ZESZYTY PROBLEMOWE POSTĘPÓW NAUK ROLNICZYCH 1994, z. 413, 251-254

CROP ROTATION, OVERHEAD IRRIGATION AND DIFFERENTIATED NITROGEN FERTILIZATION VERSUS pH OF LIGHT TEXTURED SOIL

E. Podstawka-Chmielewska

Department of Agricultural Ecology, University of Agriculture
Akademicka 13, 20-033 Lublin, Poland

A b s t r a c t. The present paper pertains to the changes of pH values of soil under plants cultivated in two crop rotations: market-oriented (1. sugar beet, 2. brewery barley, 3. edible potato, 4. winter wheat) and fodder (1. fodder beetroot, 2. fodder barley, 3. fodder potato, 4. winter triticale). The research was made on the basis of the experiment held in the years 1986-1989 on non-uniform podzolic soil laying on marl with grain-size distribution of light and heavy loamy sand. The influence of water conditions naturally differentiated and optimized through sprinkling, as well as of two levels of nitrogen fertilization: basic - amounting for respective pairs of plants in both crop rotations 90, 30 and 60, 75, 75 kg N/ha and doubled one, on yields of plants and changes of some physical and chemical properties of soil was compared. The soil reaction was determined potentiometricaly in 1 mol KCl dm^{-3} in two terms: early spring before starting the experiment and after harvesting. Soil samples were taken from the layers 0-25 and 25-50 cm.

The statistic analysis of the results showed that only sprinkling and season conditions had a significant influence on the soil acidity. The plant species tested did not modify the soil reaction. Nitrogen fertilization did not prove to change the acidity of the tested layers of soil and it did not interact with irrigation. This leads us to the conclusion that during sprinkling light textured soils one should take into consideration a certain acidification of soil which in case of sensitive plant's cultivation may lead to the decrease of yields if it will not be prevented through liming.

K e y w o r d s: crop rotation, overhead irrigation, nitrogen fertilization, pH of light soil

INTRODUCTION

Sprinkling and nitrogen fertilization, intensifying the plant production, may simultaneously cause the changes in soil environment. They concern, among others soil reaction which in our climate zone is modified mainly by predominance of percolating water over evapotranspiration which causes acidification. As we know it from literature, high doses of mineral fertilizers, including nitrogen ones, in general cause the acidification of soil [1,2,5,6]. However, the influence of sprinkling is not so univocal because, as some authors state [1,2,6], this measure may decrease the soil acidification. Buniak [2] explains it by introducing alkaline elements into soil with water used for irrigation.

The present paper aims at broadening and explaining these problems on the basis of the experiments carried out in the climatic conditions of Middle Lublin Region.

METHODS

The research was made on the basis of the experiment carried out in the years 1986-1989 in Bezek (Chełm voivodeship) on non-uniform podzolic soil laying on marl with grain-size distribution of light and heavy loamy sand. The soil is classified into a good rye complex.

The experiment was started on the permanent fields according to joined double model of split-block with split-plots in four repetitions. Its scheme comprised two crop rotations, i.e., market-oriented (merchandise)

one (1. sugar beet, 2. brewery barley, 3. edible potato, 4. winter wheat) and fodder one (1. fodder beetroot, 2. fodder barley, 3. fodder potato, 4. winter triticale); two water variants: W_0 - control (not sprinkled), W_1 - complementary sprinkling as well as nitrogen fertilization differentiated into two levels: N_1 and N_2. Nitrogen doses for the respective pairs of plants were in variant N_1 as follows: 90, 30, and 60, 75, 75 kg N/ha and in variant N_2 respectively: 180, 60 and 120, 150, 150 kg N/ha.

The plants were irrigated by a sprinkling machine with sprinklers of the medium rainfall intensity (about 12 mm/h). Water for sprinkling was taken from the pond. Single water doses were, depending on the plant from 25 mm (grain crops) to 30 mm (root crops). Season irrigation norms in comparison to natural rainfalls are presented in Table 1. The necessity of applying irrigation was determined on the basis of regional rainfall needs [4].

Table 1. The amount of natural rainfall and irrigation doses in the vegetation period

Years	Rainfall IV-IX mm	Irrigation doses in mm			
		Beet-roots	Barley	Potatoes	Winter grain crops
1986	345	170	90	110	-
1987	318	145	60	120	60
1988	366	165	60	135	75
1989	344	165	75	120	75

Nitrogen doses in variant N_1 were applied totally before sowing the plants, while in variant N_2 they were divided into two equal parts: the first was given before sowing the plants and the second as top dressing in the proper development phase for a given plant. Nitrochalk was applied before sowing and ammonium nitrate as a top-dressing. Phosphorus and potassium fertilization was determined every year on the basis of soil availability in these components which was tested each time after harvesting the forecrop plant. All the plants were cultivated according to the rules of proper agrotechnics.

To determine the influence of the factors tested on physical and chemical properties of soil, soil samples were taken from all the testing fields from two layers, i.e., 0-25 and 25-50 cm each year before starting the experiment and after harvesting the plants. In these samples soil reaction was determined, among others, potentiometricaly in 1 mol KCl dm^{-3} [3].

The obtained results were elaborated statistically with the analysis of variance.

RESULTS AND DISCUSSION

The statistic analysis showed that only sprinkling and season conditions had a significant influence on the acidity of soil (Table 2). In the conditions of the experiment sprinkling, irrespectively of other factors of the experiment, lowered pH on the average by 0.2.

It does not correspond neither with the results of Buniak [1,2] and Nazaruk [5] research, which prove diminishing of the soil acidity, especially in the surface layer as a result of irrigation nor with the results of the earlier research of the author [7], though on brown soil, which show the lack of influence of overhead irrigation on the pH of soil.

Similar differences as those caused by the effect of sprinkling were noted in the discussed experiment between extreme years which resulted not so much from the amount of rainfall but from its distribution and other not controlled factors (Table 2).

Double doses of nitrogen applied under respective plants of both crop rotations did not increase the acidity of the tested soil layers in a statistically proved level as compared with variant N_1. Nitrogen fertilization did not interact with irrigation similarly as in the earlier research of the author [7] on medium soil. It is interesting because in other experiments, carried out on light textured soils, the increasing fertilization increased soil acidity, although the negative effect of this factor was lessened by sprinkling [2]. In Nazaruk's [5] research a distinct soil acidification was noted only at doses over 360 kg N/ha, while in the discussed experiment the applied doses of this element were much smaller.

Both the term of performing the determination of the acidity and the soil layer did not

Table 2. Soil pH in relation to factors studied and seasonal conditions (mean values from two crop rotations)

Water variant	Soil layer (cm)		Nitrogen dose		pH determination term		Years				Mean
	0-25	25-50	N_1	N_2	Spring	Fall	1986	1987	1988	1989	
No irrigation	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Sprinkling	5.7	5.7	5.7	5.8	5.7	5.7	5.6	5.7	5.9	5.8	5.7
Mean	5.8	5.8	5.8	5.8	5.8	5.8	5.7	5.8	5.9	5.9	
$LSD_{P=0.05}$	Between water variants = 0.1; between years = 0.2										

Table 3. Soil pH under plants in two crop rotation systems in relation to the factors studied (mean for the years 1986-1989)

Plant species	Water variant		Nitrogen doses		Mean
	W_o	W_1	N_1	N_2	
			Market-oriented crop rotation		
Sugar beet	5.9	5.7	5.8	5.8	5.8
Brewery barley	6.0	5.9	6.0	6.0	6.0
Edible potato	5.9	5.7	5.8	5.8	5.8
Winter wheat	6.0	5.8	5.9	5.8	5.9
			Fodder crop rotation		
Fodder beetroot	5.9	5.6	5.7	5.8	5.8
Fodder barley	5.9	5.8	5.9	5.9	5.9
Fodder potato	5.8	5.6	5.7	5.8	5.7
Winter triticale	5.8	5.8	5.8	5.9	5.8

significantly influence the value of the pH of soil under the experiment, although in some works the increase in soil acidification level together with the increase of depth of taking the soil samples has been noted [1].

The compared crop rotation systems and the respective plants also did not significantly modify soil reaction in the present experiment (Table 3).

CONCLUSIONS

1. Only sprinkling and seasonal conditions had a significant effect on the pH of soil. Sprinkling the plants on light textured soils one may expect a certain soil acidification which, in case of cultivation of sensitive plants, may lead to the decrease of their yields if it will not be prevented by liming.

2. Nitrogen fertilization did not change the acidity of the tested soil layers and it did not interact with irrigation.

REFERENCES

1. **Buniak W.**: Wpływ nawadniania oraz zróżnicowanych dawek, form i stosunku N:P:K w nawozach mineralnych na przemieszczenie składników pokarmowych w glebie lekkiej. Zesz. Probl. Post. Nauk Roln., 199, 354-363, 1978.
2. **Buniak W.**: Wpływ nawadniania i nawożenia na skład jakościowy gleb i roślin. Zesz. Nauk. AR Wrocław (Rozprawy habilitacyjne), 89, 1990.
3. **Czuba R.**: Metody badań laboratoryjnych w Stacjach Chemiczno-Rolniczych. I. Badania gleb. Wrocław, 1969.
4. **Dzieżyc J., Nowak L., Panek K.**: Metoda sterowania deszczowaniem uwzględniająca potrzeby opadowe roślin uprawnych. Zesz. Probl. Post. Nauk Roln., 314, 137-148, 1987.
5. **Nazaruk M.**: Wpływ deszczowania i wzrastającego nawożenia na plonowanie pastwisk, wykorzystanie składników nawozowych i niektórych właściwości gleby lekkiej. Zesz. Probl. Post. Nauk Roln., 199, 450-458, 1978.
6. **Nowak L.**: Zmiany jakości plonu i zasobności gleby pod wpływem zróżnicowanego nawożenia i nawadniania buraków cukrowych, pszenicy i bobiku. Zesz. Probl. Post. Nauk Roln., 199, 343-353, 1978.
7. **Podstawka E.**: Studia nad deszczowaniem i nawożeniem mineralnym buraków cukrowych na rędzinie. III. Chemizm gleby. Ann. Univ. Mariae Curie-Skłodowska, 40(7), 67-76, 1985.

ZMIANOWANIE ROŚLIN, DESZCZOWANIE ORAZ ZRÓŻNICOWANE NAWOŻENIE AZOTOWE A pH GLEBY LEKKIEJ

Praca dotyczy zmian wielkości pH gleby pod roślinami uprawianymi w dwóch płodozmianach: towarowym (1. burak cukrowy, 2. jęczmień browarny, 3. ziemniak jadalny, 4. pszenica ozima) i pastewnym (1. burak pastewny, 2. jęczmień pastewny, 3. ziemniak pastewny, 4. pszenżyto ozime). Badania wykonano na podstawie doświadczenia przeprowadzonego w latach 1986-1989 na glebie bielicowej niecałkowitej na podłożu marglistym, o składzie granulometrycznym piasku gliniastego lekkiego i mocnego. Porównywano w nim wpływ warunków wodnych, zróżnicowanych na naturalne oraz optymalizowane drogą deszczowania a także 2 poziomów nawożenia azotowego - podstawowego, wynoszącego dla kolejnych par roślin obu płodozmianów 90, 30 i 60, 75, 75 kg N/ha i dwukrotnie zwiększonego na plonowanie roślin oraz niektórych fizycznych i chemicznych właściwości gleby. Odczyn oznaczano potencjometrycznie w 1 mol KCl dm^{-3} w dwóch terminach: wczesną wiosną przed założeniem doświadczenia i po zbiorze roślin. Próbki glebowe pobierano z warstw 0-25 i 25-50 cm.

Analiza statystyczna wyników wykazała, iż istotny wpływ na kwasowość gleby wywierało jedynie deszczowanie i warunki sezonowe. Badane gatunki roślin nie modyfikowały odczynu gleby. Nawożenie azotowe nie zmieniało w sposób udowodniony kwasowości badanych warstw gleby, nie wchodziło też w interakcję z nawadnianiem. Doprowadza to do wniosku, że deszczując rośliny na glebach lżejszych należy się liczyć z pewnym zakwaszeniem gleby, co w przypadku uprawy wrażliwych gatunków może prowadzić do obniżki ich plonów, jeśli się temu nie zapobiegnie poprzez wapnowanie.

S ł o w a k l u c z o w e: zmianowanie roślin, deszczowanie, nawożenie N, pH gleby lekkiej.