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THE INFLUENCE OF FERTILIZING AND LIMING ON THE REACTION AND SORPTION PROPERTIES OF MEADOW SOILS OF FLOODED MEADOW

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A b s t r a c t. In the years 1987-1990, in the conditions of exact experiment, a research on the influence of mineral and organic fertilizing as well as liming upon the cropping from the undergrowth and the properties of meadow soils of three chosen flooded meadow was carried out.

As the soil conditions of the chosen flooded meadow are strongly differentiated, the influence of fertilizing upon the reaction and sorption properties of the meadow soils under study reaches different degrees. In a proper forest site the brown soil formed from slightly loamy sand in the top layer of turf horizon had a reaction in degrees from strongly acid on objects fertilized with NPK and manure, to neutral on objects fertilized with NPK and limed. In the soil of objects fertilized with NPK and limed, a clear increase in the content of Ca^{2+} and Mg^{2+} can be observed, as well as in the sum of basic cations and the degree of saturation with these cations of the soil sorption complex. The influence of mineral fertilizing upon the soil reaction and sorption properties is the least evident in the grey-brown soil formed from clayey silt in a wet meadow forest site. On all objects of the experiment the reaction of the grey-brown soil remained within the range of neutral reaction and no differentiation of sorption properties is evident.

K e y w o r d s: meadow soils, soil reaction, sorptive properties, fertilizing, liming

INTRODUCTION

Fertilizing of meadow soils influences not only the cropping of the undergrowth, but also some characteristics of these soils [1,2]. From among the characteristics of meadow soils, especially worth mentioning are the reaction and sorption properties. It can be assumed that the influence of fertilizing and liming upon the reaction and sorption properties of meadow soils is noticeable in different degree among the differentiated soils in certain site conditions.

MATERIALS

The influence of organic and mineral fertilizing as well as liming upon the reaction and sorption properties of meadow soils was tested in the conditions of exact experiment, in the years 1987-1990 on the three following locations:

- in Jaźwiny, a farm belonging to State Farms of Trzebnica, on brown soil derived from light loamy sand, among the 4th land capability taxation and agricultural suitability complex 3z, in a proper forest site;
- in Pawłowice, a farm belonging to the Agricultural University of Wrocław, on fen brown soil on loose sand, 4th land capability taxation and agricultural suitability complex 2z, in a swampy-meadow forest site;
- in Małuszyn, a farm belonging to State Farms of Trzebnica, on brown soil formed from clayey silt on medium loam, 2nd land capability taxation and agricultural suitability 1z, in a wet-meadow forest site.

A detailed characteristics of the soils under study is given in a separate publication [3]. In the three aforementioned locations, experiments with fertilization of the permanent turf was started in 1987.

In the experiments carried out in Jaźwiny and Pawłowice, the following fertilizer combinations were applied:

1 - control object witthout fertilizer
2 - 80 kg P_2O_5/ha + 100 kg K_2O/ha
3 - 80 kg P_2O_5/ha+120 kg N/ha
4 - 80 kg P_2O_5/ha+ 240 kg N/ha
5 - 80 kg P_2O_5/ha+liming
6 - 80 kg P_2O_5/ha+120 kg N/ha
7 - 80 kg P_2O_5/ha+ 240 kg N/ha
8 - farmyard manure (FYM) - 40 t/ha
9 - 80 kg P_2O_5/ha + 100 K_2O/ha + 240 N/ha + FYM.

In Małuszyn, on a fertile soil rich in humus, with base reaction, liming or fertilization with FYM was not applied, only the combinations 1, 2, 3, and 4 were used and test object 10 was added, fertilized with 80 kg P_2O_5/ha + 100 kg K_2O/ha + 360 kg N/ha. In the soil samples taken in autumn period of 1987-1990, the soils reaction and sorption properties were determined, with the help of methods commonly used in soil science.

RESULTS

The results of determining the reaction and sorption properties in meadow soils of the chosen flooded meadow, to be found in Tables 1-5, show a differentiation of the sites, which have a different degree with particular soils depending on the object and the period of the experiment, as well as the depth of sampling.

Between 1987 and 1990 the soil's reaction in fertilized and non-fertilized control objects becomes differentiated on particular locations. It proves especially evident in Jaźwiny, in brown acid soil formed from slightly loamy sand, showing on the unfertilized test object 1, in a layer of 0-5 cm a variation of reaction in the range from slightly acid to very strongly acid, with pH_{KCl} values of 5.6 in 1987 to 4.1 in 1990. In deeper layers a slight decrease in the value of pH was observed and the degrees of variations of the reaction also became smaller (Table 1).

On the control object 1 in Pawłowice, in the top layer of brown medium fen soil on loose sand the reaction varies between slightly acid to acid (Table 1), and in Małuszyn the grey-brown soil derived from clayey silt on medium loam in a layer between 1 and 5 cm has a reaction varying from neutral to slightly acid. In the layers below 5 cm of depth the pH value increases slightly and the reaction remains in the range from neutral to basic in Małuszyn and slightly acid to neutral in Pawłowice.

In the experiments carried out the influence of fertilizing upon the reaction of the meadow soils under study is found differentiated. In Jaźwiny, as compared with the control object 1 on test objects 3, 4, 8 and 2, 9 in the layer of 0-5 cm a decrease in the pH value was observed in the years 1987-1990, and on test objects 5, 6, and 7 fertilized and limed during the whole period of time, the pH_{KCl} value evidently grows to slightly acid and neutral reaction.

In Pawłowice in a top layer of 0-5 cm on test object 9 fertilized with NPK and FYM, a decrease in the value of pH was observed, as compared to the control object 1. On the fertilized and limed test objects 5, 6, 7 the pH evidently increases. Also an increase in pH value on the remaining test objects 2, 3, 4 was observed in some years.

In Małuszyn in the top layer of soil 0-5 cm the reaction in some years (1987, 1989) remains in the range of neutral reaction, showing pH_{KCl} variations of 0.2-0.6 units and the influence of fertilizing upon the soil acidity is clearly visible. It must be assumed that it is connected with a large content of humus and colloidal silt fractions (3), which conditions the buffer properties of soil.

Sorption properties of the soils under study were investigated on the basis of results of research carried out in 1988, to be found in Table 3.

In Jaźwiny the acid brown soil in the top layer 0-5 cm deep on the control object 1 has a low sum of exchangeable basic cations and very low degree of the sorption complex saturation with these cations. However, in comparison with the control object 1, on the fertilized and limed test objects 6 and 7, an increase in the content of Ca^{2+} and Mg^{2+} cations, and then the hydrolytic acidity is clearly lower then the

Table 1. Soil reaction in investigated soils from Jaźwiny and Pawłowice

Site	Years	Sampling depth (cm)	Treatments* 1	2	3	4	5	6	7	8	9
			pH H_2O								
Jaźwiny	1987	0-5	6.2	5.7	4.8	4.9	6.8	7.6	7.1	4.9	5.2
		5-10	5.9	5.3	5.1	5.3	5.9	5.9	6.3	4.8	4.9
		10-15	5.7	5.0	4.8	5.1	5.0	5.0	5.3	4.7	4.8
	1988	0-5	6.3	6.4	5.4	5.4	7.6	7.1	7.3	5.3	5.6
		5-10	6.8	6.4	5.9	5.9	6.7	5.6	6.3	5.7	5.2
		10-15	5.9	5.6	5.1	5.8	5.9	5.3	5.4	5.5	5.3
	1989	0-5	5.2	5.0	4.8	4.6	6.7	7.1	7.2	5.0	4.7
		5-10	5.0	5.0	4.6	4.3	6.5	5.9	6.5	5.0	4.6
		10-15	5.0	4.8	4.5	4.2	5.6	5.4	5.5	5.2	4.5
	1990	0-5	5.0	5.0	4.8	4.6	6.8	6.5	6.3	5.2	5.4
		5-10	4.6	5.1	4.5	4.8	5.0	5.4	5.3	4.7	4.8
		10-15	4.5	4.9	4.5	4.7	5.2	5.2	4.8	4.7	4.8
			pH KCl								
	1987	0-5	5.6	5.4	4.5	4.7	6.2	7.2	6.8	4.5	5.0
		5-10	5.1	4.7	4.9	4.7	5.3	5.4	5.5	4.3	4.5
		10-15	4.9	4.5	4.5	4.4	4.5	4.5	4.7	4.2	4.4
	1988	0-5	5.7	5.6	4.7	4.6	6.7	6.2	6.7	4.6	4.7
		5-10	5.9	5.6	4.3	4.4	5.6	4.9	5.6	4.9	4.5
		10-15	4.8	4.7	4.2	4.3	5.3	4.6	4.7	4.5	4.4
	1989	0-5	4.6	4.4	4.2	4.1	6.6	7.0	7.2	4.5	4.1
		5-10	4.4	4.3	4.1	4.0	6.5	5.0	6.5	4.4	4.0
		10-15	4.2	4.1	4.0	4.0	5.1	5.0	5.3	4.7	4.1
	1990	0-5	4.1	4.3	4.2	4.2	6.7	6.1	6.3	4.3	5.2
		5-10	4.0	4.4	4.0	4.0	4.4	4.8	4.8	4.1	4.2
		10-15	4.0	4.3	4.1	4.0	4.5	4.5	4.3	4.0	4.1
			pH H_2O								
Pawłowice	1987	0-5	6.6	7.0	7.3	6.6	6.7	6.6	6.9	6.7	6.2
		5-10	6.6	7.1	7.5	7.5	7.1	6.8	7.3	7.2	6.8
		10-15	6.9	7.6	7.6	7.5	7.2	7.2	7.6	7.3	7.2
	1988	0-5	6.4	6.2	6.8	5.9	6.9	7.2	6.9	7.0	6.0
		5-10	6.6	6.1	7.3	7.2	6.4	6.7	6.5	7.3	7.0
		10-15	7.2	7.1	7.5	7.6	6.6	6.8	7.5	5.3	7.1
	1989	0-5	6.3	5.8	6.2	6.1	7.2	7.1	7.0	6.5	5.5
		5-10	6.5	6.0	6.7	6.6	6.8	7.1	7.3	7.0	6.0
		10-15	7.0	6.5	6.2	7.1	6.8	7.2	7.7	7.2	6.4
	1990	0-5	6.0	5.6	5.4	5.5	6.8	6.4	6.5	6.4	5.3
		5-10	6.3	5.7	5.8	6.2	6.6	7.0	7.0	6.4	6.0
		10-15	6.8	6.0	6.3	6.6	6.6	7.3	6.7	6.7	6.2
			pH KCl								
	1987	0-5	6.0	6.8	7.1	6.1	6.6	6.0	6.7	6.4	5.6
		5-10	6.0	6.8	7.2	6.8	6.8	6.2	6.0	6.8	6.3
		10-15	6.5	7.4	7.0	7.0	7.0	6.2	7.0	7.1	6.5
	1988	0-5	5.7	5.4	5.9	5.3	6.3	6.5	6.3	6.2	5.2
		5-10	5.9	5.5	6.6	6.5	5.7	6.0	5.9	6.6	6.4
		10-15	6.6	6.4	6.7	6.9	5.9	6.0	6.7	6.6	6.4
	1989	0-5	6.0	5.4	6.0	6.0	7.1	7.0	7.0	6.3	5.2
		5-10	6.3	5.7	6.5	6.5	6.7	7.0	7.2	6.5	5.7
		10-15	6.8	6.1	6.8	6.7	7.2	7.0	7.0	7.0	6.0
	1990	0-5	5.5	5.1	4.9	5.0	6.5	6.1	5.8	6.0	4.6
		5-10	5.8	5.1	5.4	5.7	6.4	6.6	6.2	5.8	5.4
		10-15	6.3	5.5	5.8	6.2	6.0	7.0	6.2	6.2	5.7

*For explanation see Materials.

Table 2. Soil reaction in investigated soils from Małuszyn

Years	Sampling depth (cm)	Treatments				
		1	2	3	4	10
				pH H_2O		
1987	0-5	7.5	7.4	7.8	7.6	7.6
	5-10	7.8	7.6	7.9	7.6	7.8
	10-15	7.9	7.9	7.6	7.6	7.6
1988	0-5	7.2	7.2	7.0	7.8	7.3
	5-10	7.8	7.8	7.7	7.8	7.8
	10-15	7.8	7.7	7.8	7.2	7.7
1989	0-5	7.1	7.1	7.2	7.8	6.9
	5-10	7.6	7.4	7.5	7.8	7.5
	10-15	7.4	7.5	7.6	7.8	7.6
1990	0-5	6.5	6.5	6.8	6.8	6.5
	5-10	6.9	7.0	7.3	7.3	7.3
	10-15	7.2	7.0	7.3	7.4	7.4
				pH KCl		
1987	0-5	7.0	7.1	7.2	7.2	7.2
	5-10	7.2	7.4	7.5	7.4	7.4
	10-15	7.4	7.5	7.1	7.4	7.1
1988	0-5	6.5	6.5	6.3	6.9	6.4
	5-10	6.9	6.9	6.9	6.5	6.9
	10-15	6.9	6.9	7.0	6.5	6.9
1989	0-5	7.0	7.1	7.2	7.4	6.8
	5-10	7.2	7.3	7.3	7.6	7.3
	10-15	7.4	7.4	7.4	7.6	7.4
1990	0-5	6.3	6.5	6.7	6.5	6.2
	5-10	6.6	6.7	6.8	6.7	6.8
	10-15	6.8	6.7	6.9	6.8	6.9

degree of the soil sorption complex saturation with basic cations increases.

On test objects 3, 8, and 9 fertilized with NPK (3), FYM (8) and NPK +FYM (9), the content of basic cations, their sum and the soil sorption complex saturation with basic cations has a similar distribution as in the control object 1.

Fertilizing and liming have a comparatively small influence upon the differentiation of sorption properties of medium fen soil on test objects of the experiment in Pawłowice. On the control object 1 a high content of the Ca^{2+}cation, a high sum of exchangeable basic cations and the soil's sorption complex saturation with these cations can be observed. In comparison to the control object 1, on the test objects 8 and 9 fertilized with FYM (8) and NPK +FYM (9) in the top layer of 0-5 cm the content of Ca^{2+} decreases slightly, and on test object 8, where the hydrolytic acidity was clearly lower, the degree of the soil sorption complex saturation with basic cations evidently grows. Also on the fertilized and limed test objects 5, 6, and 7 the hydrolytic acidity decreases, the soil sorption complex saturation with basic cations increases, and there can be observed a slight decrease in the content of Ca^{2+}, whereas the content of Mg^{2+} clearly grows.

Mineral fertilizing has the least influence upon the differentiation of sorption properties of grey-brown soil formed from clayey silt of the test objects in Małuszyn. In comparison to the control object 1, on the objects 2 and 4 the content of Ca^{2+} becomes slightly higher and so does the sum of exchangeable basic cations. Whereas on test object 10 fertilized with NPK, 360 kg N/ha the hydrolitic acidity increases and the soil sorption complex saturation with basic cations becomes slightly lower.

Table 3. Hydrolytic acidity and base exchange capacity of the investigated soils

Treat-ments	Sampling depth (cm)	Hydrolytic acidity H_h	Exchangeable basic cations (mmol(+)/100 g of soil)			S=Ca+Mg+K+Na		$T=S+H_h$	Degree of saturation with basic cations V (%)
			Ca^{2+}	Mg^{2+}	K^+	Na^+	S	T	
					Jaźwiny				
	0-5	4.05	0.62	0.20	0.16	0.09	1.07	5.12	20.90
1	5-10	4.30	0.55	0.16	0.14	0.10	0.95	5.25	18.10
	10-15	2.60	0.50	0.15	0.12	0.10	0.87	3.47	25.07
3	0-5	3.00	1.28	0.21	0.19	0.12	1.80	4.80	37.50
	5-10	2.55	0.70	0.15	0.16	0.17	1.18	3.73	31.63
	10-15	2.47	0.70	0.18	0.17	0.10	1.15	3.62	31.77
6	0-5	1.12	1.84	1.55	0.20	0.15	3.74	4.86	76.95
	0-5	0.97	2.46	2.30	0.21	0.36	5.33	6.30	84.60
7	5-10	2.55	1.26	1.08	0.21	0.10	2.65	5.20	50.96
	10-15	2.17	0.76	0.77	0.19	0.12	1.81	3.98	45.48
8	0-5	3.00	0.50	0.27	0.27	0.12	1.15	4.15	27.71
9	0-5	2.55	0.76	0.39	0.23	0.16	1.54	4.09	37.65
					Pawlowice				
	0-5	3.00	17.64	1.71	0.38	0.68	20.41	23.41	81.18
1	5-10	1.80	17.04	0.94	0.21	0.57	18.76	20.56	91.24
	10-15	0.45	21.20	0.77	0.20	0.63	22.80	23.25	98.06
2	0-5	2.70	17.30	1.15	0.20	0.59	19.24	21.94	97.69
3	0-5	2.17	16.40	1.38	0.40	0.85	19.03	21.20	93.04
4	0-5	3.59	16.60	1.22	0.27	0.59	18.68	22.27	83.87
5	0-5	0.45	16.20	5.26	0.43	0.71	22.60	23.05	98.04
	0-5	0.60	16.08	5.26	0.33	0.71	22.38	22.98	97.38
6	5-10	2.17	16.34	1.64	0.21	0.63	18.82	20.99	89.66
	10-15	1.35	16.90	1.15	0.19	0.63	18.87	20.22	93.32
7	0-5	1.20	14.82	2.91	0.30	0.57	18.60	19.80	93.32
	10-15	0.37	17.46	1.05	0.18	0.61	19.30	19.67	98.11
8	0-5	1.50	15.10	1.71	0.48	0.66	17.95	19.45	92.28
	0-5	3.82	5.10	1.48	0.46	0.63	17.67	21.45	82.22
9	5-10	2.10	15.24	1.27	0.22	0.59	17.32	19.42	89.18
	10-15	0.67	15.80	1.05	0.19	0.57	17.61	18.28	96.39
					Małuszyn				
	0-5	0.82	15.92	0.72	0.64	0.61	17.89	18.71	95.62
1	5-10	0.90	15.52	0.56	0.42	0.54	17.04	17.94	94.98
	10-15	0.37	15.80	1.05	0.43	0.54	17.82	18.19	97.96
2	0-5	0.90	21.20	1.27	0.77	0.64	23.88	24.78	96.37
	0-5	0.90	18.24	0.82	0.60	0.96	20.62	21.52	95.82
4	5-10	0.45	18.40	1.08	0.43	0.66	20.57	21.02	97.86
	10-15	0.45	16.34	1.08	0.34	0.54	18.30	18.75	97.60
10	0-5	1.27	15.80	1.31	0.57	0.55	18.23	19.50	93.49

CONCLUSIONS

1. The influence of mineral and organic fertilization, and liming upon the differentiation of the reaction and the sorption properties of the chosen soils on flooded meadow proves that the soil is an important factor conditioning the shaping of the characteristics under study.

2. The variations in the soil pH value of the control object of the experiment on the chosen flooded meadow justify the need of further multiannual research, which would allow a proper evaluation of the course of shaping the reaction of soils fertilized minerally and limed.

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WPŁYW NAWOŻENIA I WAPNOWANIA NA ODCZYN I WŁAŚCIWOŚCI SORPCYJNE GLEB ŁĄKOWYCH SIEDLISK GRĄDOWYCH

W latach 1987-1990 przeprowadzono w warunkach ścisłych doświadczeń badania nad wpływem nawożenia mineralnego i organicznego oraz wapnowania na plonowanie runi i właściwości gleb łąkowych wybranych trzech siedlisk grądowych.

Na tle zróżnicowania warunków glebowych wybranych siedlisk grądowych w różnym stopniu zaznacza się wpływ nawożenia na odczyn i właściwości sorpcyjne badanych gleb łąkowych. W siedlisku grądu właściwego gleba brunatna wytworzona z piasku słabogliniastego w wierzchniej warstwie poziomu darniowego wykazała odczyn w przedziałach od bardzo kwaśnego na obiektach nawożonych NPK i obornikiem do odczynu obojętnego na obiektach nawożonych NPK i wapnowanych. W glebie obiektów nawożonych NPK i wapnowanych wyraźnie zaznacza się wzrost zawartości Ca^{2+} i Mg^{2+} oraz sumy kationów zasadowych i stopnia wysycenia tymi kationami kompleksu sorpcyjnego gleby. Najsłabiej zaznacza się wpływ nawożenia mineralnego na odczyn i właściwości sorpcyjne gleby szarobrunatnej wytworzonej z pyłu ilastego w siedlisku grądu popławnego. Na wszystkich obiektach doświadczenia odczyn gleby szarobrunatnej utrzymuje się w przedziałach odczynu obojętnego i nie zaznacza się wyraźnie zróżnicowanie właściwości sorpcyjnych.

S ł o w a k l u c z o w e: gleby łąkowe, odczyn, właściwości sorpcyjne, nawożenie, wapnowanie.