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FLORISTIC COMPOSITION OF COMMUNITY WITH DOMINATION OF *BROMUS INERMIS* LEYSS ON THE BACKROUND OF SOIL CONDITIONS

Summary

The paper contains soil and floristic characteristics of grassland communities where ecological arable tillage is conducted. The characteristics includes the assessment of variability and a detailed description and interpretation of soil and phytosociological conditions. The research was conducted in September 2015 in an individual farm land in Mniszek (a village in Wielkopolskie Voivodship in Czarnkowsko-Trzcianecki County). On the basis of 18 phytosociological relevés made with Braun-Blanquet's method, floristic diversity of the community as well as botanical structure and natural value were determined; the community with the predominance of Bromus inermis (Bromus inermis Leyss) was dominant. Four soil profiles were prepared and such soil properties as pH, content of total carbon and total nitrogen, soil texture, bulk density of soil, particle density, total porosity, maximal hygroscopic capacity, the potential of water binding by the soil and its total and readily available water as well as the saturated hydraulic conductivity were determined. The investigated soils represented sandy alluvial soils (Haplic Fluvisols), formed from alluvial materials of the Noteć River's ice-marginal valley. The permeability of studied soils was high and their retention was low, what is characteristic for coarse-textured soils The production and plant available water appeared in small amounts in the soils under study. Total porosity, bulk density, particle density, as well as pH, were on a beneficial level. The surface soil horizons were characterized by high (as for sands) content of total carbon, what was the result of an alluvial specificity of the studied soils genesis. The investigated soils were a natural environment for thermophilic flora.
***Key words**: floristic composition, soil properties, termophilic flora*

SKŁAD FLORYSTYCZNY ZBIOROWISKA Z DOMINACJĄ *BROMUS INERMIS* LEYSS NA TLE WARUNKÓW GLEBOWYCH

Streszczenie

W pracy przedstawiono gleboznawczą i florystyczną charakterystykę siedlisk łąkowych, na których prowadzona jest rolnicza gospodarka ekologiczna. Obejmowała ona ocenę zróżnicowania oraz szczegółowy opis i interpretację warunków glebowych i fitosocjologicznych. Badania wykonano we wrześniu 2015, na terenie indywidualnego gospodarstwa rolnego we wsi Mniszek (województwo wielkopolskie; powiat czarnkowsko-trzcianecki). Na podstawie 18 zdjęć fitosocjologicznych określono zróżnicowanie florystyczne zbiorowiska oraz strukturę botaniczną i wartość przyrodniczą, w którym dominowało zbiorowisko z przewagą stokłosy bezostnej (Bromus inermis Leyss). W materiale glebowym pochodzącym z czterech profili glebowych oznaczono takie właściwości, jak: pH, zawartość węgla i azotu ogólnego, skład granulometryczny, gęstość gleby oraz jej fazy stałej, porowatość całkowitą, maksymalną pojemność higroskopową, potencjał wiązania wody przez glebę, jej potencjalną i efektywną retencję użyteczną oraz współczynnik filtracji. Badane gleby reprezentowały typ mad właściwych (Haplic Fluvisols), wytworzonych z piasków aluwialnych pradoliny Noteci. Charakteryzowały się bardzo lekkim, piaszczystym uziarnieniem oraz, typową dla gleb lekkich, wysoką wodoprzepuszczalnością i niską retencją. Woda produkcyjna oraz dostępna dla roślin występowała w nich w niewielkich ilościach. Porowatość całkowita i gęstość gleby, jak również pH, kształtowały się na korzystnym poziomie. Poziomy wierzchnie cechowały się wysoką – jak na piaski – zawartością węgla ogólnego, co wynikało ze specyfiki aluwialnej genezy tych gleb. Badane gleby stanowiły naturalne podłoże dla roślinności ciepłolubnej.
***Słowa kluczowe**: skład florystyczny, wartość przyrodnicza, właściwości gleb, roślinność ciepłolubna*

1. Introduction

Bromus inermis is a species characteristic for *Agropyretea intermedio – repentis* class (Oberd et al. 1967) (Muller et Gors 1969). In Wielkopolska this species is popular and often encountered. Precipitation which is sufficient for its sustainable development is about 500 mm. It grows on dry soils, with a tendency to overdrying. It prefers well sunlit habitats.These are most often half-ruderal, xerothermic pioneer communities. By some researchers it is called *marginal grass* [19]. What is interesting, that it is able to cope with temporary overflows [20]. It harvests at a level of 50 – 80 q/ha and its fodder value is very high [11]. Soil cover of river valleys is usually formed from organic soils [12]. However, the area adjacent to river is often formed from its seasonal silts and alluvial materials. Such areas may be covered with mineral soils – river alluvial soils. During the process of formation of these alluvial soils, classic soil-forming processes are dominated by a geological process (alluvium) [16]. The formation of alluvial soils is one of the stages of the development of a river valley, and is connected with the amount and energy of floating water, as well as with the length of surface overflow periods. The type of alluvial material depends on these factors; as a parent rock, which co-decides for soil properties and therefore – about the character of plant community [18]. The paper presents a soil and floristic characteristics of grassland communities in a part of the central valley of the Noteć River.

2. Object and methodology

The research was conducted in September 2015 in an individual farm land in Mniszek (a village in Wielkopolskie Voivodship in Czarnkowsko-Trzcianecki County). The object of the research included a grassland of the total area of 15.4 ha. Its extensive utilization allowed for the observation of the succession of flora similar to natural flora.

Soil cover of the study area was formed mainly by very coarse-textured *Haplic Fluvisols* (in Polish mady właściwe) [3, 16], formed from alluvial sands. Well visible stratification of recent sedimentation in the study soil profiles were observed, what is typical for this soil type. Up to the depth of 1.5 m, no ground water table was found. The morphology of the investigated soils was similar (Ai-C1-C2). Studied soils represented the IV and the V bonitation class, and the 3z complex of agriculture suitability. Floristic research were carried out with Braun-Blanquet's method [1] in the area of 100 m^2 in well-formed communities of 10x10 m^2. On the basis of 18 phytosociological relevés, the community was put under a floristic and phytosociological analysis, in which floristic diversity was determined and which was completed by the analysis of species composition, i.e. of botanical structure (in %), total number of species in a given community. Furthermore, the following parameters were calculated: the coefficient of diversity with Shannon-Weiner's formula: $H' = -\sum (p_i \times \log p_i)$ and natural value of the community. The identification of species was based on the nomenclature of *Polish Plants* key, as well as on *Vascular Plant of Poland a checklist* [9]. Floral community was classified with a syntaxonomical pattern by Matuszkiewicz [8].

Soil material for laboratory analysis were sampled by genetic soil horizons from four soil profiles. Both, undisturbed and disturbed soil samples were collected. The following soil properties were measured: soil texture by sieving (sand) and hydrometer (silt and clay), after sample dispersion with sodium hexametaphosphate [14], particle density using the picnometric method [17], bulk density (with Nitzsh's vessels of 100 cm^3 capacity), total porosity (calculated on the basis of particle and bulk density) [10], maximal hygroscopic capacity (in a vacuum chamber at subpressure of 0.8 atm., with a saturated solution of K_2SO_4), soil's water binding potential by the method of Richards' pressure chambers) [4], saturated hydraulic conductivity [5], total and readily available water (on the basis of pF determination), content of total carbon and nitrogen using the Vario Max CNS analyser, pH in 1M KCl (soil to liquid ratio of 1:2.5 v/v) potentionometrically. All the analysis where performed in five replications, results presented in tables represent mean values from five replications.

3. Results and discussion

3.1. Florstic research

Based on the investigation of floristically diversified communities with the domination of *Bromus inermis,* the appearance of 23 species was noticed (Tab. 1). The majority of species belongs to *Poaceae* family – 52.9% of the whole species in the green growth. Little percentage share of *Fabaceae* and *Cyperaceae* families was observed, whereas in the group of herbs and weeds, numerous species from *Asteraceae*, *Polygonaceae* and *Lamiaceae* families as well as others were found (41.2% of species in the sward). When analysing a phytosociological structure of the community, it may be stated that the floristic composition of the investigated communities suggests a relation to *Molinio-Arrhenathertea* class, especially to *Arrhenatheretalia elatioris* order.

When analysing the community in terms of natural values (Tab. 2), an average valorisation number of 2.1 was determined, of valorisation class III which, according to Oświt [13], proves that these are communities of little natural values. Flora of this community is often naturally developed and has a natural or half-natural character of the environment [2]. Some examined communities were poor in species and facially diversified. Floristic variability of the investigated community, calculated with Shannon-Wiener's indice, is 1.8, which determines it as small. The community is dominated by species of native origin (Ap - apophytes), in the amount of 78.3% of the share in the sward, and spontaneophytes (Sp) in the amount of 13.8% (Tab. 2).

Table 1. Floristic diversity of *Bromus inermis* communities
Tab. 1. Różnorodność florystyczna zbiorowiska Bromus inermis

Community	Number of species		Percentage proportion of the remaining species			
	Total	Average	*Grasses*	*Fabaceae*	Carex and sedges	*Herbs* and *weeds*
Low swards on periodically flooded soils						
with *Bromus inermis*	23	11	52.9	4.1	1.8	41.2

Source: own research / Źródło: opracowanie własne

Table 2. Natural values of the *Bromus inermis* communities
Tab. 2. Walory przyrodnicze zbiorowiska Bromus inermis

Natural value number (Nvn)				
Potentillo-Festucetum arundinaceae	Mean evaluation number	Natural qualities	Evaluation category	*H'
Natural values	2.1	low	III	1.8
Percentage proportion of the synantropic species		Ap – apophytes	78.3	
		Sp.- spontaneophytes	13.8	
		Arch. – archeophytes	6.8	

Explanation: *H'- Shannon-Viener index

Source: own research / Źródło: opracowanie własne

3.2 Selected properties of investigated soils

Particle size distribution analysis showed homogenous texture of the investigated soils. The texture was dominated by sand fraction (92-98%) and, as a consequence of this fact where classified to soil texture subgroup of sand (S) [3, 15]. The content of clay and silt fraction ranged between 0 to 2%, and between 1 and 8 %, respectively (Tab. 3).
The values of particle density was balanced in all soil horizons and were close to the density of quartz, oscillated between 2.61 and 2.65 $Mg·m^3$, depending on the content of total carbon (Tab. 4, 6).

The bulk density of the investigated soils was low. Its values were lower in surface A horizons than in endopedones. Bulk density values in surface horizons ranged from 1.12 (profile 4 depth 0-28 cm) to 1.39 (profile 3 depth 0-21 cm). Corresponding values in the sandy parent material were higher by ca. 0.1-0.4 $Mg·m^3$ and were between 1.15 $Mg·m^3$ (profile 4 depth 28-52 cm) and 1.51 $Mg·m^3$ (profile 1 at depth 75-150 cm) (Tab. 4).

Total porosity value in investigated soils was in the range 43.02 – 57.58% (Tab. 4). Lower values were observed in the endopedons than in the surface A horizons.

Maximal hygroscopic capacity (MH) oscillated in quite a wide interval of 0.25 (profile 3; depth 37-150 cm) to 1.69 %v (profile 3; depth 0-21 cm). It was visible that MH values depended on texture and carbon content in study soils (Tab. 3, 5, 6).

All filtration speeds which were marked oscillated between 46.8 and 467.7 $\mu m \cdot s^{-1}$. The highest filtration speed was observed in profile 3 at the depth of 37-150 cm; equally high one (412.4 $\mu m \cdot s^{-1}$) was found in profile 1 at the depth of 33-75 cm. The lowest saturated hydraulic conductivity was observed in C1 horizon in profile 2 (depth of 34-79 cm), which was probably the result of mud material admixture. Relation between saturated hydraulic conductivity and total porosity was small - Pc/ks – R^2 = -0,47159. Based on the obtained results it may be ascertained that the speed of filtration was similar in all profiles and characteristic for sandy material (Tab. 4). For deposits of alluvial origin and sandy texture, the determined values oscillated within wide intervals given by numerous authors [7, 18].

Natural moisture characterized the investigated soils in terms of water content only in the time of field works. This soil parameter is required for proper describing soil morphology. Its values give a view on current (temporary) moisture of each of the soil horizons.

Table 3. Texture of studied soils
Tab. 3. Uziarnienie badanych gleb

Profile number	Soil horizon	Depth [cm]	Percentage content of particle-size fraction [mm]						Texture class acc.	
			2.0 - 0.10	0.10 - 0.05	0.05 - 0.02	0.02 - 0.005	0.005 - 0.002	<0.002	PTG 2008	FAO/ USDA
	A	0-33	94	1	1	1	1	2	pl	S
1	C1	33-75	96	1	1	0	1	1	pl	S
	C2	75-150	95	1	1	1	1	1	pl	S
	A	0-34	93	3	1	2	0	1	pl	S
2	C1	34-79	93	3	1	1	1	1	pl	S
	C2	79-150	97	1	1	0	0	1	pl	S
	A	0-21	90	7	1	1	0	1	pl	S
3	C1	21-37	92	5	1	0	0	2	pl	S
	C2	37-150	97	1	1	1	0	0	pl	S
	A	0-28	97	1	1	1	0	0	pl	S
4	C1	28-52	82	12	3	1	1	1	pl	S
	C2	52-150	81	10	5	2	1	1	pl	S

Explanation: pl - piasek luźny / S - sand

Source: own research / Źródło: opracowanie własne

Table 4. Basic physical and water properties of studied soils
Tab. 4. Podstawowe właściwości fizyczne i wodne badanych gleb

Profile number	Soil horizon	Depth [cm]	Natural moisture [%m]	Particle density [$Mg·m^{-3}$]	Bulk density [$Mg·m^{-3}$]	Total porosity [%v]	Saturated hydraulic conductivity [$\mu m·s^{-1}$]
	A	0-33	11.52	2.64	1.19	54.92	110.5
1	C1	33-75	9.60	2.65	1.48	44.15	412.4
	C2	75-150	12.39	2.65	1.51	43.02	375.5
	A	0-34	11.68	2.63	1.17	55.51	136.1
2	C1	34-79	11.85	2.61	1.40	46.36	46.8
	C2	79-150	11.71	2.65	1.43	46.04	361.4
	A	0-21	9.37	2.63	1.39	47.15	184.9
3	C1	21-37	9.85	2.65	1.47	44.53	68.9
	C2	37-150	20.72	2.65	1.41	46.79	467.7
	A	0-28	10.22	2.64	1.12	57.58	103.7
4	C1	28-52	11.86	2.65	1.15	56.60	106.3
	C2	52-150	10.36	2.65	1.42	46.41	127.1

Source: own research / Źródło: opracowanie własne

Table 5. Soil water potentials and the total and readily available water of studied soils
Tab. 5. Pojemności wodne oraz potencjalna i efektywna retencja użyteczna badanych gleb

Profile number	Soil Horizon	Depth [cm]	Water capacity at pF [%v]						Readily available water [%v]	Total available water [%v]
			0.0	2.0	2.5	3.7	4.2	4.5	2.0 – 3.7	2.0 – 4.2
1	A	0-33	52.50	14.86	13.12	7.48	3.28	0.95	7.38	11.58
	C1	33-75	41.82	12.23	10.54	4.65	1.49	0.31	7.58	10.74
	C2	75-150	41.07	10.75	9.08	3.89	1.76	0.44	6.86	8.99
2	A	0-34	53.15	12.36	9.76	5.43	2.29	1.14	6.93	10.07
	C1	34-79	43.77	9.88	5.73	3.50	2.50	1.01	6.38	7.38
	C2	79-150	43.52	9.49	7.61	3.85	1.89	1.07	5.64	7.60
3	A	0-21	43.89	16.16	13.22	7.41	3.27	1.69	8.75	12.89
	C1	21-37	42.17	11.55	10.11	7.00	2.47	0.52	4.55	9.08
	C2	37-150	43.86	9.39	7.98	3.77	1.60	0.25	5.62	7.79
4	A	0-28	55.43	14.18	9.57	5.01	2.77	0.15	9.17	11.41
	C1	28-52	55.76	10.54	8.46	3.06	2.17	0.71	7.48	8.37
	C2	52-150	44.20	9.46	8.31	3.52	2.32	0.58	5.94	7.14

Source: own research / Źródło: opracowanie własne

Table 6. Basic chemical properties of studied soils
Tab. 6. Podstawowe właściwości chemiczne badanych gleb

Profile number	Soil horizon	Depth [cm]	pH in 1M KCl	Total carbon [$g \cdot kg^{-1}$]	Total nitrogen [$g \cdot kg^{-1}$]	C/N
1	A	0-33	6.55	11.3	1.25	9.04
	C1	33-75	6.04	1.70	0.36	4.72
	C2	75-150	6.12	1.30	0.23	5.65
2	A	0-34	6.24	13.6	0.97	14.0
	C1	34-79	7.06	12.5	1.22	10.3
	C2	79-150	5.78	1.50	0.28	5.36
3	A	0-21	6.79	10.4	0.77	13.5
	C1	21-37	6.21	1.60	0.25	6.40
	C2	37-150	5.95	1.20	0.21	5.71
4	A	0-28	6.17	8.40	0.89	9.44
	C1	28-52	6.32	1.70	0.22	7.87
	C2	52-150	6.28	1.30	0.20	6.50

Source: own research / Źródło: opracowanie własne

A complete soil water characteristics may be obtained by the analysis of so called water-soil constants, which is presented below. Slight overdrying of surface horizons was observed, in which natural moisture was lower by a few percent than in endopedones. In the lower parts of soil profiles natural moisture usually raised, which was probably connected with the circulation of oozing and seeping water (Tab. 4).

Maximal water capacity was lower by a few percent (0.84-3.26%) than total porosity in all soil horizons. Field water capacity (pF 2.0) was low an oscillated between 12.36 (profile 2; depth 0-34 cm) and 16.16%v (profile 3; and 0-21 cm) for epipedones and between 9.39 (prof. 3; depth 37-150 cm) to 12.23 (profile 1; depth 33-75 cm) for endopedones. At the pF 3.7, the content of water was higher in epipedones – from 5.01 (profile 4) to 7.48% (profile 1), than in sandy endopedones – from 3.06 (profile 4; depth 28-52 cm) to 7.00% (profile 3; depth 21-37 cm). At the permanent wilting point (pF 4.2), corresponding values were lower by ca. 1-5% and oscillated between 1.49 (profile 1; depth 33-75 cm) and 3.28% (profile 1; depth 0-33 cm). Total and readily available water calculated on the basis of pF determination, were on a level which is typical for coarse-textured soils [10, 18]. RAW in the investigated sandy deposits was between 4.55 (profile 3; depth 21-37 cm) and 9.17% (profile 4; depth 0-28 cm) , and TAW was higher by around 0.9 (profile 4; depth 28-52 cm) – 4.5%v (profile 3; depth 21-37 cm) (Tab. 5).

Reaction of the examined soils was slightly acidic or acidic (pH values from 5.78 to 6.79). Only in C1 horizon in profile 2 higher values of pH = 7.06 were observed. Contents of total carbon and nitrogen were low and the C:N proportion was diverse: in epipedones it was between 9 and 14 and it narrowed along with the depth (Tab. 6). The determined values of basic chemical properties were typical for coarse-textured mineral soils [10, 18].

4. Summary

Natural value and floristic diversity of the community with the domination of *Bromus inermis* is low, however, taking into consideration the fact that it is dominated by species of native origin (apophytes and spontaneophytes), and due to their low water demand as well as its natural and half-natural character, the community is valuable in terms of fodder and natural environment. Properties of the investigated soils were typical for coarse-textured mineral soils. High water permeability, low retention and the lack of ground water table within a soil profile, determined their low agriculture value. They were characterized by a precipitation soil water regime. Sandy textured generated a tendency to the maintenance of low pH in studied soils. Low content of nitrogen limited the possibilities for the appearance of nitrophilious species. Contents of carbon were irregularly diversified at various depths, which was a result of specificity of river alluvial soils formed from seasonal depositions of alluvial materials of various composition and content of organic matter.

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