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Problem Acidification And Alkalinization Of The Chernozems In The Stavropol Territory.

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ABSTRACT

This article presents research on the main subtypes of chernozems of the Stavropol Territory in the interconnected areas of virgin land and arable land. As a result of the conducted studies it was revealed that the pH of calcareous chernozems (southern and ordinary) does not undergo significant changes in arable land in comparison with the virgin land for 100-120 years of use. In the upper horizon of chernozem, an ordinary one with a pH at virgin soil equal to 8.28, the decrease in arable land was 0.13 units. On southern chernozem, this decline was 0.15 units. The transformation of the acid-base potential only affects the upper horizons: Ad, Aar and A. Downward along the profile, the changes in pH between the virgin and the arable land are insignificant. Consequently, the decrease in the investigated value occurs only in the root zone, which is more saturated with microorganisms.
Keywords: chernozem, acidity of soils, virgin land, arable land.

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INTRODUCTION

When black chernozems are involved in agricultural production, their acidification is predominant. Only in some cases alkalization of soils under conditions of waterlogging is observed, or the pH can remain unchanged [1.10]. This is evident from the results of the work of the department and the generalization of the data obtained from soil batches, agrochemical surveys and publications of scientists on this topic.

On chernozem leached changes are more significant. Not having sufficient buffer protection in the form of a carbonate complex, soil pH is reduced from 7.05 units per virgin land to 1.03 units per plowland. The zone of decline of the studied value covers horizons A and AB.

On the solonetsous chernozem the pH also decreases, although less significant than on leached chernozem [6]. So in the upper horizon on virgin land this indicator was 7.3 units and decreased to 6.76 units on arable land, i. by 0.54 units. But here the transformation of the pH covers almost the entire profile up to the horizon of the sun.

In order to explain the change in pH in one direction or another, it is necessary to understand the mechanism of acidification and alkalization [9].

As V.V. Ponomareva [7] "The soil is the result of mineral nutrition of plants, autotrophic creation of organic matter and its transformation (including mineralization) by microorganisms". Soil is used by plants exclusively as a mineral substrate for nutritional purposes.

At the core of plant nutrition is the destruction of minerals and rocks that make up the soil body. This is especially true at the initial stages of soil formation, after passing through which the products of mineralization of fresh organic matter are included in the nutritional cycle of plants. This is the philosophy of life - in order to create something, it is necessary to destroy something.

Table 1: Acidic-alkaline potential of chernozems of virgin soil and arable land

Ordinary chernozem (n=8)			Southern chernozem (n=7)			Leached chernozem (n=12)			Chernozem solonetsous (n=17)		
Gen. horizon	Virgin soil	Arable land	Gen. horizon	Virgin soil	Arable land	Gen. horizon	Virgin soil	Arable land	Gen. horizon	Virgin soil	Arable land
Ad.,ar.	8,28	8,15	Ad.,ar.	8,35	8,20	Ad.,ar.	7,05	6,02	Ad.,ar.	7,30	6,76
A	8,35	8,30	A	8,40	8,25	A	7,20	6,58	A	7,35	6,91
AB	8,42	8,38	B1	8,40	8,30	AB	7,45	7,10	B1	7,26	6,73
B	8,43	8,42	B2	8,45	8,40	B	7,58	7,50	B2	7,60	6,79
BC	8,45	8,43	BC	8,48	8,45	BC	7,80	7,90	BC	7,90	7,28
C	8,45	8,43	C	8,48	8,45	C	8,10	8,20	C	8,50	8,40

At the heart of the destruction of minerals lies their acid hydrolysis or as we say proton bombardment. At the heart of the appearance of protons is photosynthesis. In photolysis, as is known, water decomposes into hydrogen and oxygen. The latter evaporates into the atmosphere, and the remaining hydrogen provides the basis for the formation of the oxonium molecule (H_3O). The quantum energy of the sun passes into the electrochemical energy, which further participates both in the processes of destruction and in the processes of creation.

Thus, the plant receives a powerful "weapon" - a proton of hydrogen, which it uses when extracting elements of mineral nutrition. K. Olier [5] writes that "living plants are a permanent source of H^+ ions, which create an acidic environment and weather nearby minerals. Plants exchange H^+ for nutrients and, by removing H^+, the reaction is constantly unbalanced, so that weathering continues throughout the life of plants, and the weathering front extends to the sides from the interface between the root and clay".

Another acidifier of the soil is bacteria. The process of their breathing is accompanied by the formation of acids. Under aerobic conditions, this is mainly mineral (nitric, coal, etc.), and in anaerobic organic acids, intermediate metabolism (citric, acetic, oxalic, etc.). Thus, the process of soil acidification is constant and inevitable.

MATERIAL AND METHODS

Why does acidification of soils of agrocenoses go much faster than in natural conditions? Three reasons are guilty. **The first** is that arable land has a larger biomass and a more powerful root system than virgin grasses. This allows them to produce and allocate much more proton material for the implementation of destruction processes. In this they are assisted by rhizosphere microorganisms, which feed on organic matter of root secretions, and whose abundance significantly increases on the plowland.

The second reason is that there is no supply of fresh organic matter in the plowland along with the fallace. Acidification also goes acid, but its rates are significantly reduced, because an organic substance appears on the way of acid products, which is mineralized and is a constant source of nutrients for plants. The destruction of minerals in large volumes is not required and the weathering is slowed down. On agrocenoses the deficit of organic matter. In the sphere of proton hydrolysis, soil minerals are increasingly involved.

The third reason is that in agrocenoses there is not only a deficit of organic matter, but also macro- and microelements of plant nutrition. They are constantly alienated along with the harvest. In the conditions of a lack of food elements, the plant is forced to destroy the mineral base of the soil with new and new portions of protons.

RESULTS AND DISCUSSION

In some farms of the region, alkalinization of soils has been noted recently. I must say that they lie in the zone of intensive irrigation and changed the automorphous type of water regime to hydromorphic (capillary-backed). This, as well as alkalization, concerns not only irrigated, but also rain-fed areas.

Table 2: Acid-base potential of chernozems, depending on conditions of underflooding

Depth, cm	automorphic	Meadowish	meadow gley-flooded (waterlogged land)
Leached chernozem			
0-10	7,3	7,4	7,8
10-20	7,2	7,3	7,8
20-30	7,2	7,4	7,8
30-40	7,1	7,6	7,9
40-50	7,2	7,4	7,9
Ordinary chernozem			
0-10	8,3	8,3	8,5
10-20	8,2	8,3	8,5
20-30	8,2	8,4	8,4
30-40	8,1	8,4	8,4
40-50	8,3	8,3	8,3

We investigated submerged areas of leached chernozems powerful low-humus heavy loam on loess-like loam and chernozems of ordinary carbonate powerful low-humus heavy loam on loess-like loam. In the area of the wetlands identified 3 study areas: automorphic Chernozem-at a distance of 50-100 meters from the wetlands; meadow Chernozem-the outskirts of wetlandsand meadow Chernozem glee-wetlands (wetlands itself).

Studies have established a significant alkalinization of the entire half-meter horizon of leached Chernozem. Acid-alkaline potential from 7.1-7.3 in automorphic conditions increased to 7.4-7.6 on the outskirts of the sponge and to 7.8-7.9 directly on the wetlands.

On ordinary chernozem pH increase is less significant. At rates of 8.2-8.3 in automorphic conditions increased by an average of 0.2 units on the wetlands.

The energy orientation of soil formation in aerobic and anaerobic conditions has significant differences. In aerobic conditions, it is controlled by a community of terrestrial plants and the associated aerobic microorganisms. Oxidation-reduction reactions have an oxidative orientation. To ensure the continuity of these reactions in the soil, it is necessary to continuously supply H + and remove excess water. For soil formation under aerobic conditions, mainly proton energy transport is characteristic.

With the stagnation of water, the process of proton destruction of minerals slows down and stops the concentration of H^+ film water drops sharply. Oxidation-reduction reactions have a reductive orientation and are generated by anaerobic heterotrophic microorganisms during fermentation, methanogenesis and anaerobic respiration [2, 12].

In the process of fermentation of carbohydrates, intermediate products of acidic nature, water and carbon dioxide are formed. In anaerobic respiration, as in the aerobic, the electron acceptor is oxygen, but only bound compounds. The hydrogen protons released during the fermentation process also act as electron acceptors.

According to G. Schlegel [12], nitrate respiration is a chain of mutual redox reactions in which denitrifying agents carry out electron transfer according to the following scheme:

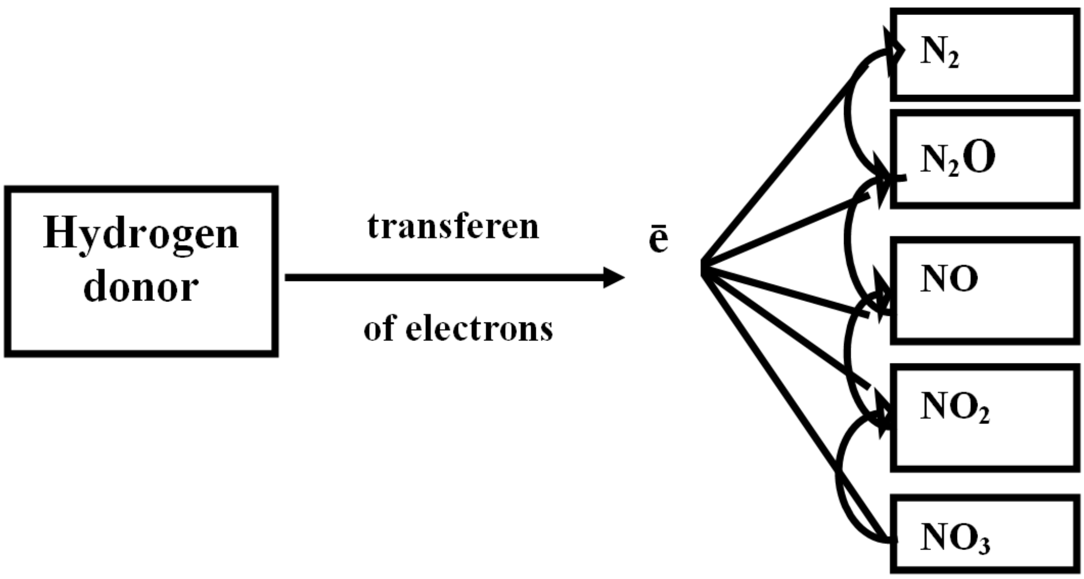

Figure 1: Diagram of nitrate respiration of plants

The whole process of denitrification, as M.V. Gusev, L.A. Mineev [3], consists of four reconstruction stages.

1) $NO^-_3 + 2\bar{e} + 2H^+ \rightarrow NO^-_2 + H_2O$
2) $NO_2 + \bar{e} + H^+ \rightarrow NO + OH^-$
3) $2NO + 2\bar{e} + 2H^+ \rightarrow N_2O + H_2O$
4) $N_2O + 2\bar{e} + 2H^+ \rightarrow N_2 + H_2O$

As a result of this reaction, the loss of nitrate nitrogen from the soil can be up to 80%. In soils, nitrate ions are usually in the form of salts of calcium, magnesium and sodium. If we proceed from the presence of these salts, the total reaction of denitrification can have the following form:

$$Ca(NO_3)_2 + 10H^+ + 10\bar{e} \rightarrow N_2\uparrow + 4H_2O + Ca(OH)_2;\ 2NaNO_3 + 10H^+ + 10\bar{e} \rightarrow N_2\uparrow + 4H_2O + 2NaOH;\ Mg(NO_3)_2 + 10H^+ + 10\bar{e} \rightarrow N_2\uparrow + 4H_2O + Mg(OH)_2$$

The increase in pH due to the formation of alkalis during denitrification (as in other and desulfurization) leads to the precipitation of calcium and magnesium carbonates and the temporary appearance of soda according to the reactions:

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3;$$
$$Mg(OH)_2 + CO_2 \rightarrow MgCO_3;$$
$$2Na(OH)_2 + CO_2 \rightarrow Na_2CO_3$$

Under conditions of assimilative denitrification, the reaction does not end with molecular nitrogen, but proceeds to the formation of ammonia, which also leads to alkalization of the soil.

If there are salts of sulfuric acid in the soil in anaerobic regime, the process proceeds according to the same scheme.

Frequent changes in the energy flows of matter during the vegetation of the electron to the anaerobic phase and proton into the aerobic phase lead to the formation of fused soils. S.V. Zonn [4] noted that repeated repetition of anaerobic and aerobic cycles in time leads to the filling of soil smectites and they acquire the whole complex of properties inherent in slitozems.

In our opinion, there is another reason why soils on agrocenoses become more alkaline. It is associated with actively developing erosion processes. According to E.I. Ryabov [8], soil losses within the boundaries of the Stavropol Territory from dust storms are 80-265 million tons, exceeding losses at an accelerated stage by 2-30 times. Blowing out of the entire arable horizon is observed in places. This guarantees exposure of the lower horizons, which have a more alkaline reaction medium.

And yet, the very change in pH in one direction or the other does not determine the productivity of any land, including arable land. More L.M. Thompson and F.R. Trow [11] showed that "the direct effect of pH on plant growth is slight or nonexistent. The change in the concentration of H^+ and OH^- ions over a wide range does not seem to matter for plants, while other factors remain favorable.

CONCLUSION

Thus, it is necessary to pay attention, first of all, to why the acid-base potential changes. If strong acidification of soils, for example, is associated with an increase in the concentration of dissolved Al^{3+}, it exhibits a toxic effect. When alkalinized, the toxic effect may cause soda.

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