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THE EFFECT OF FERTILIZING WITH SLURRY AND MINERAL FERTILIZERS ON THE CHANGES IN AVAILABLE NUTRIENTS CONTENT IN SOIL

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A b s t r a c t. In the present work the results of the research pertaining to long-term fertilizing of a pasture with various doses of mineral fertilizers and slurry and its effect on changes in soil pH, as well as the content of humus and available nutrients were given. The obtained results indicate the influence of high doses of slurry on the increase of soil pH as well as humus and available nutrients contents. On the other hand the increasing mineral fertilizing caused the lowering of soil pH and Mg and K content. Whithin the period of the study on the after-effect of fertilizing the lowering of the pH of soil and the determined nutrient content was noted.

K e y w o r d s: pasture fertilizaton, NPK, slurry, soil pH, available nutrients

INTRODUCTION

Slurry is one of the most frequently applied organic fertilizers. Its effect is often compared to the effect of mineral fertilizers. At long term applying of high doses of NPK and slurry, great changes in soil environment may occur. However, the problem of after-effect of slurry on the changes of chemical properties of soil is little known.

The aim of the present paper was to determine the effect of high doses of mineral fertilizers and slurry on some physical and chemical properties forming the fertility of soil.

MATERIALS

The pasture experiment was made with the method of randomized blocks in four repetitions, on brown soil formed from silt on boulder clay. The area of testing fields was 20 m^2. In 1977 the pasture owned by WOPR in Końsko-wola was brought into cultivation with the method of full cultivation and sown with mixed pasture grass with papilionaceous. In the years 1978-1981, three levels of mineral fertilizing were applied: 1. N - 150, P - 39, K - 125; 2. N - 300, P - 78, K - 174; 3. N - 450, P - 78, K - 174 kg/ha and five levels of cattle dense slurry fertilizing (>8 % d.m.): 4. 450 m^3+N - 125, P - 26; 5. 50 m^3, 6. 100 m^3, 7. 150 m^3, 8. 200 m^3/ha. The first level of NPK corresponded in the respect of nitrogen to the dose of 50 m^3 of slurry. The pasture, after taking the samples and yielding evaluation, was pastured 4 to 5 times within a year. Mineral nitrogen was applied in the form of urea in various doses under each outgrowth. Potassium was sown as 47 % potassium salt in two different doses: before starting the vegetation and after the third outgrowth. The outflow of slurry was made in the terms: 0.5 of the dose in spring: 0.2 of the dose after the second and 0.3 of the dose after the fourth outgrowth. Slurry contained on the average N - 0.36, P - 0.05, K - 0.33, Ca - 0.09, Mg - 0.05 % at pH - 7.3.

Because of the shallow root system of the grass and forming dense turf in the surface layer of soil, samples were taken from the deeper layer 5 to 30 cm in the following terms:

- before starting the experiment (autumn 1976),
- after completing the five-year cycle of ferti-

lizing (autumn 1981),
- after finishing the research of the above mentioned-sequent fertilizing (autumn 1984).

In the soil samples the following were determined: pH in 1 mol KCl/dm^3, the humus content with Tiurin's method, available phosphorus and potassium with Egner-Riehm's method available magnesium with Schachtsabel's method and easily hydrolyzing nitrogen with Cornfield's method.

The results were worked out statistically with the analysis of variance for double cross classification.

RESULTS

On the basis of pH (Fig. 1) in 1976 it was determined that the soil had acid reaction - pH was 5.2. After four years of fertilizing the lowering of pH was noted by 0.1 to 0.9 units in object fertilized with NPK, which was inversely proportional to the doses of these fertilizers. However, in soil fertilized with slurry in doses 50 m^3 and 50 m^3+NP the soil reaction was unchanged in comparison to pH before starting the experiment.

The objects fertilized with slurry in the amounts of 100-200 m^3/ha showed slight increase of pH, which amounted from 0.2 to 0.4 units in comparison to the pH of samples from 1976. From the testing of soil pH three years after stopping fertilizing it results that soil pH in all objects fertilized both with mineral fertilizers and slurry lowered in comparison to the pH in these objects in 1981. In the objects with slurry the lowering of pH was larger than in the objects with mineral fertilizers.

Pasture soil before starting the experiment contained 1.3 % of humus (Fig. 2). After four years of applying mineral fertilizers and low doses of slurry this amount stayed on the un-

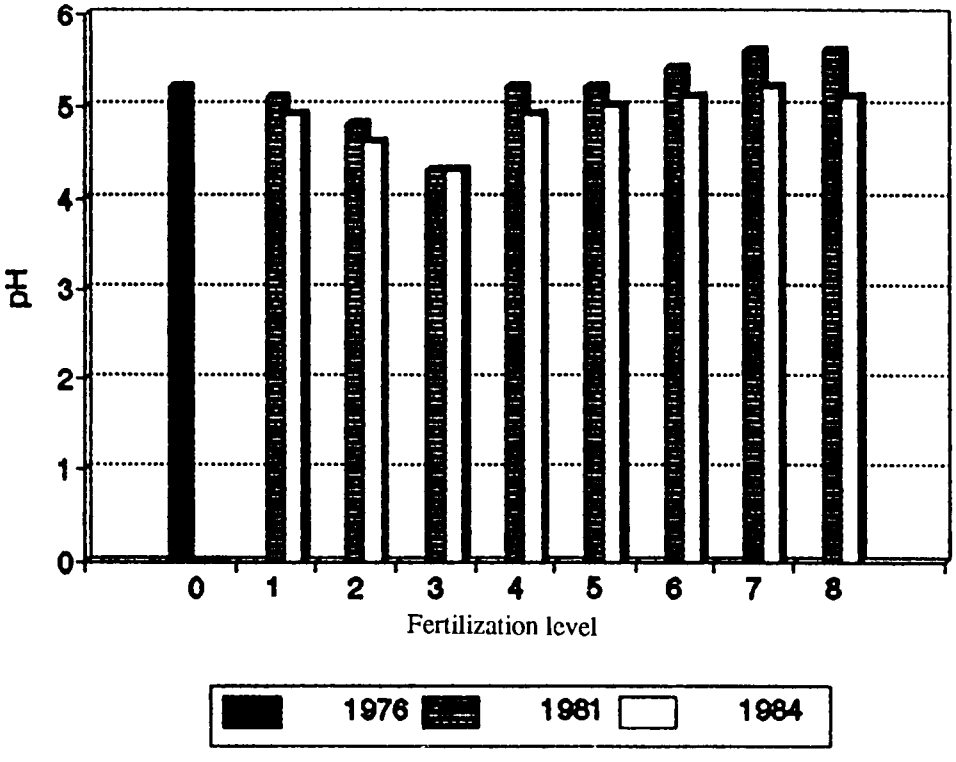

Fig. 1. Effect of various fertilization on soil pH. LSD (p=0.05): fertilization 0.2; years 0.1; fertilization x year 0.3. Mineral fertilization: 1- N-150, P-39, K-125; 2- N-300, P-78, K-174; 3 - N-450, P-78, K-174 kg/ha; cattle slurry fertiliziation: 4 - 450 m^3+N-125, P-26; 5 - 50 m^3, 6 - 100 m^3, 7 - 150 m^3, 8 - 200 m^3/ha.

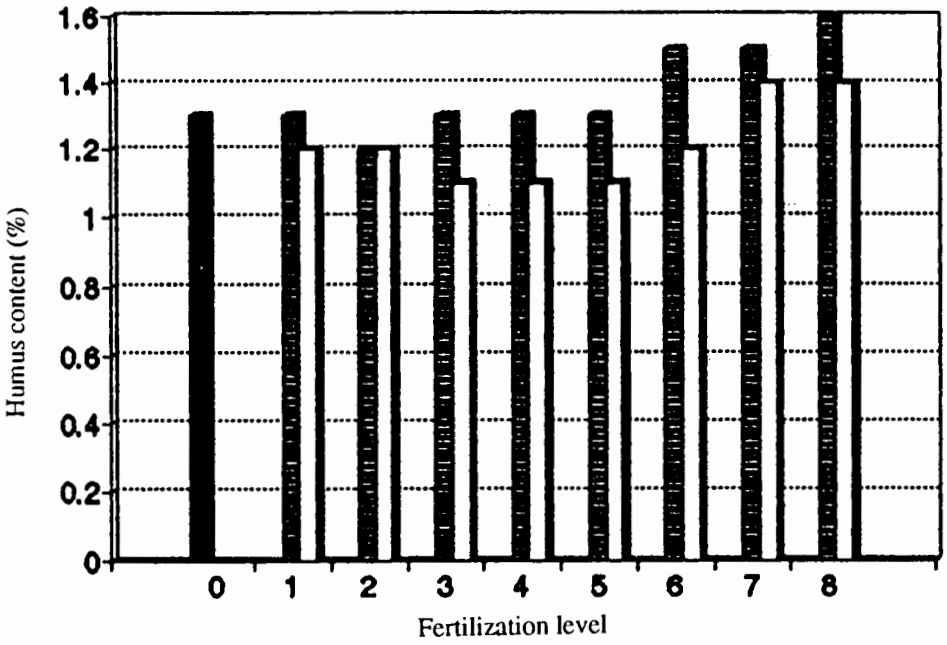

Fig. 2. Humus content in soil under NPK and slurry fertilization. LSD (p=0.05): fertilization 0.2; years 0.1; fertilization x year n.i. For explanation see Fig. 1.

changed level. However, doses of slurry from 100-200 m^3/ha caused the increase of its content in soil in 1976. After three years of sequent effect of the applied fertilizers in the objects fertilized with NPK and low doses of slurry a significant decline of humus content occurred in comparison to preceding years and in objects with slurry doses of 150 and 200 m^3/ha a bit larger humus content in soil occurred in comparison to the initial year and a bit lower in the last year of fertilizing.

Figure 3 shows the data pertaining to available phosphorus content in soil. It had a medium content of phosphorus before starting the experiment. In 1981 a significantly lower available phosphorus content was noted in the soil from objects with the lowest dosage of NPK. The doubling of the phosphorus dosage in the second and third objects gave a significant increase in its content in comparison to the first object. The objects fertilized with slurry+NP had a slightly lower phosphorus content than the objects with double mineral phosphorus dosage. However, the object with 50 m^3 dose of slurry can be compared in the respect of this component content to the object with the lowest dosage of mineral fertilizers. In the objects fertilized with 100-200 m^3 doses of slurry, a proportional though not large increase in phosphorus content was noted, as compared to the doses of mineral fertilizers which contained a double phosphorus dose (78 kg P/ha).

After three years of using the pasture without fertilizing a significant decrease of available phosphorus content was noted in soil. However, phosphorus content remained almost unchanged as compared to the year 1981 in objects with the lowest dose of NPK and slurry.

The soil in which the experiment was performed was considered one with low potassium content (Fig. 4). After four years of the applied fertilizing only soil fertilized with slurry in doses 150-200 m^3/ha had high and very high potassium content. However, in soil fertilized with mineral fertilizers and lower doses of slurry the decrease in potassium content was noted and these objects can be numbered among those with very low content of this component. After

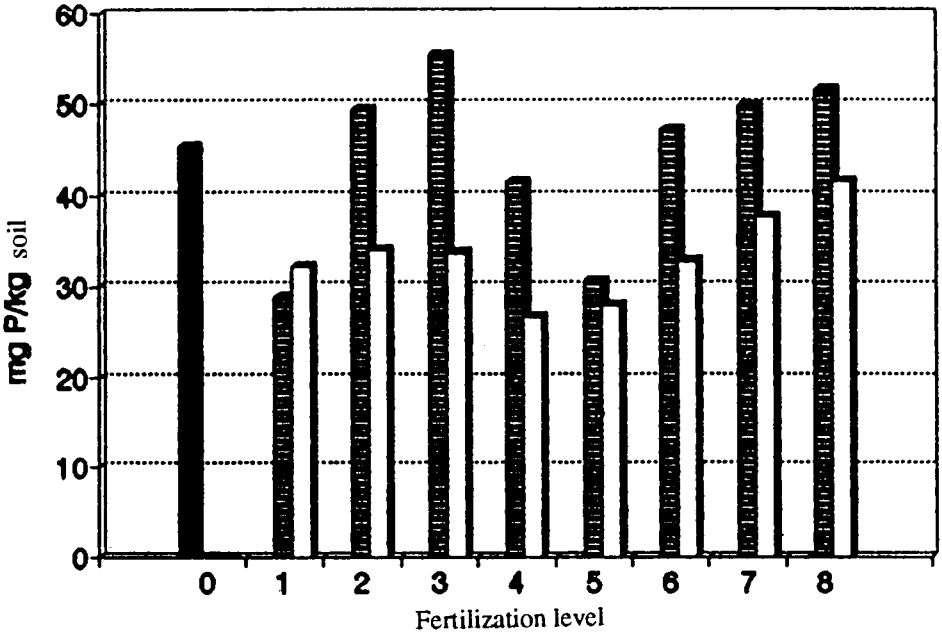

Fig. 3. The content of available phosphorus in soil under NPK and slurry fertilization. LSD (p=0.05): fertilization 10.3; years 3.0; fertilization x year 16.6. For explanation see Fig. 1.

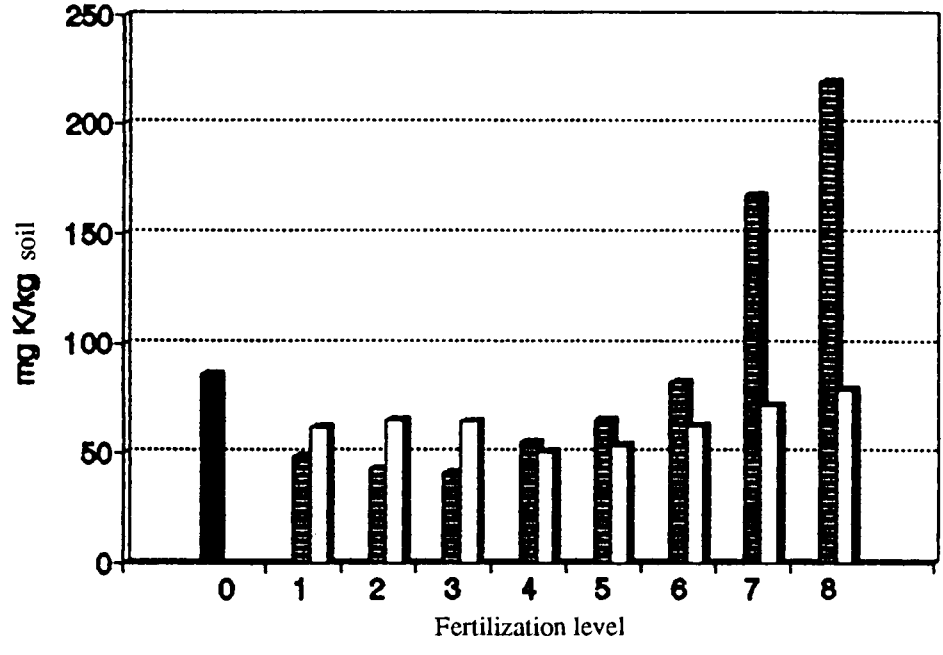

Fig. 4. The content of availbale potassium in soil under NPK and slurry fertilization. LSD (p=0.05): fertilization 7.5; years 2.2; fertilization x year 12.1. For explanation see Fig. 1.

three years from finished fertilizing in the objects with NPK, a significant increase in potassium content as compared to the previous period proceded, however, this component content in these objects was lower than in the initial year. Potassium content stayed on slightly changed level in the objects with the doses of 50 m^3 of slurry and 50 m^3 of slurry+NP. The objects fertilized with higher doses of slurry had a significantly lower potassium content than in the previous period.

Available magnesium content in soil in the year 1976 amounted to 60 mg Mg/kg of soil (Fig. 5) and it was the soil quality class with medium content of this component. After four years of applying NPK doses, the lowering of magnesium content was noted as compared to the year 1976. Low doses of slurry caused a slight increase magnesium content in soil and higher doses caused the further increase of this element content in soil. After three years of after-effect of the applied fertilizers the magnesium content decreased and in all objects was similar independently of the kind of fertilizers and their doses. The greatest decrease in magnesium content as compared to the previous period occurred in the objects with slurry.

Easily hydrolyzing nitrogen can be a form considered a potential source of nitrogen available for plants. The content of this form of nitrogen in soil before starting the experiment amounted to 75 mg N/kg of soil (Fig. 6). After a four-year long mineral and organic fertilizing, nitrogen content in soil was similar to that in the initial year, with the exception of the object with the dose N_{450} P_{78} K_{174}, where higher concentration of this nitrogen form was noted. After three years of the pasture utilizing without fertilizing, a significant decrease in easily hydrolyzing nitrogen content proceded as compared to the years 1976 and 1981. Nitrogen content in all the objects was similar and did not depend either on kinds or the doses of the applied fertilizers.

DISCUSSION

On the basis of the results of the research it was stated that the changes in pH, humus and available nutrient contents in soil were signifi-

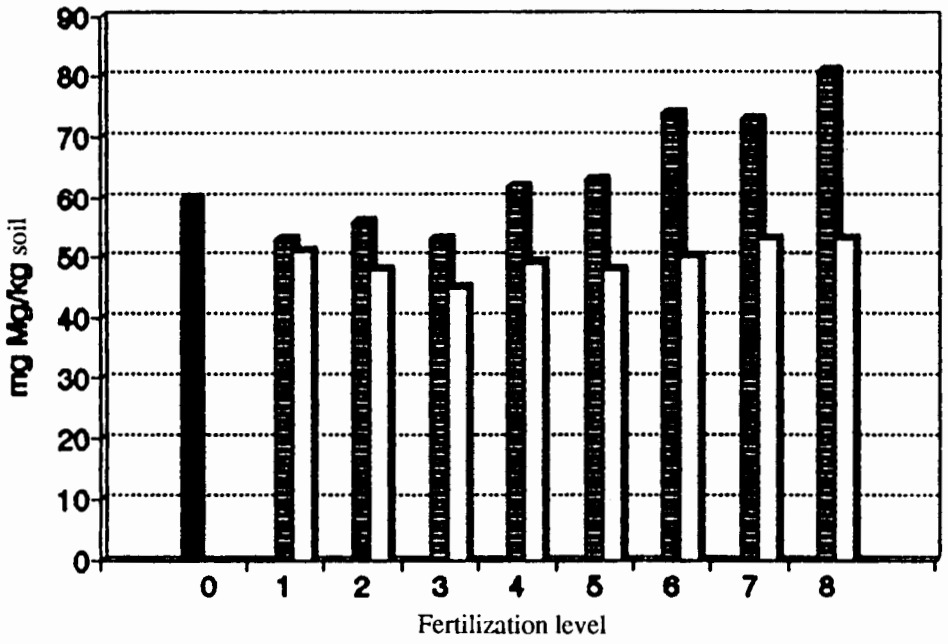

Fig. 5. The content of availbale magnesium in soil under NPK and slurry fertilization. LSD (p=0.05): fertilization 18.9; years 5.5; fertilization x year 30.4. For explanation see Fig. 1.

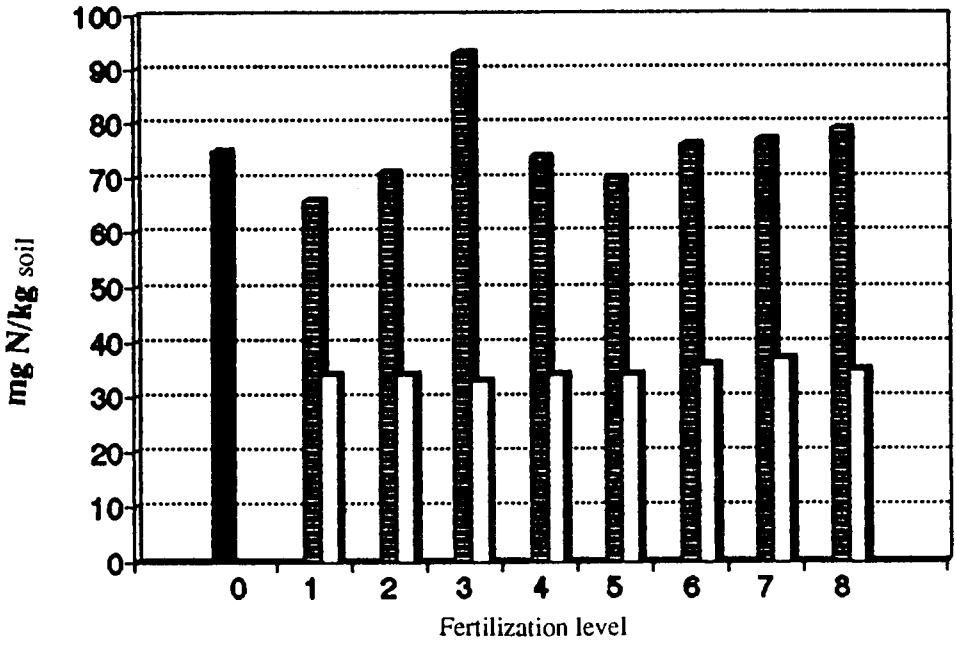

Fig. 6. The content of easily hydrolyzable nitrogen in soil under NPK and slurry fertilization. LSD (p=0.05): fertilization 18.9; years 5.5; fertilization x year 30.4. For explanation see Fig. 1.

cantly influenced by the kind and doses of the applied fertilizers as well as by the periods in which the samples were taken.

Mineral fertilizing together with the increase of its doses significantly decreased the pH of soil. Similar dependence was noted by Dembek and Łyszczarz [3] and Koc [9].

However, positive influence of slurry especially of its high doses, on the increase of soil pH should be stressed which is confirmed by the research of other authors [3-5,14]. On the other hand, Borowiec [1] states that slurry acidifies soil in spite of its usually neutral reaction.

After four years of applied fertilizing the soil fertilized with high doses of slurry contained more humus than the soil fertilized with mineral fertilizers. Similar results are testified by other authors [1,9,10,12,17,18]. However, low doses of slurry and mineral fertilizers caused the decrease in humus content or maintained it on the same level. Such results are described also by other authors [6,15].

A significant increase in phosphorus and easily hydrolyzing nitrogen content in soil proceded only under the influence of the highest dose of NPK, while the highest doses of slurry caused the increase of phosphorus, potassium and magnesium contents. Mineral fertilizing caused the decrease in potassium and magnesium contents in soil and, in case of its low doses, also of phosphorus content. Very similar results were obtained by Jarecki and Meller [7] and Koc [9].

The research did not prove positive effect of slurry and smaller doses of mineral fertilizers on easily hydrolyzing nitrogen content in soil. The research of Goerlitz [6] and Koriath [11] also prove the lack of dependence between fertilizing with slurry and nitrogen content in soil. However, Dechnik *et al.* [2] stress the increase of this nitrogen form content in case of fertilizing with slurry in doses 100-200 m^3/ha.

The influence of after-effect of slurry and mineral fertilizing on the changes of soil pH and humus content as well as the available nutrient content was controversial. We can presume that the positive sequent effect of the applied fertilizers on the changes of chemical properties of

soil might occur only in the first year. However, in the third year after finishing fertilizing a significant decrease in the soil pH proceded and also a significant decrease in humus and available nutrients content occurred. Most probably pasture grass growth in the third year to a great extent utilized the soil reserve of available nutrients, which is testified by the results of potassium, phosphorus and nitrogen contents in soil. Weak sequent effect of slurry on the available nutrient content in soil was earlier noted by Käding and Krell [8] and Kuszelewski [13]. However, Schönmeier *et al.* [16] noted strong sequent effect of slurry on the available nutrients content in soil, but only up to the second year.

Our research prove that slurry and mineral fertilizers even applied in high doses do not have a long-term effect on the soil availability and do not keep constant soil pH. In case of the intensive utilizing of pasture (4-5 outgrowths) one cannot speak of long sequent effect of applied fertilizers.

CONCLUSIONS

1. Slurry has different effect on soil than mineral fertilizers. Especially it holds to its more positive effect on forming soil pH and organic matter contents.

2. High doses of slurry cause the increase of pH and humus compounds as well as the content of available potassium and magnesium, and even phosphorus forms.

3. High mineral NPK fertilizing decreases the soil pH value, humus content, the content of available potassium and magnesium forms.

4. After three years of sequent effect of mineral fertilizers and slurry the decrease in the pH of soil and humus content was noted, as well as the decrease in the soil fertility in potassium, magnesium and easily hydrolyzing nitrogen.

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ZMIANY ODCZYNU GLEBY I ZAWARTOŚCI W NIEJ PRZYSWAJALNYCH SKŁADNIKÓW POKARMOWYCH POD WPŁYWEM NAWOŻENIA NAWOZAMI MINERALNYMI I GNOJOWICĄ

W pracy podano wyniki badań dotyczące wieloletniego nawożenia pastwiska różnymi dawkami nawozów mineralnych i gnojowicy oraz ich następczego wpływu na zmiany pH gleby, zawartości w niej próchnicy i przyswajalnych składników pokarmowych. Uzyskane wyniki wskazują na wpływ wysokich dawek gnojowicy na wzrost pH gleby i zawartość próchnicy oraz składników przyswajalnych. Natomiast wzrastające nawożenie mineralne wpływało na obniżenie pH gleby oraz zawartości Mg i K. W okresie badań działania następczego nawożenia obserwowano obniżenie pH gleby i zawartości oznaczanych składników.

S ł o w a k l u c z o w e: nawożenie pastwisk, NPK, gnojowica, odczyn gleby, zawartość przyswajanych składników.