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CONTENT OF ELEMENTS IN SOILS OF ROADSIDES' AND CHARACTERISTIC OF PLANT SPECIES SETTLED

ZAWARTOŚĆ PIERWIASTKÓW W GLEBACH POBOCZA DRÓG ORAZ CHARAKTERYSTYKA GATUNKÓW ROŚLIN JE ZASIEDLAJĄCYCH

Abstract: The paper presents research results concerning the content of micro- and macroelements in soils of roadsides and spatial distribution of roadside flora on the basis of trophic index. Shoulder area with width of 5 m was studied, along roads with hardened surface going through agricultural lands in Szczecin Lowlands. The content of forms regarded assimilable macroelements (phosphorus, potassium, magnesium) in zone soils - the edge of the shoulder and proper shoulder - was different from the zone soils - ditch and slope. Soil richness in assimilable phosphorus was low in all researched areas, potassium was high in A and B zones, medium in C and D zones, and magnesium on the edge of shoulder and proper shoulder was medium, and low in the ditch and embankment. Assessing soil richness in microelements (with the exception of iron), it was found that it was in the same class in the researched shoulder areas: manganese - medium, zinc - high, copper - high (A, B, C zones). Calculated rates of soil salinity (Z, SAR) show no signs of salinity and present good conditions for plant growth. Analysis of the trophic index showed domination of species preferring eutrophic soil (Tr = 4) and extremely eutrophic (Tr = 5) throughout the whole profile of vertical formation of roadsides in the mid-field on the researched area.

Keywords: roadside soils, content of macro- and microelements in soil, roadside flora

Introduction

The use of salt during winter exploitation of roads is a factor influencing soil properties. Snow-clearing of routes can lead to soil salinity and greenery eradication along them [1]. The strength of their impact is associated with both substrate material properties as well as the distance from the roadway. Chemicals used for snow removal are chemical compounds that cause melting of ice according to Kolodziejczyk [2] the most commonly used are pure sodium chloride (NaCl), road salt which is a mixture of sodium chloride (NaCl) - 97%, calcium chloride ($CaCl_2$) - 2.5% and hexacyanoferrate(II), potassium ($K_4Fe(CN_6)$) - 0.5%, saline - sodium chloride (NaCl) or calcium chloride ($CaCl_2$) at a concentration of 20-25%, technical calcium chloride (77-80% $CaCl_2$), pure magnesium chloride ($MgCl_2$), and a mixture of sodium chloride (NaCl) with calcium chloride ($CaCl_2$) or magnesium chloride ($MgCl_2$).

The aim of this paper is to access changes in content and richness category of forms acknowledged as assimilable macro- and microcomponents in roadside soil along agricultural areas in Szczecin Lowlands and participation of plant species with different trophic index.

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Material and methods

In Spring 2005, research was carried out in order to study roadsides with hardened surface (asphalt) and with comparable capacity, located along agricultural areas of Szczecin Lowlands.

For the purpose of observation there were chosen four sample collection points located outside build-up areas along forest roads (mid-field): Kolbacz 53º18'17"N, 014º48'00"E; Zabow 53º07'26"N, 014º47'14"E; Kunowo 53º20'28"N, 014º56'21"E; Kobylanka 53º20'07"N, 014º51'41"E.

Sampling from the top layer of humus 0-10 cm of roadside was performed in spring (March) in each sample collection point. Four characteristic roadside zones were researched, situated as follows:

A - road shoulder edge adjoining the road surface (0.2-0.3 m width),
B - proper road shoulder (1.0-1.2 m width),
C - ditch (1.0-1.5 m width, 0.5-0.8 m depth),
D - slope (1.0-2.5 m height, inclination 30°) [3].

Using methods generally accepted in soil science, determinations were done as follows: granulation, soil pH reaction measured in KCl solution of 1 mol · dm^{-3} (pH_{KCl}) concentration and loss on ignition at 550ºC. Content of forms regarded as available to plants, after extraction with HCl at a concentration of 0.5 mol · dm^{-3} [4], was determined by AAS: K, Ca Mg, Na, Cu, Fe, Mn, Zn, and P colorimetrically.

Soil salinity was calculated on the basis of degree of changes in soil sodium (Z) relative to the amount of sodium ions of calcium and magnesium ions expressed in equivalent amounts [5], and SAR (*Sodium Adsorption Ratio*) [6]:

$$Z = \frac{Na}{Ca + Mg}$$

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

The significance of differences in element content between zones was determined by using Tukey's HSD test, while the LSD value at 0.05 significance level test of Newman-Keulus, using the program Statistica 9.

The assessment of soil was carried out according to the classification of Sapek and Sapek [4], which is applied to agricultural grasslands. Because the tested samples contained less than 20% of organic matter, classification of the nutrient content was made, which divided soil richness into three grades: low, medium and high. The exception was magnesium, which content was valued for five grades of abundance.

Results and discussion

Data included in Table 1, characterizing researched soil, were already presented in earlier publications [3, 7]. Re-presentation was necessary to assess soil fertility.

Granulation of researched objects was even, in first zone was sand, and the rest loamy sand according to PTG classification [8], pH_{KCl} values allowed to determine that in A and B zones the reaction was neutral.

Salinity as well content of organic carbon were decreasing as the distance from the edge of the road was further revealing high negative correlation [3].

Table 1

The mean value of chosen properties in the 0-10 cm layer of mid-field sideroads

Roadside zone	**Corg. [%]**	**pH_{KCl}**	**Salinity [g NaCl · kg^{-1} of soil]**	**Percentage content of fractions with diameter [mm]**			
				> 2	**2-0.5**	**0.5-0.002**	**< 0.002**
A	4.23	7.22	0.739	13.5	86.4	10.6	2.9
B	2.49	7.16	0.503	4.7	83.3	13.4	3.3
C	1.62	6.89	0.238	2.2	79.4	15.7	4.9
D	1.62	6.66	0.210	2.3	79.2	17.1	3.7

The content of phosphorus extracted from soil of 0.5 mol · dm^{-3} HCl from soil was significantly greatest at the edge of the road shoulder (4.68 mg · 100 g^{-1} of soil). The further from the roadway, the content of this element was decreasing. In the second area there was about 30.6, about 53.0 in the third and in the fourth 62.4% less phosphorus in comparison with the first zone (Table 2).

Table 2

The average content of macro- and microelements soluble in 0.5 mol · dm^{-3} HCl in 0-10 cm layer of soil from the roadsides and homogenous groups

Shoulder zone	**Chemical elements**														**Soil salinity indicator**	
	P		**K**		**Mg**		**Ca**		**Na**		**Cu**	**log Fe**	**Mn**	**Zn**	**Z**	**SAR (*Sodium Adsorption Ratio*)**
	[mg · 100 g^{-1} of soil]										**[mg · kg^{-1} of soil]**					
A	4.68	a	51.2	a	79.0	a	5.98	a	0.975	a	36.5	1.45 a	164.7	76.4	0.0115	0.053
B	3.25	ab	41.7	ab	51.3	ab	6.21	a	0.555	b	15.6	1.28 ab	128.2	104.5	0.0096	0.036
C	2.20	b	26.3	b	33,9	ab	3.27	ab	0.175	c	10.3	1.24 ab	132.1	61.3	0.0047	0.014
D	1.76	b	22.7	b	27.7	b	2.67	b	0.099	c	5.4	1.14 b	181.4	50.8	0.033	0.0090
$LSD_{0.05}$	1.52		20.9		49.2		3.07		0.249		n.i.	-	n.i.	n.i.	-	-

Indeed, in roadside ditch there was the least abundance of phosphorus comparing with the edge of shoulder. However, abundance in all those areas was low. The content of phosphorus soluble in 0.5 mol · dm^{-3} HCl in muck soils for the surface layer amounted from 36.6 to 44.5 mg · 100 g^{-1} of soil [9]. In the assessment of abundance by Sapek and Sapek [3] in muck peat soil and proper muck soil high content of soluble phosphorus assimilable for plants was stated. This is due to the large share of iron complexed with humic compounds, which reduces its sorption ability toward phosphorus. Valuing the content of potassium it was established that in A and B zones it was high, and in two others it became medium. Indeed, most potassium was in zone A, in comparison with C and D zones. In studies conducted by Kochanowska and Kusza [10] content of potassium in water extract from urban soils prone to salinity ranged from 0.78 to 5.16 mg K · 100 g^{-1} of soil. The amount of magnesium in soil was decreasing as the distance from the road was further, significant difference of its content was found only between the soils at the edge of the shoulder and soil on the slope (Table 2). Together with changes in magnesium content there were changes in abundance, in the first two zones it was medium, while in the remaining it was low. The content of calcium ranged from 2.67 mg $\cdot$ 100 g^{-1} of soil (slope) to 6.21 mg $\cdot$ 100 g^{-1} of soil (the edge of the shoulder). Significant differences were found between zones A, B and D. The content of sodium was the smallest and most diverse. Considerable differences occurred between the soils at the edge of the shoulders, the proper shoulders and soils of zones C and D, which form a homogeneous group.

In the case of differences of microelements in the content of forms available to plants, they were found only for iron. The decrease in iron content occurred as the distance from the road was further and it caused a significant difference between A and D zones. In analysis of the other microelements no important dissimilarities were found. Abundance was developing as follows: copper from the first zone to the third was high, for the fourth zone it was medium, manganese for all the researched zones was medium, and high for zinc.

Soil salinity indicators Z and *SAR* are not equivalent. Both allow for assessment of environmental risks associated with soil environment connected to content of soluble salts of sodium [5]. In the study, the rate was less than 1 which indicates no signs of salinity. Moreover, the *SAR* ratio was less than 10, so there are normal conditions for the development of plants in the soil (Table 2). It was observed that the further from the roadway, the lower was the value of indexes researched.

Rating the number of species observed on the edge of the road shoulder (A), on the proper road shoulder (B), in ditches (C), and on slopes (D) showed a similar number of species found in roadside ditches and on slopes (on average 19 taxons).

In further zones of the road shoulder, which were situated next to road surface, the most species were recorded on the roadside slope (on average 15 taxons), proper shoulder (on average 14 taxons) and the edge of the shoulder (on average 8 taxons). Analysis of trophism index based on ecological index numbers [11] showed a definite domination of species preferring eutrophic soils (Tr = 4) and extremely eutrophic (Tr = 5) throughout the whole profile of vertical formation of mid-field roadsides in the researched area. The edge of the shoulder marked out itself with the highest presence of taxons preferring eutrophic soils and extremely eutrophic, including more than 70% of all observed species. Among them the most frequently noted were as follows: *Plantago major, Lolium perenne, Poa annua, Chamomilla suaveolens, Trifolium repens* and *Chenopodium album* (Fig. 1).

In the following shoulder zones participation of species associated with eutrophic soils and extremely over-fertalised was gradually diminishing. On the proper shoulder of mid-field roads they accounted for about 56% of all recorded species, and the most frequently observed taxons were as follows: *Daucus carota, Dactylis glomerata, Arrhenatherum elatius, Ranunculus repens, Leontodon autumnalis, Lamium purpureum, Trifolium pratense* and *Glechoma hederacea.* In roadside ditches and on roadside slopes of mid-field roads in the reasearch area, participation of such species reached 46% and 44%. The most frequently observed plants here were as follows: *Urtica urens, Melandrium album, Anthriscus sylvestris, Galium aparine, Artemisia sylvestris, Solidago gigantea, Epilobium hirsutum, Arctium tomentosum, Rumex crispus* or *Alopecurus pratensis.*

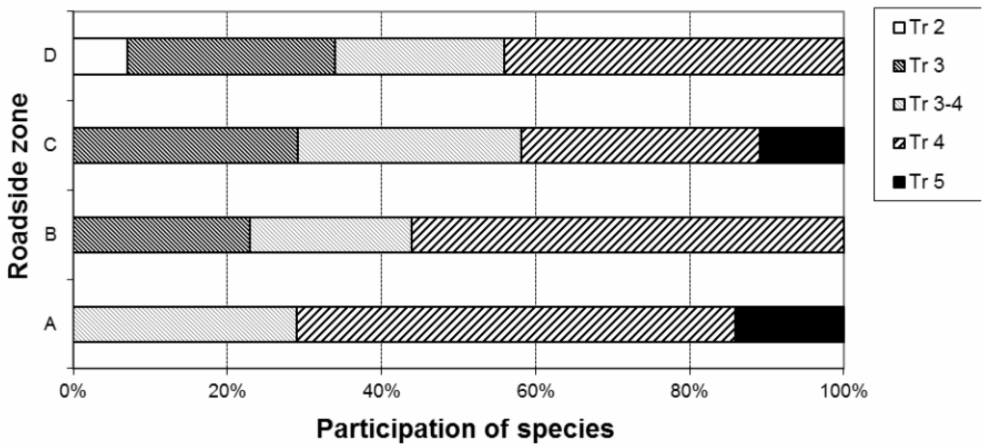

Fig. 1. The percentage of species at different trophic index by Zarzycki et al [11], in particular zones of mid-field roadsides. Key: A - edge of shoulder; B - proper shoulder; C - roadside ditch; D - roadside slope; Tr 1 - extremely oligotrophic soils; Tr 2 - oligotrophic soils; Tr 3 - mesotrophic soils; Tr 3-4 - meso- to eutrophic soils; Tr 4 - eutrophic soils; Tr 5 - extremely eutrophic soils

Conclusions

1. The content of forms regarded assimilable macroelements - phosphorus, potassium and magnesium in soils of roadsides and proper roadside edges, was higher than in ditches and embankments, which were more distant from the road. Soil richness in assimilable phosphorus was low in all researched zones, high in potassium in A and B zones, medium in C and D zones, as it comes to magnesium it was medium on the edge of shoulder and proper shoulder, and low in the ditch and embankment.
2. Assessing the content of microelements in the soil, we can conclude that there were no significant differences between soils of each zone. The exception was the iron, where there was an important dissimilarity in its content between the edge of the shoulder and slope. Abundance of manganese, zinc and copper located itself in all areas of shoulders in the same class, medium for manganese, high for zinc and copper (A-C zones).
3. Calculated rates of soil salinity (Z, SAR) show no signs of salinity and present good conditions for plant growth.
4. Analysis of the trophic index showed domination of species preferring eutrophic soil (Tr = 4) and extremely eutrophic (Tr = 5) regardless of the distance from the roadway.

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ZAWARTOŚĆ PIERWIASTKÓW W GLEBACH POBOCZA DRÓG ORAZ CHARAKTERYSTYKA GATUNKÓW ROŚLIN JE ZASIEDLAJĄCYCH

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Abstrakt: Przedstawiono wyniki badań dotyczące zawartości makro- i mikroskładników w glebach poboczy dróg i przestrzennego rozmieszczenia flory przydrożnej na podstawie wskaźnika trofizmu. Badaniami objęto strefy pobocza o łącznej szerokości 5 m, wzdłuż dróg o nawierzchni utwardzonej przebiegającej przez tereny rolnicze na Nizinie Szczecińskiej. Zawartości form uznanych za przyswajalne makroskładniki (fosfor, potas, magnez) w glebach strefy skraj pobocza i pobocze właściwe różniła się od gleb stref rów i skarpa. Zasobność gleby w przyswajalny fosfor była niska we wszystkich badanych strefach, potasu wysoka w strefie A i B, a średnia w C i D, zaś magnezu średnia na skraju pobocza i poboczu właściwym, a niska w rowie i skarpie. Oceniając zasobność gleby w mikroskładniki (z wyjątkiem żelaza), stwierdzono, że była w tej samej klasie w badanych strefach pobocza: mangan - średnia, cynk - wysoka, miedź - wysoka (strefa A, B, C). Obliczone wskaźniki zasolenia gleby (Z i SAR) wskazują na brak oznak zasolenia i dobre warunki do wzrostu roślin. Analiza wskaźnika trofizmu wykazała zdecydowaną przewagę gatunków preferujących gleby eutroficzne (Tr = 4) i skrajnie eutroficzne (Tr = 5) w całym profilu pionowego ukształtowania pobocza dróg śródpolnych na badanym terenie.

Słowa kluczowe: gleby przydrożne, zawartość makro- i mikroskładników w glebie, flora przydrożna