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# REACTION AND SORPTION PROPERTY CHANGES OF LIGHT SOIL AT SLURRY FERTILIZATION

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A b s t r a c t. In the field experiment on very light, acid soil pig slurry was applied of in doses with 60-300 kg N/ha under each plant. The slurry effect was compared with mineral fertilization of 60 and 120 kg N/ha. After 4, 8 and 12 years there were taken soil samples and determined: reaction, hydrolytic acidity, exchange cations, aluminium content, available iron and manganese content.

There was showed that applied slurry influenced on systematic increase of the soil acidity. The acidity effect of slurry was in the both studied soil layers, i.e., arable and subarable layer. However, there was slower and smaller extent of slurry acidity effect than mineral fertilization. With increase in hydrogen ion content in soil, there were moving of calcium and magnesium ions into soil depth. The slurry applied with these compounds influenced on their lower decrease in the soil sorption complex. In the case of calcium, there was observed higher content of its exchange forms in the deeper soil layer. The slurry fertilization increased the soil sorption complex, but with high increase in hydrolytic acidity the degree of base saturation, systematically decreased. The slurry application did not stop this process, but in this soil the base saturation degree was higher than in the soil after mineral fertilization.

In the studied soil increased of exchange aluminium content at slurry treatments, but it was strongly lower than at mineral fertilization. There was increased of available iron and manganese in soil in the higher amounts as it was slurry as effect of theirs moving from reserve of acid soil.

K e y w o r d s: soil reactioon, light soil, slurry fertilization

## INTRODUCTION

The slurry, it is a fertilizer with various effect on soil. It change physical, chemical and biological soil properties [1-3,5-9]. The slurry effect on soil properties it is an effect of the many processes with contrary influences, such as: organic matter mineralization, ammonium cation sorption, nitrification, exchange of alkali cations, salinity. One from the essential soil feature changed as slurry effect is soil solution composition and cations sorbed by the soil sorption complex [1,3,5-9]. In many experiments different slurry effects on soil were state with the contrary authors opinion. The cause of different effects, probably is great differentiation of slurry chemical composition and change of agroecological conditions of slurry treatment. The especially susceptible on the property change are light soils with low sorption complex.

The purpose of this paper was to determine the effect of many years slurry fertilization on changes of sorption complex saturation and light soil acidity.

## MATERIALS

The field experiment was conducted in 1978 on very light, brown acid soil with low content of humus, very high soil fertility in available phosphorus, medium content of available potassium and low content of magnesium. The soil was classified as the weak rye complex. There were cultivated: potatoes in 1979, 1983 and 1986, spring oat in 1980, 1984 and 1987, winter rye for green fodder in

1980/81 and 1987/88, corn for silage in 1978 and 1988 and winter rye for grain in 1981/82, 1984/85 and 1988/89. After winter rye cut for green fodder in 1981 the sunflower was sown which was ploughed then. The pig slurry was applied under each plant before sowing in doses containing 60, 120, 180, 240 and 300 kg N/ha. As compared with slurry there were applied mineral fertilization of 60 and 120 kg N/ha in two doses (before sowing and as top fertilization) and doses of slurry (60 and 120 kg N/ha) completed by 60 kg N/ha in the top mineral fertilization. In the combinations with total dose of 60 kg N/ha there was applied 50 kg $P_2O_5$ and 60 kg $K_2O$ per ha, and in the combinations with higher nitrogen doses - 100 kg $P_2O_5$ and 120 kg $K_2O$ per ha. In the objects with slurry fertilization completed P and K to the mentioned mineral fertilizer levels.

After 4, 8 and 12 years of study the soil samples were taken form two levels: 0-20 and 30-50 cm. In these samples were determined: acidity by potentiometric method, hydrolytic acidity by Kappen method, exchange cation content in 1 mol $CH_3COONH_4$ $dm^{-3}$ and exchangeable aluminium by Sokołow's method. In the samples taken after 12 study years manganese and iron soluble in 1 mol HCl $dm^{-3}$ were also determined.

## RESULTS

In the conducted studies a systematic soil acidification process was shown (Table 1). On the control object (without nitrogen) a systematic decrease in pH value in the both soil levels was stated. The slurry fertilization activated soil acidity process. In effect of this, pH in $H_2O$ decreased additionally about 0.4 unit after 4 years and 0.2 unit after 8 years and, pH in KCl about 0.1 unit after 4 years. In the 30-50 cm soil layer reaction was higher than in arable layer. In this condition soil reaction decreased as effect of slurry application and it was greater by 1.1 unit of pH in $H_2O$ after 4 years, and 0.3 unit after 8 years and, pH in KCl - 0.4 unit after 4 years, 0.2 unit after 8 years and 0.1 unit after 12 years. The mineral fertilization in the same conditions caused greater soil acidification than slurry. There was lower reaction in both studied soil levels to the value indicating on soil degradation (pH in KCl 4.0). The slurry fertilization together with the mineral fertilization also activated soil acidity.

The above soil reaction changes were reflected in the sorption complex condition (Table 2). With elapse of time the soil hydrolytic acidity increased. This process was the effect of natural acidity processes and fertilization increased them. The slurry increased hydrolytic acidity of the arable level by about 0.2 mmol $H^+$/100 g soil after 4 years, about 0.5 mmol $H^+$/100 g soil after 8 years and 0.4 mmol after 12 years. The changes in hydrolytic acidity in deeper layer were considerably lower. However, after 12 years of fertilization, there was considerable acidity effect of slurry (0.4-0.7 mmol $H^+$/100 g of soil).

The mineral fertilization increased soil hydrolytic acidity more than the slurry. The mineral and the slurry fertilization applied together considerably increased the soil acidity as compared to slurry applied alone, especially in deep soil layer.

Together with the soil acidity process the alkali sum was decreased in the arable layer without fertilization (Table 2). As effect of this, there was decrease in base saturation degree of soil (V) from 66 to 46 %. The slurry fertilization was only fragmentary contrary to this unfavourable process and the base saturate degree to 50 %. The mineral fertilization increased this process and the base saturation degree decreased to 37 %. Paralelly there was increase in soil sorption capacity about 6-23 % in relation to soil without fertilization.

The mineral fertilization influenced on decrease of bases in deeper soil level, however, the slurry influenced on stationary level of them. The sorption complex capacity was systematically increased but with decreased of base saturation degree. The slurry fertilization influenced on the decrease of this in relation to soil without fertilization but to lower degree than mineral fertilization.

The applied fertilization influenced on

**Table 1.** Effect of slurry fertilization on soil reaction

| Dose N kg/ha | | pH $H_2O$ | | | pH KCl | | |
|---|---|---|---|---|---|---|---|
| | | Fertilization years | | | | | |
| in slurry | in fertilizers | 4 | 8 | 12 | 4 | 8 | 12 |
| | | Depth 0 - 20 cm | | | | | |
| 0 | 0 | 5.2 | 5.0 | 4.7 | 4.4 | 4.0 | 4.0 |
| 60 | 0 | 5.1 | 4.9 | 4.8 | 4.4 | 4.1 | 4.0 |
| 120 | 0 | 4.8 | 4.7 | 4.7 | 4.4 | 4.1 | 3.9 |
| 180 | 0 | 4.9 | 4.6 | 4.6 | 4.3 | 4.1 | 4.0 |
| 240 | 0 | 4.9 | 5.0 | 4.9 | 4.3 | 4.1 | 4.0 |
| 300 | 0 | 4.8 | 4.8 | 4.8 | 4.3 | 4.1 | 4.0 |
| 0 | 60 | 4.8 | 4.7 | 4.7 | 4.1 | 4.0 | 3.9 |
| 0 | 120 | 4.3 | 4.1 | 4.1 | 4.0 | 3.9 | 3.4 |
| 60 | 60 | 4.9 | 4.7 | 4.5 | 4.3 | 4.0 | 3.9 |
| 120 | 60 | 4.8 | 4.5 | 4.4 | 4.1 | 4.0 | 3.9 |
| | | Depth 30 - 50 cm | | | | | |
| 0 | 0 | 6.5 | 5.4 | 4.5 | 5.2 | 4.5 | 4.1 |
| 60 | 0 | 6.1 | 5.2 | 4.4 | 5.0 | 4.4 | 4.2 |
| 120 | 0 | 5.8 | 5.1 | 4.4 | 4.8 | 4.4 | 4.1 |
| 160 | 0 | 5.7 | 5.1 | 4.7 | 5.0 | 4.4 | 4.1 |
| 240 | 0 | 5.4 | 5.1 | 4.9 | 5.1 | 4.4 | 4.1 |
| 300 | 0 | 5.4 | 5.1 | 4.7 | 5.0 | 4.3 | 4.0 |
| 0 | 60 | 5.3 | 5.1 | 4.5 | 4.5 | 4.0 | 3.8 |
| 0 | 120 | 5.2 | 4.7 | 4.2 | 4.2 | 3.9 | 3.7 |
| 60 | 60 | 6.0 | 4.8 | 4.3 | 4.7 | 4.3 | 4.0 |
| 120 | 60 | 5.7 | 4.9 | 4.4 | 4.5 | 4.2 | 4.0 |

considerable changes of cation composition in soil sorption complex (Table 3). In the soil arable layer there was continuous decrease in calcium and magnesium content, not great decrease in potassium with increase of calcium and potassium content, and not great decrease in manganese in deeper soil layer as effect of moved calcium and potassium. The mineral fertilization influenced on increase of soil impoverishment in exchange calcium and magnesium. The slurry considerably decreased the calcium content in arable soil level and, considerably increased its content in deeper soil layer. The slurry partially decreased the process of soil impoverishment in available magnesium content in the arable soil layer. The amount of exchangeable potassium in fertilized soil was increased, what showed that the application of this compound was higher than fertilizer needs. The amount of exchangeable sodium in soil sorption complex did not change much. There was tendency to accumulate this compound in soil fertilized with slurry and moving it to deeper soil layer.

Paralelly to acidity and sorption complex composition changes of soil there were changes of exchangeable aluminium and available iron and manganese forms (Table 4). The increase of exchange aluminium was connected with change in soil reaction and it was the effect of natural soil acidity process and fertilization. It was considerably most rapid and the greatest amounts of aluminium moved into soil with mineral fertilization. There was also considerable aluminium moving in objects with slurry and mineral fertilization applied together. The slurry applied without mineral fertilization influenced on lower aluminium moving than on object without fertilization, but only in arable soil layer. In soil with slurry there was shown increased available iron content, about 10 % in arable soil layer and 30 % in deep soil layer and, increased available manganese, about 15 % in arable soil layer and about 70 % in deep soil

**Table 2.** Effect of slurry fertilization on sorption complex capacity of soils (mmol (+)/100 g soil)

| Dose N kg/ha | | Hh | | | S | | | T | | | V % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in slurry | in fertilizers | Fertilization years | | | | | | | | | | | |
| | | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 |
| Depth 0 - 20 cm | | | | | | | | | | | | | |
| 0 | 0 | 1,6 | 2.1 | 2.6 | 3.1 | 2.2 | 2.2 | 4.7 | 4.3 | 4.8 | 66 | 51 | 46 |
| 60 | 0 | 1.6 | 2.2 | 2.9 | 3.2 | 2.4 | 2.2 | 4.8 | 4.6 | 5.1 | 67 | 52 | 43 |
| 120 | 0 | 1.7 | 2.2 | 3.0 | 3.2 | 2.9 | 2.5 | 4.9 | 5.1 | 5.5 | 65 | 57 | 45 |
| 180 | 0 | 1.7 | 2.4 | 3.0 | 3.2 | 3.0 | 2.9 | 4.9 | 5.4 | 5.9 | 65 | 56 | 49 |
| 240 | 0 | 1.8 | 2.6 | 2.9 | 3.2 | 3.0 | 2.9 | 5.0 | 5.6 | 5.8 | 64 | 54 | 50 |
| 300 | 0 | 1.8 | 2.6 | 3.0 | 3.2 | 3.0 | 2.9 | 5.0 | 5.6 | 5.9 | 64 | 54 | 49 |
| 0 | 60 | 1.7 | 2.6 | 3.1 | 3.1 | 2.2 | 2.1 | 4.8 | 4.8 | 5.2 | 65 | 46 | 40 |
| 0 | 120 | 1.8 | 2.8 | 3.4 | 3.0 | 2.0 | 2.0 | 4.8 | 4.8 | 5.4 | 63 | 46 | 37 |
| 60 | 60 | 1.6 | 2.2 | 2.9 | 3.2 | 2.4 | 2.2 | 4.8 | 4.6 | 5.1 | 67 | 52 | 43 |
| 120 | 60 | 1.7 | 2.6 | 3.3 | 3.2 | 2.3 | 2.1 | 4.9 | 4.9 | 5.4 | 65 | 47 | 39 |
| Depth 30 - 50 cm | | | | | | | | | | | | | |
| 0 | 0 | 0.8 | 1.3 | 2.0 | 2.5 | 2.5 | 2.6 | 3.3 | 3.8 | 4.6 | 76 | 66 | 57 |
| 60 | 0 | 0.8 | 1.3 | 2.7 | 2.5 | 2.5 | 2.6 | 3.3 | 3.8 | 5.3 | 76 | 66 | 49 |
| 120 | 0 | 0.9 | 1.3 | 2.6 | 2.5 | 2.5 | 2.5 | 3.4 | 3.8 | 5.1 | 74 | 66 | 49 |
| 180 | 0 | 1.0 | 1.3 | 2.9 | 2.6 | 2.4 | 2.5 | 3.6 | 3.7 | 5.4 | 72 | 65 | 46 |
| 240 | 0 | 1.0 | 1.4 | 2.6 | 2.6 | 2.5 | 2.7 | 3.6 | 3.9 | 5.3 | 73 | 64 | 51 |
| 300 | 0 | 1.0 | 1.4 | 2.4 | 2.7 | 2.6 | 2.7 | 3.7 | 4.0 | 5.1 | 72 | 65 | 53 |
| 0 | 60 | 1.0 | 1.4 | 2.3 | 2.6 | 2.4 | 2.3 | 3.6 | 3.8 | 4.6 | 72 | 63 | 50 |
| 0 | 120 | 1.1 | 1.6 | 3.1 | 2.6 | 2.2 | 2.1 | 3.7 | 3.8 | 5.2 | 70 | 58 | 40 |
| 60 | 60 | 1.0 | 1.4 | 2.8 | 2.5 | 2.4 | 2.3 | 3.5 | 3.8 | 5.1 | 71 | 63 | 45 |
| 120 | 60 | 1.1 | 1.5 | 2.8 | 2.5 | 2.4 | 2.4 | 3.6 | 3.9 | 5.2 | 69 | 62 | 46 |

**Table 3.** Effect of slurry fertilization on exchange cation content in soil (mmol (+)/100 g soil)

| Dose N kg/ha | | $Ca^{2+}$ | | | $Mg^{2+}$ | | | $K^{+}$ | | | $Na^{+}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in slurry | in fertilizers | Fertilization years | | | | | | | | | | | |
| | | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 |
| Depth 0 - 20 cm | | | | | | | | | | | | | |
| 0 | 0 | 1.95 | 1.28 | 1.30 | 0.74 | 0.52 | 0.49 | 0.27 | 0.27 | 0.25 | 0.12 | 0.12 | 0.13 |
| 60 | 0 | 2.00 | 1.36 | 1.34 | 0.74 | 0.64 | 0.45 | 0.31 | 0.28 | 0.30 | 0.12 | 0.12 | 0.14 |
| 120 | 0 | 2.00 | 1.82 | 1.58 | 0.74 | 0.66 | 0.52 | 0.33 | 0.28 | 0.29 | 0.13 | 0.11 | 0.14 |
| 180 | 0 | 2.00 | 1.86 | 1.90 | 0.77 | 0.70 | 0.56 | 0.33 | 0.29 | 0.28 | 0.13 | 0.11 | 0.14 |
| 240 | 0 | 2.00 | 1.86 | 1.92 | 0.79 | 0.72 | 0.54 | 0.30 | 0.28 | 0.28 | 0.13 | 0.12 | 0.14 |
| 300 | 0 | 2.00 | 1.90 | 1.90 | 0.79 | 0.70 | 0.55 | 0.30 | 0.28 | 0.28 | 0.13 | 0.12 | 0.14 |
| 0 | 60 | 1.90 | 1.32 | 1.20 | 0.76 | 0.50 | 0.42 | 0.31 | 0.30 | 0.31 | 0.12 | 0.10 | 0.13 |
| 0 | 120 | 1.90 | 1.16 | 1.15 | 0.69 | 0.46 | 0.42 | 0.34 | 0.30 | 0.30 | 0.10 | 0.10 | 0.12 |
| 60 | 60 | 2.00 | 1.36 | 1.26 | 0.74 | 0.62 | 0.52 | 0.31 | 0.28 | 0.29 | 0.11 | 0.11 | 0.14 |
| 120 | 60 | 2.00 | 1.28 | 1.18 | 0.73 | 0.60 | 0.49 | 0.34 | 0.31 | 0.32 | 0.13 | 0.12 | 0.14 |
| Depth 30 - 50 cm | | | | | | | | | | | | | |
| 0 | 0 | 1.40 | 1.42 | 4.50 | 0.74 | 0.72 | 0.70 | 0.21 | 0.21 | 0.22 | 0.10 | 0.10 | 0.13 |
| 60 | 0 | 1.45 | 1.48 | 1.60 | 0.74 | 0.66 | 0.63 | 0.24 | 0.24 | 0.26 | 0.10 | 0.10 | 0.14 |
| 120 | 0 | 1.40 | 1.50 | 1.60 | 0.74 | 0.66 | 0.52 | 0.28 | 0.28 | 0.27 | 0.09 | 0.10 | 0.14 |
| 180 | 0 | 1.45 | 1.48 | 1.60 | 0.76 | 0.54 | 0.49 | 0.25 | 0.27 | 0.26 | 0.10 | 0.10 | 0.14 |
| 240 | 0 | 1.50 | 1.48 | 1.75 | 0.76 | 0.62 | 0.54 | 0.26 | 0.27 | 0.27 | 0.10 | 0.10 | 0.14 |
| 300 | 0 | 1.55 | 1.58 | 1.76 | 0.74 | 0.62 | 0.56 | 0.28 | 0.28 | 0.27 | 0.09 | 0.10 | 0.14 |
| 0 | 60 | 1.50 | 1.42 | 1.44 | 0.74 | 0.60 | 0.41 | 0.26 | 0.29 | 0.29 | 0.09 | 0.10 | 0.13 |
| 0 | 120 | 1.45 | 1.34 | 1.28 | 0.74 | 0.48 | 0.42 | 0.27 | 0.29 | 0.30 | 0.09 | 0.09 | 0.12 |
| 60 | 60 | 1.40 | 1.42 | 1.32 | 0.74 | 0.64 | 0.60 | 0.24 | 0.26 | 0.26 | 0.10 | 0.10 | 0.13 |
| 120 | 60 | 1.40 | 1.40 | 1.40 | 0.76 | 0.60 | 0.56 | 0.26 | 0.27 | 0.28 | 0.10 | 0.10 | 0.13 |

**Table 4.** Effect of slurry fertilization on exchangeable aluminium and available iron and manganese content in soil

| Dose N kg/ha | | $Al^{3+}$ mmol(+)/100 g soil | | | Fe | Mn |
|---|---|---|---|---|---|---|
| | | | | | mg/kg soil | |
| | | Fertilization years | | | | |
| in slurry | in fertilizers | 4 | 8 | 12 | 12 | 12 |
| Depth 0 - 20 cm | | | | | | |
| 0 | 0 | 0.66 | 1.00 | 1.40 | 600 | 74 |
| 60 | 0 | 0.75 | 0.70 | 0.76 | 614 | 73 |
| 120 | 0 | 0.66 | 0.75 | 0.83 | 640 | 78 |
| 180 | 0 | 0.70 | 0.70 | 0.88 | 666 | 78 |
| 240 | 0 | 0.74 | 0.78 | 0.85 | 652 | 88 |
| 300 | 0 | 0.73 | 0.78 | 0.87 | 640 | 85 |
| 0 | 60 | 0.66 | 1.03 | 1.68 | 652 | 67 |
| 0 | 120 | 0.96 | 1.84 | 2.23 | 670 | 65 |
| 60 | 60 | 0.83 | 1.36 | 1.32 | 626 | 74 |
| 120 | 60 | 0.79 | 1.62 | 1.75 | 652 | 85 |
| Depth 30 - 50 cm | | | | | | |
| 0 | 0 | 0.30 | 0.62 | 0.70 | 490 | 51 |
| 60 | 0 | 0.31 | 0.57 | 0.60 | 470 | 69 |
| 120 | 0 | 0.30 | 0.55 | 0.56 | 534 | 59 |
| 160 | 0 | 0.30 | 0.60 | 0.66 | 506 | 76 |
| 240 | 0 | 0.50 | 0.85 | 0.86 | 544 | 80 |
| 300 | 0 | 0.48 | 0.80 | 0.90 | 640 | 86 |
| 0 | 60 | 0.57 | 0.80 | 0.91 | 571 | 93 |
| 0 | 120 | 0.57 | 1.52 | 1.61 | 575 | 96 |
| 60 | 60 | 0.50 | 1.16 | 1.31 | 450 | 69 |
| 120 | 60 | 0.61 | 1.44 | 1.50 | 544 | 96 |

layer. It is characteristic that in soils fertilized with mineral fertilizes (NPK) there was also increase in available iron and manganese content.

## DISCUSSION

The conducted studies showed that the slurry effect in soil is enough considerable and also concerned some soil properties. It is the effect of some simultaneous processes with different intensification and direction. Immediately after slurry application there was intensive mineralization of organic matter and rising $CO_2$ is creating of carbon acid and acidification of soil environment [3,5,6]. However, together with slurry a great amount of ammonium ions is also introduced [5]. With elapse of time and following slurry decomposition there was move of base cations but paralelly increase in nitrification process [3]. As result of these processes the hydrogen ion content in soil increases. There is exchange of base ions with sorption complex and their moving into deeper soil layer. That was found in the discussed studies here. The higher plant yield obtained as effect of fertilization receives greater amount of the cations [4]. As the effect there was a considerable decrease in the contribution of base cations in the sorption complex, as was shown in this paper. The amounts of calcium and magnesium cations in the slurry dose calculated in nitrogen need was not enough for the stability of the above mentioned processes. There was shown an increase in the soil sorption complex capacity as the effect of the humus compound increase at the slurry fertilization, also shown in the earlier paper [3]. With the sorption complex capacity increase there is an increase in acidity.

In the soil fertilized with slurry, there was decrease in the cation soil saturation degree as effect of the shown processes. It was connected with higher amounts of exchangeable aluminium as the toxic soil compound. It influenced on yield decrease in the combination fertilized only with mineral fertilizers, also shown in the earlier paper [4]. In the objects fertilized with slurry there was no evidence of toxic effect of aluminium because the process of ion movement was slower and there was the protection effect of higher humus content [3,5]. In soil fertilized with slurry the amounts of soluble iron and manganese forms increased. The increase was higher than the amount added with slurry [3]. There was the process of the compound moving from soil reserves, what was shown by other authors [1]. As it was shown in this paper, that process was connected with the acidity increase in soil fertilized with slurry.

## CONCLUSIONS

The conducted studies allow to draw the following conclusions:

1. The slurry fertilization influenced on the decrease in the soil sorption complex capacity.
2. As effect of the slurry fertilization there was soil acidity increase, although it was lower and not so much unfavourable as the equivalent mineral fertilization.
3. The slurry fertilization compensated only the part of base cation decrease in soil. There was decrease in base saturation degree of soil.
4. In soils fertilized with slurry as the effect of acidity, the decrease in the exchange aluminium content and available forms of iron and manganese may occur.

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## ZMIANY ODCZYNU I WŁAŚCIWOŚCI SORPCYJNYCH GLEBY LEKKIEJ NAWOŻONEJ GNOJOWICĄ

W doświadczeniu polowym, na glebie bardzo lekkiej, kwaśnej, stosowano gnojowicę trzody chlewnej w dawkach zawierających 60-300 kg N/ha pod każdą roślinę. Po 4, 8 i 12 latach pobrano próbki gleby i oznaczono w nich odczyn, kwasowość hydrolityczną, zawartość kationów wymiennych, wymienny glin oraz przyswajalne żelazo i mangan.

Na podstawie przeprowadzonych badań stwierdzono, że stosowanie gnojowicy powoduje systematyczny wzrost zakwaszenia gleb. Zakwaszające dzialanie gnojowicy wystąpiło w obu badanych warstwach gleby tj. warstwie ornej i podornej. Jednak gnojowica zakwaszała glebę wolniej i w mniejszym stopniu niż nawożenie mineralne. Gromadzeniu się w glebie jonów wodorowych towarzyszyło przemieszczanie jonów wapnia i magnezu w głąb gleby. Stosowanie gnojowicy, która zawierała te składniki zmniejszyło ich ubytek w kompleksie sorpcyjnym gleby. W przypadku wapnia stwierdzono nawet kumulację jego form wymiennych w podglebiu. Nawożenie gnojowicą powodowało wzrost pojemności kompleksu sorpcyjnego gleby. Jednak z powodu znacznego zwiększenia kwasowości hydrolitycznej stopień wysycenia zasadami systematycznie malał. Stosowanie gnojowicy nie przeciwdziałało temu procesowi. Jednak gleba nawożona gnojowicą charakteryzowała się wyższym stopniem wysycenia zasadami niż gleba nawożona nawozami mineralnymi.

W badanej glebie stwierdzono wzrost zawartości glinu wymiennego na obiektach nawożonych gnojowicą. Był on jednak zdecydowanie mniejszy niż na nawożeniu mineralnym. Stwierdzono zwiększenie zawartości przyswajalnych form żelaza i manganu w glebie znacznie przewyższające ilości tych pierwiastków wniesione z gnojowicą. Nastąpiło ich uruchomienie z zapasów glebowych w wyniku zakwaszenia gleby.

S ł o w a k l u c z o w e: odczyn gleby, gleba lekka, nawożenie gnojowicą.