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THE EFFECTS OF LEAVING FIELDS FALLOW UPON SELECTED FERTILITY ELEMENTS IN SOIL

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A b s t r a c t. The aim of this work was to ascertain the levels of some selected chemical and physico-chemical properties in the fallow soils and in the neighbouring fields under cultivation. The studied fields were located on heavy brown fen soil, uncultivated for 4 and 8 years and rusty soil that lay fallow for 8 years.

Fallow soils, in comparison to arable soils, were characterized by a lower content of organic carbon and available potassium forms as well as phosphorus and magnesium. Changes in the properties of arable soils under cultivation and the soils allowed to lie fallow were much clearer in the clay soils (heavy fen soil) than in sandy rusty soils. Humus horizon in the 8-year fallow clay soil was characterized by an increased hydrolytic aci-dity and decreased exchangeable calcium level in the sorption complex.

K e y w o r d s: physico-chemical properties, fallow soils, arable fields.

INTRODUCTION

Restructuring of Polish agriculture and no viability in agricultural production contributed to the exclusion of some arable soils from cultivation. According to data presented in the Statistical Yearbook of 1998, the surface of fallow lands in Poland exceeded 1.4 million ha. This does not concern only the soils with low agricultural production value but also fertile clay soils in the valuation class II and III.

Research on the effects of leaving fields as fallow on the soil properties conducted by Niedźwiecki *et al.* [3] showed that there were no significant effects on the changes in soil fertility. However, leaving fields to lie fallow was proved to be conductive to weed infestation, as well as weed migration together with pathogens and pests to the neighbouring fields under cultivation [1-3,5].

The aim of this work was to ascertain the levels of some selected chemical and physico-chemical properties in the fallow soils and in the neighbouring fields under cultivation.

STUDY OBJECTS AND METHODS

The present research was conducted near Wrocław in the gminas of Czernica (lot I) and Jelcz-Laskowice (lot II). The studied fields were located on heavy brown fen soil, uncultivated for 4 and 8 years and rusty soil that lay fallow for 8 years. The 8-year fallow field in the lot I was grazed, whereas the field in the lot II was mowed. In both of these lots there also were fields under cultivation which were located next to the fallow land.

In 1998, soil profiles were examined in both lots (profiles 1-5). Samples were taken from the assigned genetic levels in order to determine the following parameters: grain composition by the Bouyoucos's method as modified by Casagrande and Prószyński; organic carbon by the Tiurin's method; reaction in 1 M KCl potentiometrically, contents of soluble phosphorus forms and potassium by the Egner-Riehm's method; contents of magnesium by the Schachtschabel's method and AAS technique; hydrolytic acidity (Hh) by the Kappen's method; exchange cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) by the Pallman's method.

On the basis of the estimated content of cations, the sum of cations (S) was calculated, as well as the capacity of the sorption complex (T), saturation degree of the sorption complex with basic cations (V), as well as the percentage of exchange cations in the sorption capacity of the soil.

RESULTS AND DISCUSSION

In the surface layers of heavy brown fen soils, mainly the characteristics of medium silty clay-like soils was found out. These heavy brown fen soils contained 25-38% of sandy fractions and 10-18% of colloidal silt. At the base of these soils a slightly clay-like sand was found with 90% of a sand fraction, 6% of colloidal silt and 2% of a silt fraction. At the soil base, in the 4-year old fallow field (profile 2) a loose sand layer was found at the 45-cm depth.

Grain composition found in the humus horizon of the rusty soil was characteristic of light, clay-like sands containing 4% of a silt fraction and 2% of colloidal silt. A loose sand layer (Table 1) was located directly under the humus horizon.

Table 1. Granulometric composition of soils

Object	Profile No.	Genetic horizon	Depth (cm)	% fractions, diameter in mm				
				>1	1-0.1	0.1-0.02	<0.02	<0.002
I (community Czernica)	1 (ploughed soil)	A	0-10	3	28	25	47	18
		A	10-28	2	34	31	35	12
		ABbr	28-50	2	32	31	37	11
		C	50-85	1	39	25	36	13
		II C	<85	2	91	2	7	6
	2 (4-year fallow)	A	0-10	2	38	23	39	18
		A	10-25	2	36	28	36	17
		ABbr	25-45	1	28	28	44	16
		II C	<45	2	97	3	3	2
	3 (8-year fallow)	A	0-10	3	32	33	35	10
		A	10-28	2	33	29	38	12
		ABbr	28-65	2	25	35	40	12
		C	65-125	2	27	36	37	13
		II C	<125	2	90	2	8	6
II (community Jelcz-Laskowice)	4 (ploughed soil)	A	0-25	7	90	4	6	2
		Bv	25-45	7	93	3	4	1
		C	<45	8	95	3	2	1
	5 (8-year fallow)	A	0-25	6	91	3	6	2

Data presented in Table 2 suggest that the top layer of humus in soil under cultivation was slightly acidic (pH 6.2). As a consequence of leaving the land fallow, the soil pH fell to 5.3 (acidic reaction). The lower soil layer (Bbr, C) had only a slightly acidic or neutral reaction. At the lot II, a 8-year fallow soil as well as the soil under cultivation, highly acidic reactions throughout the entire profile (pH 4.0-4.4) - was determined.

Organic carbon content in the humus horizon of the fen soil at the 0-10 cm depth ranged from 1.42-1.94%, while in the lower parts of the humus horizon at the 10-28 cm depth, organic C content was 1.20-1.63%. It was higher in the cultivated soil than in the fallow soil (profile 2 and 3). The organic carbon content in the rusty soil ranged from 0.80-0.86% C.

Humus horizon in the lot I soil under cultivation was characterized by a very high available phosphorus, potassium and magnesium content. This may have been caused by the use of mineral fertilizers during crop cultivation. The fallow soil contained medium levels of potassium and phosphorus, whereas the available magnesium content in the 4-year fallow field was, for unknown reasons, higher

Table 2. Some chemical properties of soils

Object	Profile No.	Genetic horizon	pH 1 M KCl	C org. (%)	P	K	Mg
					mg/100 g		
I (community Czernica)	1 (ploughed soil)	A	6.2	1.94	23.7	26.0	16.8
		A	6.0	1.63	21.8	21.9	8.9
		ABbr	6.8	1.34	9.6	4.8	8.0
		C	6.8	0.73	4.7	5.8	6.9
		II C	7.5	0.04	2.9	3.1	2.1
	2 (4-year fallow)	A	5.3	1.42	5.4	14.6	17.3
		A	5.7	1.20	6.9	10.0	16.6
		ABbr	6.4	0.45	4.1	4.3	8.3
		II C	6.3	0.16	1.1	3.0	3.6
	3 (8-year fallow)	A	5.3	1.52	6.5	15.6	11.1
		A	5.5	1.27	11.3	7.0	9.5
		ABbr	6.3	0.78	10.0	4.8	9.7
		C	6.6	0.24	1.3	3.8	10.2
		II C	6.9	0.20	0.6	1.7	3.1
II (community Jelcz-Laskowice)	4 (ploughed soil)	A	4.0	0.86	8.3	2.9	0.7
		Bv	4.0	0.16	6.9	1.4	0.4
		C	4.4	-	1.7	0.8	0.1
	5 (8-year fallow)	A	4.1	0.80	7.9	1.8	0.5

than in the soil under cultivation, but lower than in the 8-year fallow field. In the lot II, both the arable and fallow soils, showed very low magnesium content and high phosphorus content. The arable soil contained low levels of potassium, whereas potassium in the fallow soil was very low. It is important to note that P, K and Mg content in the arable soil were higher than those recorded in the fallow soil. Niedźwiecki *et al.* [3] conducted similar comparative studies on the fallow soils and found out that a clear reduction of available potassium occurred in the humus horizon.

The soils examined in this research showed wide diversification of physico-chemical properties especially apparent in the humus horizons (Table 3). The arable soil in the lot I displayed lower values of hydrolitic acidity than those recorded in the 8-year fallow field. This was confirmed by the reaction tests. In the upper layer of 0-10 cm, properties such as the sum of alkaline cations, sorption capacity and saturation degree of the sorption complex, were higher in the arable soil than in the 8-year fallow soil. The configuration of these properties showed that there was a relation in the content of organic carbon in the compared soil profiles. In the upper layer of 0-10 cm, a slight decrease in the exchangeable calcium was found

Table 3. Some physico-chemical properties of soils

Object	Profile No.	Genetic horizon	Hh	S	T	V	H^+	Ca^{2+}	Mg^{2+}	K^+	Na^+
			mmol(+)/100 g			%	% - in the soil CEC				
I (community Czernica)	1 (ploughed soil)	A	2.45	16.09	18.54	86.78	13.22	72.66	7.71	3.56	2.85
		A	2.45	11.47	13.92	82.39	17.61	66.79	7.05	4.74	3.81
		ABbr	1.05	13.11	14.16	92.58	7.42	79.61	7.62	1.97	3.38
		C	0.52	13.63	14.15	96.32	3.68	83.80	6.85	1.69	3.98
		II C	0.35	4.99	5.34	93.44	6.56	76.60	6.55	2.62	7.67
	2 (4-year fallow)	A	1.57	9.75	11.32	86.13	13.87	72.38	5.15	4.33	4.27
		A	0.78	10.39	11.17	93.01	6.99	79.50	5.55	3.22	4.74
		ABbr	0.78	15.63	16.41	95.24	4.76	81.48	8.28	1.40	4.08
		II C	0.61	4.41	5.02	87.84	12.16	67.54	8.56	2.78	8.98
	3 (8-year fallow)	A	3.85	12.48	16.33	76.42	23.58	61.12	8.69	3.00	3.61
		A	2.62	13.16	15.78	83.39	16.61	66.50	9.48	4.25	3.16
		ABbr	1.05	16.82	17.87	94.12	5.88	80.43	8.05	1.90	3.74
		C	0.52	12.86	13.38	96.11	3.89	78.99	10.92	2.09	4.11
		II C	0.22	4.54	4.76	95.37	4.63	73.32	10.08	3.36	8.61
II (community Jelcz-Laskowice)	4 (ploughed soil)	A	2.70	3.10	5.80	53.45	46.55	43.10	5.86	2.59	1.90
		Bv	1.87	2.07	3.94	52.53	47.47	38.07	6.85	4.55	3.06
		C	0.90	1.65	2.55	64.70	35.30	50.98	7.84	3.53	2.35
	5 (8-year fallow)	A	2.32	2.99	5.31	56.31	43.69	45.20	6.40	2.45	2.26

in the fallow soil sorption complex. This was caused by an increase in the hydrogen ions within the sorption complex, which aided calcium displacement.

The contents of magnesium, potassium and available calcium in the sorption complex were similar for all the soil profiles under comparison (profile 1 and 3).

The humus horizon in the 4-year fallow field was characterized by a lower hydrolytic acidity and a lower sorption complex capacity.

The values of the remaining physico-chemical properties in these soils were similar. Properties of the soil base (profile 1-3) did not show any significant diversification.

On the basis of the present results, it can be concluded that many years of exclusion from cultivation contributed to the degradation of the physico-chemical properties only in the upper layer of the humus horizon (0-10 cm) in clay-like soils.

The properties of the arable soils as well as the fallow soils in the lot II did not differ, with the exception of hydrolytic acidity in the humus horizon which was slightly higher in the arable soil. This was illustrated by a lower degree of the sorption complex saturation and a slight decrease in the contribution of exchangeable calcium in the sorption capacity of the arable soil as compared to the 8-year fallow soil.

CONCLUSIONS

1. Fallow soils, in comparison to arable soils, were characterized by a lower content of organic carbon and available potassium forms as well as phosphorus and magnesium.

2. Changes in the properties of arable soils under cultivation and the soils allowed to lie fallow were much clearer in the clay soils (heavy fen soil) than in sandy rusty soils.

3. Humus horizon in the 8-year fallow clay soil was characterized by an increased hydrolytic acidity and decreased exchangeable calcium level in the sorption complex.

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