UDC 631.452:631.442

OPTIMIZATION OF FERTILITY INDICES OF PODZOLIC SOILS VIA CULTIVATION OF PHYTOMELIORANTS

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Received on January 18, 2018

Aim. To determine and estimate the impact of phytopotential of cultivated plants on the fertility indices of podzolic soils, the main factors, limiting the performance of crops, and to establish economic efficiency of cultivating phytomeliorants, different in their physiological properties. **Methods.** Field, laboratory, mathematical-statistical. **Results.** Comprehensive four-year-long studies (2013–2017) established that the optimization of physical and chemical properties of podzolic soils is achieved via the application of phytomeliorant measures. First and foremost, these measures are aimed at preventing the decalcification of soils, i.e. they condition the accumulation of an active Ca^{2+} ion, which promotes improving the soil characteristics due to progressing development of cumulative soil genesis. It was established that with the mass of alfalfa roots of 9.7 t/ha and sainfoin of 9.9 t/ha, the 0–100 cm layer of podzolic chernozem contains 148.6 and 109.2 kg/ha CaO respectively. Enriching the root-containing layer of soil with calcium compounds promotes replenishing the soil with active calcium, thus ensuring the optimization of the lime potential (pH – 0.5pCa). The latter affects both the acid-alkaline balance and the regulation of physical and chemical processes in soil. It was established that after three years of phytomelioration, the soil in variants with perennial grasses is characterized with higher buffer against acid-alkaline load compared to the control variant which is confirmed with the indices of acid-alkaline buffer. Taking the abovementioned into consideration, one may assume that the very increase in the activity of calcium is one of buffer mechanisms of soil against acidification. It was proven that phytomelioration is efficient in terms of improving physical properties of soils, and soil structure, in particular, due to the decrease in the number of dusty and lumpy fractions. It was established that due to phytomeliorant measures the saturation of soil-colloid absorbing complex with calcium ensures intense improvement of water resistance of aggregates for two years. It was proven that optimal values of soil composition density for most crops of the Forest-Steppe zone may be achieved while cultivating Sudan grass for one year. The improvement of the main indices of soil fertility via phytomeliorative measures led to the increase in the performance of corn and barley and improvement of quality properties of grain. **Conclusions.** Phytomeliorative technology of cultivating podzolic soils ensures the balanced use of soils with simultaneous orientation towards preservation of resources, ecological safety and supplying the population with stable yield of crops with high quality of products.

Keywords: cultivation, phytomeliorative measures, podzolic soils, acid-alkaline state, structural aggregate composition, composition density.

DOI: 10.15407/agrisp5.01.042

INTRODUCTION

Podzolic soils are rather specific natural formations with a genetically inherent multivector character of soil-forming processes. In case of combining multidirectional podzolic-forming and accumulative processes, specific soil genesis of podzolic soils is the reason, conditioning their "problematic nature" in the aspect of resistance to degradation under the impact of increasing natural and anthropogenic burdens. First of all, climatic changes, occurring with impressive rates recently, should be referred to natural burdens, negatively impacting the soil-forming processes in podzolic soils. These changes are accompanied by contrast weather cataclysms – rapid change of temperature, continuous periods without any rains, and, vice versa, intense precipitations. The latter conditions the increase in transpirational ability of soils, promotes washing-out colloids, saturated alkali and nutrients for plants, dehumification, etc. [1–3]. A considerable impact on the development of degradation processes is also made by anthropogenic actions, which, first and foremost, include soil tillage with heavy machinery, decrease in the volumes of introducing organic fertilizers, insufficient introduction of mineral fertilizers and meliorants, especially calcium-containing ones. Starting with 1990, the average annual introduction of organic fertilizers in Ukraine decreased catastrophically from 12 t/ha to current 0.4–0.1 t/ha [4, 5]. Along with the prevailing podzolic component, the abovementioned negative factors promote the development of a number of degradation processes and phenomena in the old-arable soils, such as overconsolidation, loss of agronomically valuable structural aggregates, destabilization of acid-alkaline state, deterioration of buffer properties, development of erosion, etc. For instance, the rates of expanding the areas of podzolic soils with increased acidity are 0.4–0.5 % a year.

Due to the negative effect of the mentioned factors, the podzolic soils with high fertility transformed into soils with medium level of fertility, and their properties keep deteriorating. As a result, the Forest-Steppe of Ukraine, a place with common podzolic soils, has about 1.8 million ha soils with increased acidity [5]. It is the podzolic soils of the Forest-Steppe zone, where the deterioration of physical, chemical and aqueous-physical properties of soils is felt especially bitterly. The result of degradation of these soils is the decline in the yield of crops due to the acidity of soil, deterioration of physical-chemical and physical properties, and water-air regime, *etc*. The abovementioned degradation phenomena cause huge losses for farmers and the state in general. The actual losses of agricultural products only due to overconsolidation of soils amount to hundreds of thousands of dollars annually. The annual shortfall in the production of the main crops due to negative impact of soil acidity is about 1 million 350 thousand tons of grain units [5].

It is dangerous to leave degradation processes in podzolic soils often undetected, thus, their results are evident only in the state of decay, when common preventive measures are not capable of counteracting the degradation. Therefore, it is easier to prevent these processes than to eliminate their consequences.

The decisions of the UN Conference on Environment and Development (1992, Rio de Janeiro) stated that protection and rational use of soils should be the central component of the state policy.

At present, special relevance is attributed to the measures of increasing the fertility of soils and maintaining ecological equilibrium in agroecosystems via the application of biological factors [6]. In this aspect a hopeful direction of solving the problem of keeping the podzolic soils from degradation is phytomelioration as a "soft" ecology-safe measure of restoring the fertility of soils via natural phytopotential of crops. The main value of phytomelioration is ensuring the change in the direction of the soil-forming process from the eluvial trend to the cumulative one. In addition, due to the absence of finances for fertilizers and meliorants, this is an additional reserve of economy of energetic and material resources with the simultaneous orientation to protecting the ecological safety of the environment. Phytomelioration allows stepping aside from template technologies, commonly used to increase the fertility of podzolic soils, which are a relevant component of the soil cover of Ukraine (about 7.8 million ha of agricultural land) and a valuable component of biosphere in general, and coming to the new stage of developing balanced use of soil.

It should be noted that scientific literature highlights the issue of phytomelioration impact on the change in the properties of alkali soils rather well [7–10]. Phytobiological melioration presupposes correct selection of crops, capable of both growing and developing on halogenous soils, and promoting the formation of the negative salt balance in them. They are also one of the ways of fighting toxic burden on soils.

Regardless of rather multidirectional subject matter of studies on the application of phytomeliorative measures to improve the properties of soil both in Ukraine and abroad [11–14], this problem has not been studied sufficiently in the aspect of complex approach and introduction into practice with the purpose of preserving and restoring fertility of podzolic soils proper.

MATERIALS AND METHODS

The studies were conducted at the National Scientific Center "Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky" for 2013–2017. The object of studies was podzolic heavy loamy chernozem on forest-like clay loam (Kharkiv district, State enterprise "Experimental Farm Hrakivske").

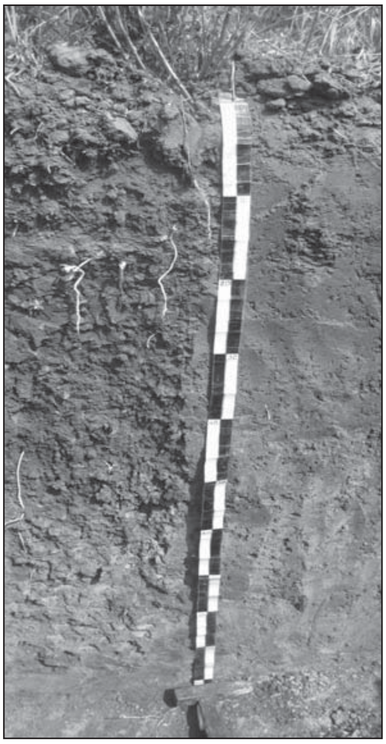

Fig. 1. The profile of podzolic heavy loamy chernozem on forest-like clay

Podzolic chernozem is heavy loamy by its granulometric composition, it contains 42.2 % physical clay. It has the following physical-chemical indices in the arable layer: pH_{salt} – 4.7, hydrolytic acidity – 4.3 mmol/100 g of soil, the sum of absorbed alkali – 21.9 mg-eq/100 g of soil. Calcium prevails in the composition of exchange cations (18.3 mg-eq/100 g of soil) and magnesium (3.1 mg-eq/100 g of soil).

Prior to starting the field experiment on small plots, podzolic chernozem had the following characteristics by agrochemical indices: the content of mineral nitrogen was 12.4 mg/kg, mobile phosphorus – 35.8 mg/kg of soil, movable potassium – 78.3 mg/kg of soil. The content of total humus was 2.5 % which characterizes the studied soil as low humus soil.

Soil section was laid in the variant with alfalfa (Fig. 1): He (0–30 cm) – humic weakly eluviated (arable), dark gray with silica powdering $Si0_2$, dusty-loamy, dry, low density, with a plow sole at the depth of 18 cm. Nut-like structure is observed starting from the depth of 20 cm. The whole horizon is densely packed with the roots of alfalfa, the transition is gradual by its structure and color;

Hpi (30–59 cm) – upper transitional, weakly eluviated, gray with brown shade, weak glossiness of aggregates is observed, nutty-loamy, dry, dense, with worm holes, less packed with roots, the transition is gradual by the color and structure;

Phi (59–75 cm) – low transitional, weakly eluviated, dark brown, with colloid glossiness, nut-prismatic, cold, heavily dense, weakly packed with roots, the transition is gradual;

P(h)i (75–105 cm) – transitional to the source rock, eluviated, brown, heavily dense, transition to the next horizon along the line of carbonate deposits;

Pк (105 cm and deeper) – the formation is forest-like clay, dark tan color, fine grain structure, carbonates in the form of mycelium, frequent mole runs, filled with humus material, some roots are observed.

The field experiment was started by the scheme, including the following variants: control, alfalfa, sainfoin, soy, lupine, mustard, Sudan grass. Annual phytomeliorants were grown in the following rotation: soy → Sudan grass → lupine → mustard; control: barley → corn → millet. The crops of varieties, introduced to the State register of varieties of plants, suitable for cultivation in Ukraine, were grown in the experiment.

The technology of cultivating crops is common for the Left-Bank Forest-Steppe of Ukraine. Two years prior to starting the field experiment and during the latter, fertilizers and meliorants were not introduced, which allowed singling out phytomeliorant properties of each selected crop proper. In addition, the studies investigated direct phytomeliorant action of crops (without covering with plow) which is absolutely different from sideration.

Field studies were performed by the method of B. O. Dospekhov, the selection of soil samples and their preliminary processing were done in accordance to DSTU 4287:2004 and DSTU ISO 11464:2007. The following indices were determined in the selected samples: acid-alkali buffer of soil (DSTU 4456:2005); density of soil composition per dry mass (DSTU ISO 11272:2001); structural and aggregate composition of soil using sieve method in the modification of M. I. Savinov (DSTU 4744:2007); the content of organic matter (DSTU 4289:2004); the content of mineral forms of nitrogen (N-nitrate and N-ammonium) by the modified method of NSC “ISSAR named after O.N. Sokolovsky” (DSTU 4729:2007); determination of calcium ions activity by the potentiometric method (DSTU 4725:2008); the content of exchange calcium and magnesium by the method of Schollenberg in the modification of NSC “ISSAR named after O.N. Sokolovsky" – MVV 31-497058-007-2005. Plant samples were used to determine nitrogen content (MVV 31-497058-019-2005), calcium content using the trilonometry method. The registration of corn grain yield was conducted according to GOST 11225-86; barley (DSTU 3769:98); soy (DSTU 4964:2008); lupine (DSTU 4789:2007); mustard seeds (DSTU 1052:2005); seeds of Sudan grass – in a one-phase way. The registration of root mass in soil was conducted by the method of solid masses of N. A. Kachynsky [15], without fractioning by size and without dividing into live and dead mass. The economic efficiency of phytomeliorant measures was estimated according to technological maps and relevant methods [16]. The mathematical processing of the results of studies was done using common methods of mathematical statistics and standard computer programs Microsoft Excel and Statistica 6.0.

RESULTS AND DISCUSSION

The decrease in the content of divalent cations of calcium and magnesium in podzolic soils is the factor, conditioning the shift of acid-alkali equilibrium of the soil solution towards acid side, promoting the acid degradation of soils and considerably limiting their performance. It was established that the optimization of physical-chemical properties of podzolic soils is achieved via phytomeliorative measures, which, first and foremost, are directed towards preventing their decalcification. Here the main factor of phytomelioration of soils is not chemical meliorants, but a number of plants, causing the accumulation of active ion Ca^{2+}, which promotes the improvement of physical-chemical, agrophysical and other characteristics due to progressing development of accumulative soil genesis. A relevant phytomeliorant measure of improving the calcium state of podzolic chernozem is cultivation of perennial grasses, which, after three years of such phyto-improvement, allowed increasing the content of exchange calcium in the 0–20 cm from 16.1 mmol/100 g of soil in the control to 26.9 mmol/100 g soil – in the variant with alfalfa and 24.8 mmol/100 g of soil – in the variant with sainfoin, and increasing the activity of ion Ca^{2+} (Table 1).

In our opinion, this fact is conditioned by the capability of the root system of perennial grasses to have biological translocation of calcium compounds from the lower layers of soil and even from the calcareous rock of forest-like clay into the upper layers. It was established that with the mass of alfalfa roots of 9.7 t/ha and sainfoin of 9.9 t/ha, the 0–100 cm layer of podzolic chernozem contains 148.6 and 109.2 kg/ha CaO respectively. Further on, after partial dying-off of the root system, calcium compounds, accumulated in the roots of alfalfa, along with the plant remains enrich the root-containing layer of soil with calcium. This meliorative specificity of perennial grasses promotes replenishing the soil with active calcium, thus ensuring the optimization of lime potential (pH-0.5pCa), the optimal values of which for podzolic chernozem are in the range of 4.8–5.2 in accordance to the current gradation [17]. The latter affects both the acid-alkaline balance and the regulation of physical and chemical processes in soil.

It was established that after three years of phytomelioration the soil in variants with perennial grasses is characterized with higher buffer against acid-alkaline load compared to the control variant. The latter is confirmed with considerable area of buffer volumes both in alkali (BVal) and acid (BVac) intervals of loads. It should be noted that the mentioned indices of buffer capacity, along with the coefficient of buffer asymmetry and total estimated index of buffer capacity, are quantitative indices of buffer capacity of soils [17]. Positive phytomeliorative action of alfalfa on acid-alkali buffer capability of podzolic chernozem after three years of cultivation is reflected on the chart of pH-buffer capacity (Fig. 2), where considerable areas of buffer volumes are observed both in alkali (positive) and acid (negative) intervals of loads.

After three years of cultivating alfalfa and sainfoin, BVal in the 0–20 cm layer was 38.74 and 33.83 points respectively, with the control of 36.12 points, BVac increased to 22.42 and 18.96 points, with the control of 17.78 points.

The total estimated index of buffer capacity and the buffer volume of the acid part decreased along the profile in the 20–40 and 40–60 cm soil layers, whereas the buffer volume of the alkali part and the coefficient of

Table 1. The change in pH of the activity of calcium ions and lime potential of podzolic chernozem (0–20 cm layer) after three years of phyto-improvement

Variant	pH	Lime potential, pH-0.5pCa	Calcium activity, aCa, mmol/dm^3
Control	5.8	4.2	1.3
Alfalfa	6.5	5.5	21.9
Sainfoin	6.2	5.1	16.6

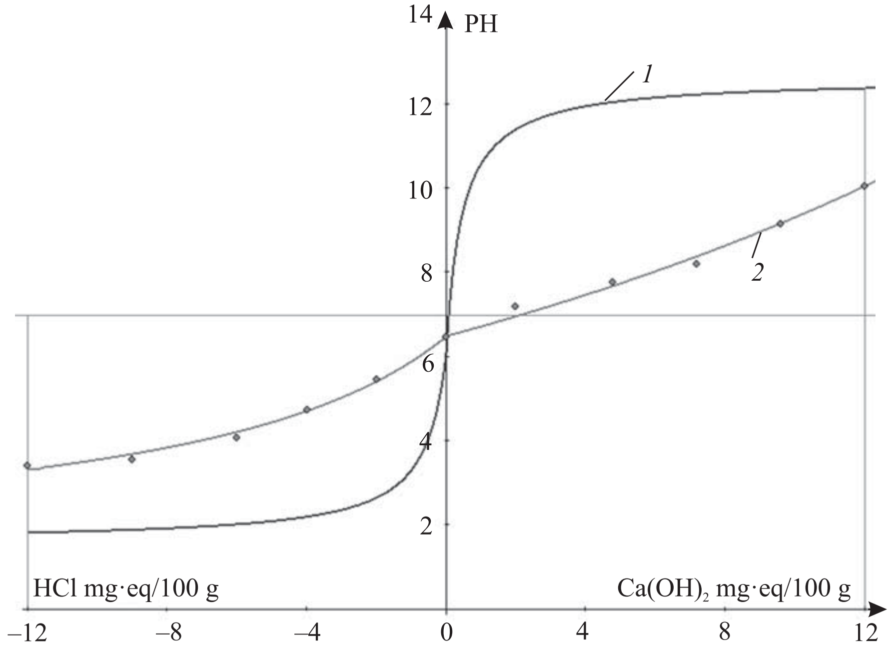

Fig. 2. The chart of pH-buffer capacity of podzolic chernozem after three years of cultivating alfalfa (0–20 cm layer): *1* – no-buffer substrate – washed river sand, pH – 5.5; *2* – podzolic heavy loamy chernozem after cultivating alfalfa, pH – 6.5

the buffer asymmetry in the 20–40 cm layer are better compared to the depth of 40–60 cm. In our opinion, this is due to the fact that the 20–40 cm layer is characterized with higher acidity and lower activity of calcium, compared to the lower layer. A similar tendency was established in the variant with cultivating sainfoin.

The statistical analysis of the results obtained allows stating that the very increased activity of calcium is one of buffer mechanisms of soil against acidification. The coefficient of correlation between these indices was 0.87, which testifies to a high level of interrelation between them.

The main indices, testifying to the aggravation of the qualitative state of soils and the development of degradation processes, include the decrease in the amount of organic matter, which is conditioned by extremely low volumes of introducing organic fertilizers due to the decay of animal breeding in Ukraine [5]. The studies established the tendency to the increase in the content of organic matter in the 0–20 cm layer due to phytocultivation, which is especially relevant in the context of catastrophic decrease in the introduction, and sometimes even complete absence of organic fertilizers. It was determined that the highest content of organic matter was observed after cultivation of perennial grasses for three years (from 1.83–1.90 % of organic matter under perennial grasses, the control being 1.51 %), which is reasonable considering the accumulation of the root mass of grasses (9.7–9.9 t/ha in the 0–100 cm layer) in soil. It proves the relevance of phytomelioration to ensure extended restoration of organic matter even in conditions of the absence of organic fertilizers.

The efficiency of phytomelioration in improving the physical properties of soils, including their structure, was proven. The highest number (89.3 %) of valuable structural components (10–0.25 mm) in the 0–20 cm soil layer under alfalfa was accompanied with the decrease in the dusty fraction down to 0.8 % at 4.4 % for the control. On the contrary, the smallest number of loamy aggregates was noted in the variant with sainfoin in the 0–20 cm layer (2.8 %). In the variant of cultivating Sudan grass for one year, the percentage of loamy aggregates was notably decreased down to 5.0–6.6 % at 11.2–16.4 % for the control. The differentiated impact of phytomeliorants of the soil structure, determined by us, allows correcting the direction of structure formation via the selection of crops, depending от the fraction, prevalent in the structure composition of soil – loamy or dusty. For instance, the decrease in the number of loamy aggregates is achieved due to the mechanic action of root systems of Sudan grass and perennial grasses. The decrease in the dusty fraction of soils takes place while cultivating alfalfa and sainfoin – via biotranslocation of calcium compounds as a relevant factor of structure formation. A similar impact is manifested by mustard – due to the structure-forming action of the root exudate

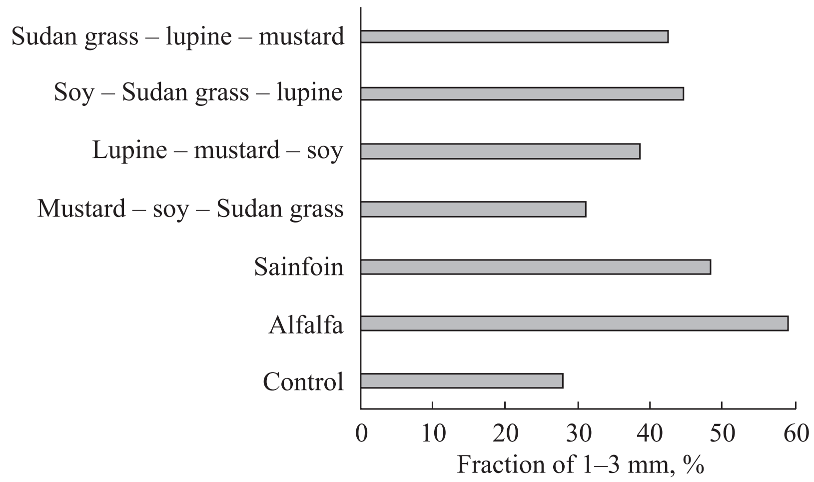

Fig. 3. The diagram of the content of 1–3 mm fraction (0–20 cm layer) in the structure of podzolic chernozem after three years of phytomelioration (in percentage)

(the sum of valuable structural components in the arable layer was increased by 11–18 % depending on the year of studies and the predecessor). In addition, the selection of phytomeliorants with well-developed root systems has a positive effect on the processes of structure formation in lower horizons of soils. It should be noted that downwards along the soil profile the highest number of valuable structural aggregates was also observed in the variants with perennial grasses − after three years of phyto-improvement it was about 87–88 % in the 0–20 cm layer and 84–85 % in the 40–60 cm layer with the control being 73–75 %.

A relevant index of structural-aggregate composition of soil is the sum of aggregates of 1–3 mm in diameter, which are characterized as “agronomically most valuable”, as this is the fraction with the highest resistance to the ruining action of water and wind erosion (Fig. 3).

As seen from the diagram (Fig. 3) the percentage share of this index compared to the control variants is rather high for all the investigated phytomeliorants (after three years of phyto-improvement). The highest content of 1–3 mm fraction is noted under alfalfa and sainfoin, which is practically twice higher compared to the same index for the control.

In our opinion, a relevant reason of the formation of solid structure of podzolic chernozem may lie in the fact that the soil under perennial grasses has a plant cover for a longer period of time, which protects it from being ruined with precipitation, as the plant cover of the fields with crops receives the impact of raindrops.

In addition, our studies prove that during the cultivation of perennial grasses, the process of structure-formation of soils also depends on the content of calcium compounds in their root mass. Thus, during the seasonal dying-off of roots, the soil solution receives a considerable amount of active calcium, which takes a direct part in the formation of an agronomically valuable structure.

It was established that due to phytomeliorant measures the saturation of soil-colloid absorbing complex with calcium ensures intense improvement of water resistance of aggregates for two years. The coefficient of water resistance increases from 0.53 in the control to 0.57–0.95 under phytomeliorant crops.

It was proven that the decrease in the density of soil composition may also be achieved via the selection of crops with well-developed root system. In our studies this crop was Sudan grass which, within one year of cultivation, decreased the density of composition of podzolic chernozem in the 0–60 cm layer (Table 2) to the optimal values of density of the composition of soil for most crops of the Forest-Steppe zone [3].

Based on the results obtained, one may assume that in case of accurate selection of phytomeliorants with the consideration of their physiological specificities

Table 2. The impact of the cultivation of Sudan grass on the density of soil composition

Depth, cm	Density of composition, g/cm^3	
	Initial value	Sudan grass
0–20	1.31	1.19
20–40	1.34	1.26
40–60	1.39	1.31

and meliorative possibilities, the danger of excessive density, dusting and formation of loams decreases. In addition, the studies demonstrate a close correlation (a reverse linear dependence) between the density of composition and content of organic matter in podzolic chernozem while cultivating Sudan grass (r = 0.64).

At the same time, phyto-improvement also has a positive impact on the accumulation of macroelements in soil, required for balanced growth and development of crops, for instance, nitrogen, the deficiency of which inhibits the growth of crops, especially during the initial period of their ontogenesis. It was determined that the cultivation of alfalfa, sainfoin, lupine and soy promotes the increase in the level of supplying the soil with nitrogen from the low level to the medium one. The latter testifies to the ability of these crops to provide for both its own need of nitrogen, and that of the crops of the following years, which is a relevant economic factor.

The improvement of the main indices of soil fertility using phytomeliorative measures led to the increase in the yield: corn – in the first year of aftereffect up to 4.4–5.8 t/ha with the control being 3.3 t/ha; barley – the second year of aftereffect up to 1.4–2.2 t/ha with the control being 1.3 t/ha. Here the qualitative properties of grain are improved as well, in particular, there is an increase in the nitrogen content in corn grain up to 0.46–0.84 % per dry mass with 0.45 % in the control; in barley grain – up to 0.55–1.52 % with 0.44 % in the control. There is also an increase in the calcium content in corn grain – up to 0.73–1.14 % per dry mass with 0.72 % in the control; in barley grain – up to 0.57–1.31 % with 0.43 % in the control.

Therefore, the application of phytomeliorant measures allows ensuring high functional resistance of podzolic soils which gives a possibility to increase their performance, to improve the agroecological state of environment in the territory of their spreading and to save 30–60 % of finances depending on the cultivation of specific crops-phytomeliorants. The estimation of the economic effect of the application of phytomeliorative measures with the consideration of the pricing policy during the years of studies (including two years of aftereffect) proves their high economical character: a conventional profit from the cultivation of crops-phytomeliorants is 1590–3630 UAH/ha.

CONCLUSIONS.

Phytomeliorative technology of cultivating podzolic soils via the use of natural potential of crops ensures the balanced use of soils with simultaneous orientation towards preservation of resources, ecological safety and supplying the population with stable yield of crops with high quality of products.

It was determined that the cultivation of perennial grasses for three years is reasonable to ensure optimal indices of fertility of podzolic chernozem with the purpose of optimizing the acid-alkali state and pH-buffer capacity. The optimization of agrophysical parameters of soil is achieved while cultivating perennial grasses, mustard, and Sudan grass. It was proven that the cultivation of Sudan grass for one year allows achieving optimal indices of the density of podzolic chernozem composition for most crops. The prolonged action of phytomeliorative measures was established. High efficiency of this agromeasure and adaptive properties of phytomeliorants to soil and climatic specificities allow stating the possibility of using the phytomelioration not only in the Forest-Steppe of Ukraine, but also in other zones of podzolic soils.

Оптимізація показників родючості опідзолених ґрунтів шляхом вирощування фітомеліорантів

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Мета. Виявлення та оцінювання впливу фітопотенціалу культурних рослин на показники родючості опідзолених ґрунтів, головні лімітуючі урожайність сільськогосподарських культур, а також встановлення економічної ефективності вирощування різних за фізіологічними особливостями фітомеліорантів. **Методи.** Польовий, лабораторний, математично-статистичний. **Результати.** На основі комплексних чотирирічних (2013–2017 рр.) досліджень встановлено, що оптимізація фізико-хімічних властивостей опідзолених ґрунтів досягається шляхом застосування фітомеліоративних заходів. Ці заходи, в першу чергу, спрямовані на запобігання їх декальцинації, тобто обумовлюють акумуляцію активного іона Ca^{2+}, який сприяє покращенню характеристик ґрунту внаслідок прогресуючого розвитку акумулятивного ґрунтоґенезу. Встановлено, що при масі коріння люцерни 9,7 т/га та еспарцету 9,9 т/га, у шарі 0–100 см чорнозему опідзоленого зосереджується, відповідно 148,6 та 109,2 кг/га CaO. Збагачення кореневмісного шару ґрунту кальцій-сполуками сприяє поповненню ґрунту активним кальцієм, а отже забезпечує оптимізацію вапняного потенціалу (pH-0,5pCa). Останнє впливає як на кислотно-основну рівновагу, так на регуляцію фізико-хімічних процесів у ґрунті. Встановлено, що після трьох років проведення фітомеліорації ґрунт на варіантах з багаторічними травами характеризується вищою буферністю проти кислотно-лужних навантажень, порівняно з варіантом контролю, що підтверджується показниками кислотно-основної буферності. Відповідно до вищенаведеного, можна стверджувати, що саме підвищення активності кальцію є одним з буферних механізмів ґрунту проти підкислення. Доведено ефективність фітомеліорації щодо покращення фізичних властивостей ґрунтів і, зокрема, ґрунтової структури за рахунок зменшення кількості пилуватої і брилуватої фракцій. Встановлено, що насичення ґрунтово-колоїдного поглинального комплексу кальцієм, завдяки фітомеліоративним заходам, забезпечує інтенсивне покращення водостійкості агрегатів протягом двох років. Доведено, що оптимальних значень щільності складення ґрунту для більшості сільськогосподарських культур зони Лісостепу можна досягти при вирощуванні суданської трави впродовж одного року. Покращення основних показників родючості ґрунту завдяки фітомеліоративним заходам призвело до підвищення урожайності кукурудзи та ячменю та покращенню якісних характеристик зерна. **Висновки.** Фітомеліоративний спосіб окультурювання опідзолених ґрунтів забезпечує вихід на збалансоване використання ґрунтів з одночасною орієнтацією на ресурсозбереження, екологічну безпеку та забезпечення населення сталими врожаями сільськогосподарських культур з високою якістю продукції.

Ключові слова: окультурювання, фітомеліоративні заходи, опідзолені ґрунти, кислотно-основний стан, структурно-агрегатний склад, щільність складення.

Оптимизации показателей плодородия оподзоленных почв путем выращивания фитомелиорантов

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Цель. Выявление и оценка влияния фитопотенциала культурных растений на главные, лимитирующие урожайность сельскохозяйственных культур, показатели плодородия оподзоленных почв, а также установление экономической эффективности выращивания различных по физиологическим особенностям фитомелиорантов. **Методы.** Полевой, лабораторный, математический, статистический. **Результаты.** На основе комплексных четырехлетних (2013–2017 гг.) исследований установлено, что оптимизация физико-химических свойств оподзоленных почв достигается путем применения фитомелиоративных мероприятий, которые, в первую очередь, направлены на предотвращение их декальцинации, то есть обусловливают аккумуляцию активного иона Ca^{2+}, который способствует улучшению характеристик почвы, вследствие прогрессирующего развития аккумулятивного генезиса почвы. Установлено, что при массе корней люцерны 9,7 т/га и эспарцета 9,9 т/га в слое 0–100 см чернозема оподзоленного сосредотачивается, соответственно, 148,6 и 109,2 кг/га CaO. Обогащение корнеобитаемого слоя почвы соединениями кальция способствует пополнению почвы активным кальцием, а, следовательно, обеспечивает оптимизацию известкового потенциала (pH-0,5pCa). Последнее влияет как на кислотно-основное равновесие, так и в целом на регуляцию физико-химических процессов в почве. Установлено, что после трех лет проведения фитомелиорации почва на вариантах с многолетними травами характеризуется высокой стойкостью к кислотно-щелочным нагрузкам, по сравнению с контрольным вариантом, что подтверждается показателями кислотно-щелочной буферности. Согласно вышеприведенному, можно утверждать, что именно повышение активности кальция является одним из буферных механизмов почвы против подкисления. Доказана эффективность фитомелиорации в улучшении физических свойств почв и, в частности почвенной структуры, за счет уменьшения количества пылевидной и глыбистой фракций. Определено, что насыщение почвенно-коллоидного поглотительного комплекса кальцием, в результате фитомелиоративных мероприятий, обеспечивает интенсивное улучшение водостойкости агрегатов в течение двух лет. Доказано, что оптимальных значений плотности сложения почвы, для большинства сельскохозяйственных культур зоны Лесостепи, можно достичь при выращивании суданской травы течение одного года. Улучшение основных показателей плодородия почвы фитомелиоративными мероприятиями привело к повышению урожайности кукурузы и ячменя, улучшению качественных характеристик зерна. **Выводы.** Фитомелиоративное направление окультуривания оподзоленных почв обеспечивает выход на сбалансированное использование почв, с одновременной ориентацией на ресурсосбережение, экологическую безопасность и обеспечение населения постоянными урожаями сельскохозяйственных культур с высоким качеством продукции.

Ключевые слова: окультуривание, фитомелиоративные мероприятия, оподзоленные почвы, кислотно-основное состояние, структурно-агрегатный состав, плотность сложения.

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