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EFFECT OF FERTILIZING WITH NITROGEN AND POTASSIUM ON CHANGES IN CHEMICAL SOIL PROPERTIES

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A b s t r a c t. In the years 1987-1991 a field experiment on brown acid soil was carried out. Two grass species were involved in the study (*Dactylis glomerata* and *Bromus unioloides*). Each year they were fertilized with progressive doses of potassium and nitrogen. After three and five years of cultivation, samples of soil were collected and were determined: a reaction (pH in 1 mol KCl), available aluminium content (Al^{+3}), hydrolytic acidity (Hh), sum of available bases (S) and degree of saturation of soil with the bases (V).

With growth of nitrogen dose increased soil acidity and available aluminium content as well hydrolytic acidity but the sum of available bases and the degree of saturation with the bases decreased. Fertilization with potassium in a double dose caused especially unfavourable changes in chemical composition at cultivation of brome grass.

K e y w o r d s: fertilizing with N, feertilizing with K, chemical soil properties

INTRODUCTION

Many years' mineral fertilization is a factor modifying physical and chemical properties of light soil [2-5], what as a consequence brings about decline in share of basic cations and growth of hydrogen content in a sorption complex. Ion balance is being shaken, what may cause unfavourable changes in soil environment.

The studies aimed at defining the effect of three and five years' mineral fertilization on some chemical properties of light soil.

MATERIALS AND METHODS

In the years 1987-1991 a field experiment on *Dactylis glomerata* and *Bromus unioloides* on light acid brown soil derived from light clayey sand was carried out, in the Agricultural Experimental Station Lipki. The experiment was established by the method of random subblocks in four repetitions. The objects for the first factor were 6 levels of fertilizing with nitrogen: 0, 60, 120, 180, 240, and 300 kg N ha^{-1} and for the second factor - levels of fertilizing with potassium: 0, 100, and 200 kg K ha^{-1}. The doses of nitrogen (ammonium nitrate 34 %) and of potassium (potassium salt 60 %) were divided into 3 parts and yearly sowed before starting vegetation, after first and second cuts. Phosphorus (single granulated superphosphate 19 %) was applied once in the amount of 53 kg P ha^{-1} before starting the vegetation of grass. Before starting the experiment, in autumn 1986, there were collected soil samples from the ploughing layer of whole experimental area and designated some chemical properties of soil (Table 1).

After 3 years (1989) and after 5 years (1991) of cultivation of grasses, were collected new average samples from each fertilization object. In the samples were determined pH in 1 mol KCl, hydrolytic acidity (Hh), available aluminium (Al^{3+}) and the sum of available bases (S).

RESULTS AND DISCUSSION

Changes of some soil properties in relation to different fertilizing with nitrogen and potassium after three and five years of cultivation of

Table 1. Some chemical soil properties before starting the experiment

Layer cm	pHKCl	Hh	S	Al
		(mmol(+)/100 g soil)		(mg/100 g soil)
0 - 20	5.1	1.25	2.12	0.44

Dactylis glomerata and *Bromus unioloides* were presented in the Tables 2, 3 and 4.

After three years of cultivating the grasses appeared the highest acidity effect of fertilizing with nitrogen, in the series without potassium, while applying 300 kg N/ha (Table 2). However, at the doses of 100 and 200 kg K/ha, at cultivation of orchard grass, more considerable decline in pH occurred in the variants, where 240 and 300 kg N/ha were applied and at cultivation of brome grass pH value decreased yet at the dose of 180 kg N/ha.

Soil acidity after five years increased. Decrease in pH value occurred at the dose of 180 kg N/ha for orchard grass and at 120 kg N/ha for brome grass.

Fertilizing with potassium influenced more the decline in soil reaction at cultivation of brome grass than orchard grass. Negative effect on soil reaction caused by mineral fertilization, especially with nitrogen, is a well known phenomenon [1,2,7]. Additional factor which increases acidity, as states Hagnes [5] the mere grasses may be.

With the acidity of soil is connected growth of available aluminium content. Although one should mention that dynamics of the element content depends on many other elements [7].

In the studies being described one can see clearly the relationship between growth of available aluminium in soil with increasing of nitrogen doses (Tables 3 and 4). Effect of fertilizing with potassium on available aluminium especially considerable occurred while cultivating brome grass, where was noted the growth higher than by twice at 200 kg K/ha comparing to the dose of 100 kg K/ha.

The hydrolytic acidity value (Hh) in soil, likely as available aluminium content, increases with higher doses of nitrogen, achieving the greatest values in the both experimental periods at 300 kg N/ha. Fertilizing with potassium, while cultivating brome grass, caused systematically increase in pH value, however, while cultivating orchard grass occurred decline in Hh value at double doses of potassium. More considerable effect of change in Al^{3+} content and in Hh in the case of cultivation of brome grass is connected with greater change of soil reaction under grass.

Sum of available bases (S) in soil after three years' cultivation of grass decreased with higher doses of nitrogen, achieving similar values at both cultivated grasses. However, average sum of bases was higher while cultivating orchard grass. Fertilizing with potassium applied in double dose, influenced decrease of available bases sum in the first term of determinations made for both grasses, but in the second term, only for brome grass.

Grade of saturation of soil with bases decreased with progressively growing doses of nitrogen. After three years of cultivation of the grasses, the difference in saturation of soil with bases amounted to 10 % to disadvantage of orchard grass. However, at the end of experimental period, higher saturation with bases was in soil under orchard grass, what was related to greater value of sum of available bases

Table 2. Soil reaction values (pH in mol KCl dm^{-3}) after three and five years of cultivation of *Dactylis glomerata* and *Bromus unioloides*

Doses (kg ha^{-1})	K - 0		K - 100		K - 200	
	1989*	1991*	1989	1991	1989	1991
	Dactylis glomerata					
N - 0	5.2	5.1	4.9	4.7	4.8	5.2
N - 60	5.2	5.0	4.8	4.7	4.7	4.9
N - 120	4.8	5.2	4.8	4.9	5.1	5.0
N - 180	5.1	4.4	5.1	4.4	5.0	4.7
N - 240	4.9	4.3	4.5	3.7	4.6	4.3
N - 300	3.9	3.9	4.0	4.0	4.0	3.8
	Bromus unioloides					
N - 0	5.1	4.8	4.9	4.9	4.6	4.7
N - 60	4.9	4.8	4.9	5.1	4.5	4.7
N - 120	4.8	4.8	4.8	4.5	4.7	4.3
N - 180	4.8	4.6	4.4	4.6	4.3	3.9
N - 240	5.1	4.4	4.4	4.2	3.9	3.8
N - 300	3.8	3.9	4.2	4.0	3.7	3.6

1989* - after three years; 1991* - after five years.

Table 3. Some chemical soil properties after three and five years of cultivation of *Dactylis glomerata*

Doses (kg ha^{-1})	Al^{3+} (mg/100 g soil)		Hh (mmol(+)/100 g soil)		S (mmol(+)/100 g soil)		V (%)	
	1989*	1991*	1989	1991	1989	1991	1989	1991
				Subject to fertilizing with nitrogen				
N - 0	0.82	0.33	2.55	2.49	1.59	2.24	38.4	47.4
N - 60	2.14	0.30	2.45	2.79	1.62	2.15	39.8	43.5
N - 120	2.33	0.32	2.64	3.02	1.30	2.43	33.0	44.6
N - 180	2.97	1.12	2.99	3.58	1.85	1.95	38.2	35.3
N - 240	2.12	2.87	3.17	4.20	1.62	1.82	33.8	30.2
N - 300	3.17	4.95	4.24	4.44	0.95	1.49	18.3	25.1
				Subject to fertilizing with potassium				
K - 0	2.26	1.55	2.93	3.10	1.57	2.00	34.9	39.2
K - 100	2.12	1.94	3.20	3.69	1.60	1.91	33.3	34.1
K - 200	2.40	1.45	2.89	3.47	1.29	2.13	30.9	38.0
Means	2.26	1.64	3.01	3.42	1.49	2.01	33.0	37.1

1989* and 1991* - designations as in the Table 2.

Table 4. Some chemical soil properties after three and five years of cultivation of *Bromus unioloides*

Doses (kg ha^{-1})	Al^{3+} (mg/100 g soil)		Hh (mmol(+)/100 g soil)		S (mmol(+)/100 g soil)		V (%)	
	1989*	1991*	1989	1991	1989	1991	1989	1991
				Subject to fertilizing with nitrogen				
N - 0	0.93	0.39	1.55	2.89	1.47	1.95	48.7	40.2
N - 60	1.10	0.45	1.58	2.94	1.52	2.04	49.0	40.2
N - 120	1.14	1.47	1.64	3.23	1.50	1.48	47.8	31.4
N - 180	1.86	2.16	1.89	3.61	1.55	1.56	45.1	30.1
N - 240	2.39	3.36	2.17	3.71	1.37	1.31	38.7	26.1
N - 300	4.88	5.99	2.68	4.83	1.15	1.14	30.0	19.1
				Subject to fertilizing with potassium				
K - 0	1.68	2.05	1.49	3.07	1.44	1.51	49.1	32.9
K - 100	1.34	1.52	1.87	3.65	1.66	1.90	47.0	34.2
K - 200	3.12	3.34	2.40	3.90	1.18	1.33	32.9	25.4
Means	2.05	2.30	1.92	3.54	1.43	1.58	43.0	30.8

1989* and 1991* - designations as in the Table 2.

at almost equal value of hydrolytic acidity for the both grasses.

CONCLUSIONS

1. The direction of changes in contents of studied elements depended on level of fertilizing with nitrogen.

2. With growth of nitrogen doses a decline in value of pH, sum of available bases, grade of saturation with available bases and growth of available aluminium content, and hydrolytic acidity were stated.

3. Decline in pH value and growth of aluminium concentration at higher doses of nitrogen grew with years.

4. Fertilizing with potassium, especially in a double dose, caused more unfavourable changes in chemical composition of soil at cultivation of brome grass than orchard grass.

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WPŁYW NAWOŻENIA AZOTEM I POTASEM NA ZMIANY WŁAŚCIWOŚCI CHEMICZNYCH GLEBY

W latach 1987-1991 przeprowadzono doświadczenie polowe na glebie brunatnej kwaśnej z dwoma gatunkami traw (*Dactylis glomerata* i *Bromus unioloides*). Corocznie trawy nawożono wzrastającymi dawkami azotu i potasu. Po trzech i pięciu latach uprawy pobrano próby gleby i oznaczono w nich odczyn (pH w 1 mol KCL), zawartość glinu wymiennego (Al^{3+}), kwasowość hydrolityczną (Hh), sumę zasad wymiennych (S) oraz obliczono stopień nasycenia gleby zasadami (V).

W miarę wzrostu nawożenia azotem następowało zakwaszenie gleby, wzrastała zawartość glinu wymiennego i wartość kwasowości hydrolitycznej, obniżała się suma zasad wymiennych oraz stopień wysycenia gleby zasadami.

Nawożenie potasem stosowane w dawce podwójnej, powodowało szczególnie niekorzystne zmiany w składzie chemicznym gleby przy uprawie stoklosy obiedkowatej.

S ł o w a k l u c z o w e: nawożenie N, nawożenie K, chemiczne właściwości gleb.