51	1.00	1.00	1.00	1.00	0.57	0.27		1.00
22-24	0.12	0.92	0.99	0.33	0.98	1.00	1.00	1.00	0.75	0.44	1.00	

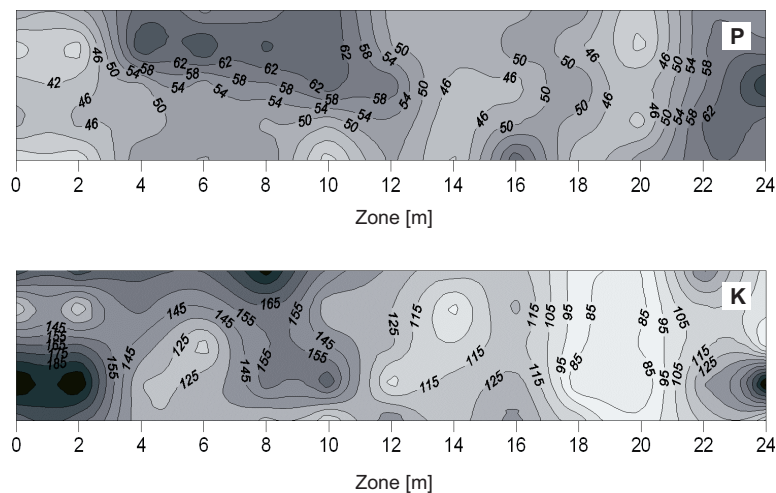


Fig. 2. Spatial distribution of available phosphorus (above) and potassium (below) content [ $\text{mg} \cdot \text{kg}^{-1}$ ] in dependence to black locust trees distance

The content of bioavailable potassium was adversely proportional to the distance from the robinia shelterbelts. The highest mean content of this element ( $168.1 \text{ mg} \cdot \text{kg}^{-1}$ ) was assessed in the samples collected from the 0–2 m zone, ie the one situated in the immediate vicinity of the shelterbelts (Fig. 2). Elevated content of this element was noted in the samples from the zones distanced 12 m from the trees. Mean content of the element declines with the distance from the shelterbelts. The lowest concentration was registered in the 18–20 and 22–24 m zones.

Table 2

Significance level of differences between average potassium content in soils of particular zones distanced from black locust trees (differences are statistically significant if significant level  $< 0.05$ )

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		0.14	0.18	0.10	0.24	0.57	1.00	0.65	0.96	1.00	0.03	0.01
2–4	0.14		1.00	1.00	1.00	1.00	0.35	1.00	0.90	0.17	1.00	0.99
4–6	0.18	1.00		1.00	1.00	1.00	0.42	1.00	0.94	0.22	1.00	0.98
6–8	0.10	1.00	1.00		1.00	1.00	0.27	0.99	0.83	0.12	1.00	1.00
8–10	0.24	1.00	1.00	1.00		1.00	0.52	1.00	0.97	0.29	1.00	0.96
10–12	0.57	1.00	1.00	1.00	1.00		0.86	1.00	1.00	0.64	0.96	0.74
12–14	1.00	0.35	0.42	0.27	0.52	0.86		0.91	1.00	1.00	0.11	0.03
14–16	0.65	1.00	1.00	0.99	1.00	1.00	0.91		1.00	0.72	0.93	0.66
16–18	0.96	0.90	0.94	0.83	0.97	1.00	1.00	1.00		0.98	0.57	0.25
18–20	1.00	0.17	0.22	0.12	0.29	0.64	1.00	0.72	0.98		0.04	0.01
20–22	0.03	1.00	1.00	1.00	1.00	0.96	0.11	0.93	0.57	0.04		1.00
22–24	0.01	0.99	0.98	1.00	0.96	0.74	0.03	0.66	0.25	0.01	1.00	

The map of spatial distribution of abundance in bioavailable potassium reveals an increased content of the studied element in the zones close to the robinia trees.

On the basis of conducted Tukey test statistically significant differences were revealed between mean content of bioavailable potassium in the zones situated at the distance of 0–10 m from the shelterbelts and in the zones 16–20 m far from the trees, where this element concentrations were the lowest (Table 2).

## Discussion

Research on the effect of black locust on soil focuses mainly on forest habitats. The investigations on robinia role in shaping the properties of forest soils demonstrated a positive effect of this plant on improvement of hydrophysical conditions in light soils, which is connected with increasing their concentrations of organic matter [6]. The Authors obtained similar results concerning robinia effect on increasing organic carbon and total nitrogen content in loess arable soil [7]. Especially elevated level of N content is visible in soil samples taken from the zones situated 12 m from the black locust. Increasing nitrogen content in soil is connected with symbiosis of these trees with nodule bacteria (*Rhizobium*, *Bacillus radicola*) fixing nitrogen from the atmosphere [4, 8].

According to von Holle et al [9] the presence of black locust trees on forest sites also leads to an increase in phosphorus and potassium content in the topsoil.

Presented investigations corroborate this thesis also for arable soils adjoining the robinia shelterbelts. Soil samples collected from the zones localized close to robinia were characterized by an elevated content of bioavailable phosphorus in comparison with more distanced zones. The content of bioavailable phosphorus and potassium was markedly increased in the zones located between 2 and 12 m from the robinia. The range of robinia trees influence on arable soil properties is connected with the tree height, which in turn affects the distance to which leaves, pods and branches, which are the source of raised element content in soil, are carried [10].

Higher concentrations of bioavailable components in the soils adjoining the shelterbelts should be taken into consideration when planning fertilization regime on such fields. Diversification of fertilization on the fields with considerable variability with respect to their chemical composition complies with the rules of so called precision agriculture [11].

## Conclusions

1. Statistically significant effect of black locust shelterbelts on the content of bioavailable potassium was found; its highest content was assessed in the zones situated in the immediate vicinity of the robinia trees. Elevated content of this element was determined in the samples collected in the zones located 12 m from the trees.

2. No such obvious dependence was determined for bioavailable phosphorus, however this element content was markedly elevated in some soil samples collected from the zones situated between 2 m and 12 m from the shelterbelts.

3. Higher contents of bioavailable components in arable soils adjoining the plantings should be considered at the application of fertilization.

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### WPLYW ZADRZEWIEN ŚRÓDPOLNYCH ROBINII AKACJOWEJ (*Robinia pseudoacacia* L.) NA ZAWARTOŚĆ PRZYSWAJALNYCH FORM FOSFORU I POTASU W GLEBIE UPRAWNEJ WYTWORZONEJ Z LESSU

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**Abstrakt:** Celem pracy było określenie wpływu zadrzewień robinii akacjowej na zawartość przyswajalnych form potasu i fosforu w uprawnej glebie lessowej. Na podstawie oznaczeń laboratoryjnych i analizy statystycznej wyników stwierdzono statystycznie istotny wpływ zadrzewień robinii na zawartość przyswajalnego potasu; jego największą zawartość oznaczono w strefach położonych w bezpośrednim sąsiedztwie drzew robinii. Podwyższona zawartość tego składnika występuje w próbkach pobranych ze stref oddalonych do 12 m od drzew. W przypadku przyswajalnego fosforu nie stwierdzono tak wyraźnej zależności, jednak zawartość tego składnika była wyraźnie zwiększona w próbkach glebowych pobranych ze stref odległych od 2 do 12 m od zadrzewień.

**Słowa kluczowe:** składniki przyswajalne, robinia akacjowa, gleba lessowa