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AGRICULTURAL PRODUCTION ON LIGHT SOIL IN THE PROTECTIVE ZONE OF MIEDWIE LAKE WATER INTAKE FOR SZCZECIN

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INTRODUCTION

The areas adjoining national parks, nature reserves, landscape parks, potable water intakes, therapeutic mud and salt deposits require special protective measures such as limiting intensive farming or even leaving the land idle.

Miedwie lake catchment area – since 1976 the main drinking water reservoir which supplies a four-hundred-thousand population of Szczecin, is such an area as mentioned above. The lake of glacial origin, which has an area of 3 677 ha and a maximum depth of 42 m, is situated in Pyrzyce valley surrounded with highly productive soil mostly classified as black earths. In the sixties the lake water was up to the standard for drinking water. However as a result of too intensive farming in Miedwie catchment area the lake water especially near the bottom, is getting more and more contaminated [Dąbrowski et al. 1989; Państwowa Inspekcja Ochrony Środowiska 1992].

Agrometeorological Station at Lipki, situated on the light soil in the vicinity of Miedwie lake, is a positive example of land use in protective zones. At the station (2.5 ha in area) which is the part of the Agricultural Experimental Station owned by Szczecin Academy of Agriculture for 25 years (1960–1985) the same crop rotation, low fertilization level and no herbicides and pesticides (except the pesticide for the potato beetle) were used. Despite that the yields of plants from the station rotation fields (0.22 ha) were equal to the yields of crops obtained from

the adjacent fields of Lipki Experimental Station where intensive farming was applied. They were even often much higher [Koźmiński 1977].

This paper shows chemical properties of the soil of Agrometeorological Station after 25 years of using low fertilization and the same crop rotation. It proves that agricultural production should be based on environmental factors and plant requirements and not on intensification but optimization of farming. At the same time it shows that there is the possibility of obtaining high yields by using soil in harmony with nature.

MATERIALS AND METHODS

The above mentioned Agricultural Experimental Station at Lipki is located on the formations of ground moraine of the last Wurmglaciation rewashed to a great extent by post-glacial waters. Their top layers down to 0.6–1.0 m are mostly boulder sands whereas the lower layers are boulder clay formations with sand layers. The soils developed from that parent material belong to the IVa class of arable land and the 5th good rye complex [Niedźwiecki et al. 1977]. According to the present classification of Polish soils they are rusty brownish soils.

For 25 years on these soils on six fields of the Agrometeorological Station the same crop rotation (and even the same varieties if it was possible) and the following fertilization were applied (kg/ha):

Field I barley – 40 kg N + 90 kg P + 120 kg K
Field II potatoes – farmyard manure 30 t/ha + 60 kg N + 36 kg P + 90 kg K
Field III field pea – 10 kg N + 54 kg P + 60 kg K
Field IV winter rye – 50 kg N + 54 kg P + 60 kg K
Field V maize – farmyard manure 15 t/ha+ 90 kg N + 90 kg P + 150 kg K
Field VI red clover

Unfortunately for the first 18 years liming was not used. Lime application (1 t/ha) became a regular treatment in 1980 and only under barley. On the adjoining fields of the Field Experimental Station at Lipki from the very beginning similar organic fertilization was applied as well as much higher mineral fertilization amounting even to 350 kg/ha under potatoes, 190 kg/ha under rye and systematic liming. Apart from that pesticides and herbicides were also regularly used.

Chemical properties of those soil were determined on the basis of composite samples and the samples taken from different horizons of 3 soil profiles. Analized soil samples of Agrometeorological Station were taken from 2 soil profiles and composite samples from 6 rotation fields. Chemical properties of the soil samples were determined by commonly used methods: humus content by the method of Tiurin, hydrolytic acidity (*Hh*) and sum of exchangeable bases by the Kappen method, available potassium and phosphorus by the method of Egner-Riehm, available magnesium by the Schachtschabel method and trace elements soluble in HCl at the concentration of 1 mol per litre by means of the atomic absorption spectrometer.

RESULTS

The results of chemical analysis of soil properties are presented in Tables 1 and 2. They show that after 25 years of the same crop rotation and fertilization the soils of the Lipki Agrometeorological Station have:

– humus content within 1%;

– strong acidity of Ap horizon, with pH KCl below 4.5;

– low degree of base saturation of the Ap horizon (average 60.1%);

– average content (mg/100 g of soil) of available potassium (10.5), phosphorus (8.6) and very low content of magnesium (1.7). The content of those elements in the soils of Experimental Station is 15.6–26.9 mg K, 12.2–12.4 mg P and 4.6–5.2 mg Mg in 100 g of soil;

– the amount of soluble zinc and manganese in HCl at the concentration of 1 mol per litre is greater (15.2 mg Zn per kg) than in the soil of Agricultural Experimental Station where it is 5.5–8.2 mg Zn per kg.

Such soil acidity of the Ap horizon of the Agrometeorological Station, low content of alkaline cations, low content of magnesium were caused by the lack of

TABLE 1. Some chemical properties of the compared soils located near the Miedwie Lake

Crop rotation fields, profile No	Depth of genetic horizon [cm]	Humus [%]	pH in		Content [me/100 g of soil]			Degree of base saturation [%]
			H_2O	KCl	*Hh*	*S*	*T*	
Agrometeorological Station Lipki								
Field I	0–20*	1.12	5.3	4.1	2.1	5.2	7.3	71.2
II	0–20*	1.07	5.5	4.2	3.1	4.1	7.2	56.2
III	0–20*	1.14	5.6	4.3	2.0	6.5	8.5	76.5
IV	0–20*	0.93	5.4	4.2	3.0	3.9	6.9	56.5
V	0–20*	1.05	5.9	4.6	2.8	3.5	6.3	55.5
VI	0–20*	0.95	5.1	4.1	3.3	2.9	6.2	46.8
Profiles 1 ,2	0–20*	0.91	5.3	4.1	3.4	4.6	8.0	57.5
Ap	0–27	0.90	5.3	4.1	3.4	5.3	8.7	60.9
BbrBv	27–40	0.29	6.5–6.7	5.3–5.4	1.2	8.1	9.3	87.1
C	40–65		6.9–7.0	5.9	0.8	7.6	8.4	90.5
C_2	65–95		6.9	5.9	0.9	10.1	11.0	91.8
C_3	95–150		6.9	5.6–6.0	0.7	8.4	9.1	92.3
Agricultural Experimental Station Lipki								
Profiles 3,4,5	0–20*	1.00	6.3–7.4	5.1–7.1	1.5	7.0	8.5	82.3
Ap	0–27	1.03	6.5–7.0	5.4–6.8	1.0	6.3	7.3	86.3
BbrBv	27–40	0.23	6.8–7.0	6.0–6.5	1.0	5.2	6.2	83.9
C	40–65		6.8–7.0	5.9–6.5	0.7	5.1	5.8	87.9
C_2	65–80		6.8–7.0	6.0–6.2	0.8	9.4	10.2	92.2
C_3	80–150		6.7–7.1	6.0–6.2	0.8	9.2	10.0	92.0

* – composite sample

TABLE 2. Available elements of the compared soil located near Miedwie Lake

Crop rotation fields, profile No	Depth of genetic horizon [cm]	Content of available elements [mg/100 g of soil]			Content of elements available in HCl** [mg/kg of soil]				
		K	P	Mg	Fe	Mn	Zn	Cu	Pb
Agrometeorological Station Lipki									
Field I	0–20*	14.7	9.8	2.2	1225	140	11.5	1.2	9
II	0–20*	8.2	8.2	1.6	1175	215	32.5	1.5	10
III	0–20*	14.7	10.6	3.3	1225	250	13.0	1.0	10
IV	0–20*	9.2	7.8	1.9	1100	170	9.2	1.0	8
V	0–20*	10.8	8.1	1.7	1175	200	15.5	1.0	9
VI	0–20*	10.8	8.5	1.7	1100	130	15.5	1.0	8
Profiles 1,2	0–20*	8.0	7.9	1.4	1225	200	11.0	1.0	8
Ap	0–27	7.4	7.8	1.7	1220	118	13.2	1.3	9
BbrBv	27–40	9.1	3.6	2.2	837	75	22.7	0.8	4
C	40–65	5.0	1.5	2.0	387	16	8.1	0.8	3
C_2	65–95	5.8	1.3	3.7	1975	43	6.1	1.0	8
C_3	95–150	4.0	1.5	5.0	1300	24	8.3	1.0	6
Agricultural Experimental Station Lipki									
Profiles 3,4,5	0–20*	15.6	12.2	5.2	1137	227	5.5	1.0	10
Ap	0–27	26.9	12.4	4.6	1162	240	8.2	0.7	10
BbrBv	27–40	13.9	5.5	3.7	900	89	3.8	0.6	4
C	40–65	8.2	1.6	3.8	662	35	2.4	0.5	3
C_2	65–80	7.6	1.7	1.9	750	42	3.8	0.7	4
C_3	80–150	7.2	2.2	5.5	1775	42	4.1	0.7	6

* – composite sample; ** at the concentration of 1 mol per litre

liming in 1960–1979 and too small doses of $CaCO_3$ and magnesium lime whose application started in 1980. Soil acidity as a result of mineral fertilization has been noted by many scientists [Czuba 1989; Niedźwiecki 1991; Urbanowski, Bilski 1988]. The applied low level of mineral fertilization on rotation fields of the Agrometeorological Station can be regarded as suitable and recommended for use on light soil [Koźmiński 1977]. It is proved on the basis of the high content of available potassium and phosphorus in soil, ranging from average to high, which was found after harvest and high content of zinc and manganese (Table 2) as well as obtained good yields of crops (Table 3).

In the years of studies the above mentioned same crop rotation and relatively low mineral fertilization resulted in 3.1 t/ha rye yield and 20.86 t/ha potato yield on Agrometeorological Station. At the same time on the adjoining fields of the Experimental Station at Lipki the obtained yields were lower (by 12.3% for rye and by 27.1% for potatoes) despite much higher mineral fertilization.

We can state that the obtained results confirm IUNG Puławy [Siuta, Pondel 1972] recommendations for the necessity of 180 kg NPK per ha fertilization on

TABLE 3. Comparison of rye and potatoes yields [t/ha] from the Agrometeorological Station with the yields from the Agricultural Experimental Station at Lipki near Stargard in 1961–1985

Plants	Yields			Standard deviation *Sd*	Variation coefficient [%]	Trend of yields
	average	highest	lowest			
			Agrometeorological Station			
Rye	3.10	4.50	2.20	0.6	19.4	$r_{xy} = 0.772^{**}$
Potatoes	20.86	32.60	14.60	4.7	22.5	$r_{xy} = 0.070$
			Agricultural Experimental Station			
Rye	2.76	3.70	2.00	0.6	21.7	$r_{xy} = 0.662^{**}$
Potatoes	16.41	30.00	7.90	5.0	30.5	$r_{xy} = 0.436^{*}$

the soil of the 5th good rye complex. Disregarding these recommendations brings about great loss of chemical elements from soil into watercourse which has been found in the Pomeranian soil by Borowiec, Skrzyczyński, Kucharska [1978] and Chudecki [1980], Chudecki i Duda [1971]. In this region leaching and runoff occur when precipitation is higher than 20 mm per day. Since April to October the number of such cases is on average 3.0 [Chudecki, Duda, Koźmiński 1971].

Agricultural practices that gave such good yields at Lipki Agrometeorological Station can be applied for cultivating fallows within the state farms of Szczecin region that are being privatized.

CONCLUSIONS

1. The obtained results show that proper rotation in soil-climatic conditions of Szczecin plain enables getting considerably high and steady yields on light soil even with the average fertilization 180 kg NPK per ha and no crop protection preparations, despite great changeability of precepitation and air temperature.

2. The applied rotation and fertilization supplemented with liming provide the soil with an average to high amount of nutrients limiting their loss by leaching which is very important in protective zones of potable water intakes.

REFERENCES

BOROWIEC S., SKRZYCZYŃSKI T., KUCHARSKA T., 1978: Migracja składników mineralnych z gleb Niziny Szczecińskiej. Szczec. Tow. Nauk Wydz. Nauk Przyr.-Rol.: 3–68.

CHUDECKI Z., 1980: Problemy wartości i ochrony potencjału produkcyjnego gleb zlewni rzeki Płoni w aspekcie zachowania czystości wód w jeziorze Miedwie. Mat. Sesji Nauk., Szczec. Tow. Nauk., AR Szczecin, Inst. Zoot. ZZT Kołbacz. Szczecin: 9–21.

CHUDECKI Z., DUDA L., KOŹMIŃSKI C., 1971 : Wpływ wielkości opadów atmosferycznych na zmianę uwilgotnienia gleby lekkiej na terenie RZD Lipki. *Zesz. Nauk. WSR Szczec.* 37: 47–68.

CHUDECKI Z., DUDA L., 1971: Annual losses of chemical components of the soil in the Płonia river basin. *Pol. J. Soil Sci.* vol. IV, 2: 145–154.
CZUBA R., 1989: Szkodliwe składniki w nawozach mineralnych i ich nagromadzanie się w glebie w warunkach intensywnego nawożenia. Krajowa Konf. Nauk.-Tech.:"Stan zagrożenia środowiska glebowo-wodnego przez agrochemikalia". SN-TliT Wrocław: 44–57.
DĄBROWSKI J, FILARY Z., MAJCHRZAK J., 1989: Wyniki badań pozostałości insektycydów i fungicydów w środowisku glebowo-wodnym. Krajowa Konf. Nauk.-Tech.: „Stan zagrożenia środowiska glebowo-wodnego przez agrochemikalia". SN-TliT Wrocław: 29–35.
KOŹMIŃSKI C., 1977: Plonowanie ziemniaków na Stacji Agrometeorologicznej RZD Lipki k/Stargardu w zależności od przebiegu warunków wilgotnościowych powietrza i gleby w latach 1962–1977. *Zesz. Nauk. AR Szczec.* 72: 119–134.
NIEDŹWIECKI E., KOĆMIT A., GREINERT H., ZABŁOCKI Z., 1977: Ogólna charakterystyka gleb brunatnych kwaśnych wytworzonych z piasków morenowych na przykładzie RZD Lipki k/Stargardu Szczecińskiego. *Zesz. Nauk. AR Szczec.* 64: 139–143.
NIEDŹWIECKI E., 1991: Physical and chemical properties of brown earths developed from boulder clay in Western Pomerania under arable farming, apple-tree orchard and deciduous forest, as effected by soil compaction. *Soil and Tillage Res.* 19: 237–244.
Państwowa Inspekcja Ochrony Środowiska, Wojewódzki Inspektorat Ochrony Środowiska. Informacja o stanie środowiska województwa szczecińskiego. Szczecin 1992: 2–57.
SIUTA J., PONDEL H., 1972: Ekologiczne podstawy intensyfikacji nawożenia. IUNG, Puławy.
URBANOWSKI S., BILSKI J., 1988: Wpływ wieloletniego nawożenia na odczyn i zawartość przyswajalnych makro- i mikroelementów w glebie. Cz. I. Odczyn gleby i zawartość fosforu, potasu i magnezu. *Zesz. Nauk. ATR Bydgoszcz,* 145-Rol. (24): 51–59.

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PRODUKCJA ROLNA NA GLEBACH LEKKICH W STREFIE OCHRONNEJ UJĘCIA WODY PITNEJ Z JEZIORA MIEDWIE DLA SZCZECINA

Katedra Gleboznawstwa i Katedra Agrometeorologii Akademii Rolniczej w Szczecinie

STRESZCZENIE

W pracy omówiono plonowanie na glebach lekkich brunatno-rdzawych, zaliczanych do piątego kompleksu przydatności rolniczej, oraz kształtowanie się ich właściwości w wyniku stosowania przez 25 lat stałego płodozmianu, niskiego poziomu nawożenia mineralnego i wyłączenia środków ochrony roślin. Doświaczenie prowadzono w Stacji Agrometeorologicznej w Lipkach. Uzyskane wyniki przedstawiono na tle właściwości i plonowania podobnych, sąsiadujących ze sobą gleb intensywnie użytkowanych w Rolniczym Zakładzie Doświadczalnym Lipki. Wyniki badań (tab. 1–3) dowodzą możliwości uzyskiwania stosunkowo wysokich plonów przy ograniczeniu chemizacji, w tym nawożenia mineralnego, co ma szczególne znaczenie m.in. w strefie ochronnej ujęcia wody pitnej z jeziora Miedwie.

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