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ON THE QUESTION OF THE RULES FOR THE DEVELOPMENT OF WORKING PROJECTS BY THE LAND DEVELOPMENT REGARDING THE PROTECTION OF LANDS FROM ACIDIFICATION (LIMING OF ACID SOILS)

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Abstract. *As a result of intensified agriculture, excessive use of nitrogen fertilizers in the race to increase yields, there is a rapid increase in the acid reaction of soils on part of the arable lands of Ukraine.*

An increase in soil acidity leads to suppression of microbiological activity in the arable layer of the soil, accumulation of mobile forms of nutrients harmful to plants, damage to plants by diseases, assimilation of radionuclides and heavy metals by plants, accumulation of nitrates in them. Due to suppression of the root system by free aluminum, the winter resistance and drought resistance of grain crops decreases, the weeding of the fields increases (most weeds can withstand the acidic reaction of the soil solution), while acidity has a negative effect on all soil biota.

The problem is gaining special importance and requires urgent state intervention.

Liming is the most economically available method of improving soil acidity. Lime can be used both to maintain the desired level of soil acidity and to restore the pH to the appropriate level. Deacidification of the soil by only one value (pH from 5.0 to 6.0) contributes to an increase in productivity by up to 50%.

In this study, theoretical and methodological approaches to the development of working land management projects for the protection of lands from acidification (liming of acidic soils) are proposed.

Keywords: *liming of soils, working project of land management, acidic soils, acidification, meliorants.*

Formulation of the problem.

In Ukraine, about 8 million hectares of arable land and 3 million hectares of natural land have high acidity and require liming. During the years of land reform, acid degradation became a special problem regarding the rational use of land in the Kyiv region. The pH level of the soil solution and hydrolytic acidity are among the main agroecological indicators, which primarily characterize the comfort of the conditions for growing agricultural crops, the level of efficiency of the use of mineral fertilizers. In the acidic environment of the soil solution, it is impossible to create favourable nitrogen and phosphorus nutrition for plants, even with sufficient reserves of these elements in the soil and applied with fertilizers.

An important problem, in this context, is the development of working land management projects to protect land from acidification (liming of acidic soils) in order to increase the ecological and economic efficiency of their use.

Analysis of the latest scientific research and publications.

The issues of land protection from dangerous degradation processes were dealt with by such scientists as: V. Andrienko, O. Kanash, V. Krivov, L. Kolomiets, A. Martyn, S. Osipchyk, S. Pogurelsky, M. Stetsyuk, I. Shevchen-ko and etc. At the same time, nourishing the defense of lands from acidification (liming of acid soils) is equal to new and little-used venerable science.

Materials and methods of scientific research.

Materials of already developed projects, methods of comparative analysis and scientific generalization were used during the research on the development of working projects of land management for the protection of lands from acidification (liming of acidic soils).

The aim of the research is consi-deration of problems related to the protection of lands from acidification and highlighting of a methodical approach to the development of working land management projects for the protection of lands from acidification (liming of acidic soils).

Research results and discussion.

Soil acidity refers to their ability to neutralize alkaline solutions and acidify natural waters and solutions of neutral salts, which is due to the presence of a significant amount of hydrogen and aluminium ions in the absorption complex. The acidic environment of such soils limits the production of high and high-quality crop yields.

The main factor in the radical improvement of agrochemical, physicochemical and physical properties of acidic soils and increasing the yield of agricultural crops is their liming.

Soil liming is the introduction of lime meliorants into the soil to neutralize the excessive acidity of the soil, which is harmful to many plants, and to improve its agro-ecological properties.

Various materials and mixtures containing calcium, dolomite, marl, etc. are used as meliorants. liming of soils must be carried out in combination with other agrotechnical measures of soil cultivation, primarily with the system of applying organic and mineral fertilizers in crop rotations.

According to agrochemical surveys, 1.6 million ha of acidic soils in need of liming (strongly and moderately acidic)

and 2.9 million ha need (maintenance) liming to prevent the process of secondary acidification.

Soil liming is a highly energy-intensive method of chemical soil reclamation. At the same time, lime standards, calculated by hydrolytic acidity, reach 4-8 tons or more per 1 ha. The dose of lime is calculated (per 100% $CaCO_3$), taking into account the granulometric composition of the soil.

Solid liming of the arable layer is expedient to be carried out only on strongly acidic and partly on highly buffered moderately acidic soils, on which it pays off with a significant increase in yield. On moderately acidic, slightly buffered and slightly acidic soils, maintenance liming and local chemical reclamation are effective. With high doses of lime application and uneven mixing of it with the soil, zones of overliming often appear, which leads to the intensification of the processes of humification of acidic soils, excessive accumulation of nitrates and their leaching into groundwater, damage to plants by diseases, and a decrease in the quality of agricultural crops. Modern resource-saving technology of local amelioration of acidic soils provides an opportunity to avoid such ecologically dangerous phenomena, to create a soil environment necessary for successful cultivation in crop rotation of different agricultural crops in terms of soil reaction.

The land use of Municipal Enterprise (ME) "Bilotserkivkhliboprodukt", which is located within the Bilotserkivska district of the Kyiv region, was an example of soil liming measures. Acidic soils occupy 223.0 hectares of arable land in the land use territory of ME "Bilotserkivkhliboprodukt" (Fig. 1).

According to the natural-agricultural zoning of the Kyiv region, the study area

Fig. 1. Scheme of placement of fields of field crop rotation on the territory of land use of ME "Bilotserkivkhliboprodukt", where soil liming measures will be carried out

is located in the Forest-Steppe zone in the Forest-Steppe Right Bank Province.

Typical low-humus, light- and medium-loam chernozems prevail in the land use territory of KP "Bilotserkivkhliboprodukt". They were formed under the cover of meadow-steppe vegetation on the leveled massifs of the loess plateau. Thanks to this, a significant amount of ash elements and plant residues, the decomposition of which took place in conditions of insufficient soil moisture, is placed in the upper soil horizon.

The most characteristic features of typical low-humus chernozems are the significant humus content of their soil profile, the absence of salts harmful to cultivated plants, relatively favourable water-physical properties, etc. The humus content of the profile is traced to a depth of 80-140 cm, so they are classified as medium deep and deep. According to the content of humus, they are classified as low-humus.

The soils are characterized by the content of absorbed bases (Ca2++Mg2+) of 24.8-30.4 mg-eq. per 100 g of soil, the degree of saturation with the bases of the absorption complex is 90-95%. Typical chernozems have significant reserves of phosphorus, the content of which lies within the range of 0.11-0.21%, and the reserves in a one and a half meter layer of soil vary from 7 to 9 t/ha. Soils are enriched with potassium, their effective fertility increases from light loam to medium loam. They are easily processed by agricultural tools, less prone to waterlogging. All nutrients are easily absorbed by plants.

Areas of typical low-humus medium-washed chernozems are found within field I. They are characterized by the washing away of the humus horizon by half or by 2/3 of its roughness, and therefore have reduced fertility.

According to agrochemical surveys, typical low-humus chernozems have high acidity, pHKCl varies from 5.1 to 5.3. Given that an increase in the level of soil acidity can contribute to a significant delay in the supply of nutrients to the root system, which, accordingly, can disrupt carbohydrate and protein metabolism in plants and slow down the synthesis process. This leads to a violation of the pollination process and the development of generative organs, worsens the conditions of pouring grain and reduces the productivity of plants. Therefore, these soils are subject to liming.

Agrochemical characteristics of I-V fields of field rotation №. 2 with acidic soils are presented in Table 1.

Table 1. **Agrochemical characteristics of fields with acidic soils**

Field	Area, ha	Code of agrogroup of soils	pHKCl	Hydrolytic acidity, mg-eq/100 g	Soil density, g/cm^3
I	**96,0**	53g, 53d, 56g, 56d	5,1	2,93	1,18
II	33,0	53g, 53d	5,1	2,46	- « -
III	50,0	53g, 53d	5,2	2,45	- « -
IV	22,0	53g, 53d	5,2	3,05	– ⇔ –
V	22,0	53g, 53d	5,3	2,46	– ⇔ –
Total	223,0				

Calculation of volumes of liming of acidic soils and the cost of limestone material.

The calculation of the volumes of liming of acidic soils is carried out in accordance with DSTU 4768:2007 "Soil quality. The procedure for carrying out works on chemical reclamation of acidic soils".

The recommended dose of limestone material in tons per 1 ha of land was determined by the formula:

$$D_{CaCO3} = \frac{0,5 * Hr * S * h * d}{1000}, \text{ where}$$

0,5 – gram equivalent of $CaCO_3$, required for neutralization of 1 mg-eq Hr in 1 kg of soil, g;

Hr – hydrolytic acidity, mg-eq/100 g of soil;

S – plot area, 10,000 m^2;

h – the depth to which $CaCO_3$ wraps after spreading, m;

d – compaction density of the soil, g/cm^3;

1000 – conversion factor.

The actual dose of limestone material in tons per 1 ha of land plot, which contains corrections for the content of moisture, impurities and inactive particles of limestone material, was determined by the formula:

$$NF = \frac{D_{CaCO3} * 100 * 100 * 100}{(100 - V) * (100 - B) * D}, \text{ where}$$

$DCaCO_3$ – recommended dose of $CaCO_3$, t/ha;

V – moisture content in the material, %;

B – the number of inactive particles in the limestone material with a diameter of more than 3 mm and particles with a diameter of 1 mm to 3 mm that are 50% less effective than smaller particles, %;

D – the amount of carbonates ($CaCO_3$ and $MgCO_3$) in the limestone material, %;

100 – transfer coefficients.

After that, the recommended and actual need for limestone material for the entire area of acidic soils is calculated.

The cost of limestone material is calculated based on the cost of 1 ton of it, which is 144 UAH.

The results of the calculation of the volumes of liming of acidic soils and the cost of limestone material in the section of the fields are shown in Table 2.

Thus, the amount of limestone material required for liming 223.0 ha of acidic soils is 1066.5 tons in physical weight, and its cost is 153.6 thousand UAH.

Table 2. **Agrochemical characteristics of fields with acidic soils**

Field	Area, ha	Recommended doselimestone material,t/ha	Recommended need for limestone material, tons	The actual dose of limestone material, t/ha	The actual need for limestone material (physical weight),tons	Cost of limestone material, UAH
I	**96,0**	3,5	336,0	5,2	497,9	71698
II	33,0	2,9	95,7	4,3	141,8	20419
III	50,0	2,9	145,0	4,3	214,9	30946
IV	22,0	3,6	79,2	5,3	117,4	16906
V	22,0	2,9	63,8	4,3	94,5	13608
Total	223,0	3,2	719,7	4,8	1066,5	153577

Table 3. **Costs for carrying out technological works on liming acidic soils (loading limestone material, transporting it and applying it to the soil)**

Field	Limestone development and loading costs material on the car-dump trucks, UAH	Expenses on transportation limestone material,		Expenses on load limestone-material scattered eyes, UAH	Costs for introducing limestone material into the soil, UAH	Others unforeseen expenses, UAH	Total costs for the implementation of technological works, UAH
		ton-km	UAH				
I	20314,3	92011,9	87411,4	20314,3	34560	6912	169512
II	5785,4	26204,6	24894,5	5785,4	11880	2376	50721,4
III	8767,9	39713,5	37727,8	8767,9	18000	3600	76863,6
IV	4789,9	21695,5	20610,7	4789,9	7920	1584	39694,6
V	3855,6	17463,6	16590,5	3855,6	7920	1584	33805,7
Total	43513,2	197089,2	187234,8	43513,2	80280	16056	370597,2

Calculation of costs for the transportation of limestone material and its introduction into the soil.

When liming acidic soils, a technological scheme will be used, which includes: development of calcareous material (excrement) in the sedimentation ponds (checks) of the sugar factory and its loading on dump trucks; transporting limestone material to the farm and unloading it near the border of fields with acidic soils. In order to minimize transport costs, unloading will be carried out in several places; load of limestone material in the spreader; introduction of limestone material into the soil (scattering on the field) by spreaders.

Cost calculations for liming acidic soils were performed based on the actual dose of limestone material required for liming all acidic soils, the costs of loading limestone material in dump trucks at the sugar factory, its transportation (transportation) and application to the soil. The average distance of transportation of limestone material from the place of its loading to the place of introduction into the soil is 77 km.

Expenses for other unforeseen works are also taken into account, in particular, transportation of equipment to the fields, excrement removal, its storage, etc. The results of the calculations are shown in Table 3.

Thus, the costs of technological works on liming 223.0 ha of acidic soils are:

expenses for loading limestone ma-terial on dump trucks - 43.5 thousand UAH;

expenses for transportation (transpor-tation) of limestone material to fields with acidic soils - 187.2 thousand UAH;

expenses for loading limestone mate-rial in the spreader - 43.5 thousand UAH;

expenses for applying limestone material to the soil - 80.3 thousand UAH;

other unforeseen expenses –16.1 thousand UAH;

The total costs for liming acidic soils, including the cost of limestone material (153.6 thousand UAH) amount to 524.2 thousand UAH.

Conclusions.

The development of working land management projects for the protection of lands from acidification (liming of acidic soils) is extremely important

for the development of land relations at the local level of united territorial communities, namely, it will contribute to the protection of lands from possible acidification and is an important measure to increase the fertility of acidic soils.

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ДО ПИТАННЯ ПРО ПРАВИЛА РОЗРОБЛЕННЯ РОБОЧИХ ПРОЕКТІВ ЗЕМЛЕУСТРОЮ ЩОДО ЗАХИСТУ ЗЕМЕЛЬ ВІД ЗАКИСЛЕННЯ (ВАПНУВАННЯ КИСЛИХ ҐРУНТІВ)

ЗЕМЛЕУСТРІЙ, КАДАСТР І МОНІТОРИНГ ЗЕМЕЛЬ 3'22: 47-53

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Анотація. *Внаслідок ведення посиленого сільського господарства, надмірного використання азотних добрив у перегонах за підвищенням врожайності, на частині орних земель України відбувається швидке підвищення кислотної реакції ґрунтів.*

Підвищення кислотності ґрунтів призводить до пригнічення мікробіологічної діяльності в орному шарі ґрунту, нагромадження шкідливих для рослин рухомих форм елементів живлення, ураження рослин хворобами, засвоєння рослинами радіонуклідів, важких металів, накопичення в них нітратів. Через пригнічення кореневої системи вільним алюмінієм знижується зимостійкість та посухостійкість зернових культур, збільшується засміченість полів бур'янами (більшість бур'янів витримують кислу реакцію ґрунтового розчину), при цьому кислотність негативно впливає на усю ґрунтову біоту.

Проблема набуває особливого значення та потребує термінового втручання держави.

Вапнування найбільш економічно доступний метод поліпшення кислотності ґрунту. Вапнуванням можна як підтримувати бажаний рівень кислотності ґрунту, так і проводити відновлення pH до відповідного рівня. Розкислення ґрунту лише на одиницю значення (pH від 5,0 до 6,0) сприяє підвищенню урожайності до 50 %.

В даному дослідженні запропоновано теоретико-методичні підходи до розробки робочих проектів землеустрою щодо захисту земель від закислення (вапнування кислих ґрунтів).

Ключові слова: *вапнування ґрунтів, робочий проект землеустрою, кислі ґрунти, закислення, меліоранти.*