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INFLUENCE OF DIFFERENT METHODS OF CULTIVATION AND FERTILIZATION OF MEADOW-CHERNOZEM SOIL ON THE CONTENT OF NON-EXCHANGEABLE POTASSIUM

ВПЛИВ РІЗНИХ СПОСОБІВ ОБРОБІТКУ ТА УДОБРЕННЯ ЛУЧНО-ЧОРНОЗЕМНОМГО ГРУНТУ НА УМІСТ НЕОБМІННОГО КАЛІЮ

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Abstract. *The influence of different methods of cultivation of meadow-chernozem leached soil on the content of non-exchangeable potassium is described. It has been established that minimal tillage compared to traditional plowing increases the content of this form of potassium, improving the conditions for its mobilization into an available form.*

Key words: *meadow-chernozem soil, minimal tillage, non-exchangeable potassium, root escutcheons, mobilization.*

Introduction.

Of all the elements of mineral nutrition of plants, potassium is presented as a cation that has a strong influence on quality indicators that determine the marketable properties of agricultural products, the content of nutrients useful for human health and, accordingly, competitiveness in the market. However, many factors related to the specific conditions of agricultural production (culture, soil, environmental conditions) often limit the absorption of potassium from the soil in quantities sufficient to meet the needs of plants for full fruit development and ensure high quality indicators [11, 12 , 13].

It is known that potassium is one of the elements of biophiles, which actively participates in complex soil processes and in the transformation of energy in plants, transport and biosynthesis of carbohydrates, as well as the formation of enzymes. In recent years, during the period of intensification of agriculture, the area sown by potassium-loving plants, which constantly remove it from the soil, has increased significantly, while the use of potassium fertilizers has significantly decreased since 1990, and their effectiveness has increased due to the extension of crop rotation [14, 15].

Non-exchangeable potassium in soils plays a very important role, as it sometimes makes up almost half of its gross content (i.e. tens of tons per hectare) and is capable of gradually changing into exchangeable forms. AND. Sokolova indicates

that this form of potassium is fixed, mainly, in the composition of crystal lattices of mica-like minerals - illites [10]. Their amount in the soil profile depends on the rock, they are partly formed as a result of weathering of micaceous silicates, or as a result of non-exchangeable sorption of potassium by three-layer silicates. A certain amount of non-exchangeable potassium is in trioctahedral micas, unstable to weathering. Illite and mica minerals - carriers of non-exchangeable potassium - are present in the soil in the composition of the most finely dispersed fractions - colloidal, silty and dusty [5, 6, 7, 10].

In 1912, K.K. Hedroits showed the fundamental possibility of the transition of non-exchangeable potassium into exchangeable forms [9, 10, 14]. Later, this conclusion was confirmed by many scientists [2, 9, 10]. Thus, exchangeable and immobile forms of potassium are in a constantly changing equilibrium. As plants use readily available exchangeable forms of potassium, part of the inactive (non-exchangeable) forms due to weathering processes, as well as under the action of root secretions, is mobilized into forms available to plants, and vice versa, when fertilizers are applied to the soil, part of potassium is transferred to the non-exchangeable form.

The purpose of the research is to study the content of the non-exchangeable form of potassium in meadow-chernozem soils and to find ways to involve the non-exchangeable fixed forms of the element in the soil-plant cycle.

Research material and methodology.

The research was carried out in a meadow-chernozem leached soil on a loam loam of the Andrushiv natural-agricultural district. In the chain of crop rotation: corn for silage, spring barley and perennial grasses against the background of traditional plowing and minimal tillage, five fertilizer options were used. In the experiment, fertilizers were applied to different crops (for example, mineral and organic fertilizers were applied to corn, and only mineral fertilizers were applied to spring barley and perennial grasses). It is obvious that the transformation of potassium forms in such conditions takes place differently, which probably affects the conditions of potassium nutrition of plants.

To determine non-exchangeable (hydrolyzed) potassium according to Pcholkin, it was extracted from the soil by extracting 2N HCl and the content was calculated based on the difference between this and acetic acid (according to Maslova) extraction [1]. The possibility of its mobilization was assessed by the amount of the content of non-exchangeable hydrolyzed potassium. The greater the difference between the amount of potassium obtained from these extractions, the higher the possibility of its mobilization and the greater the use of soil potassium by plants can be expected [3,5,11].

Research results and their discussion.

The results of the determination of non-exchangeable potassium indicate that its content changes under the influence of agrotechnical measures and the nature of the fertilizer (table).

Результати досліджень та їх обговорення

Результати визначення необмінного калію свідчать про те, що його вміст змінюється під впливом агротехнічних заходів і характеру удобрення (таблиця).

The content of non-exchangeable potassium in meadow-chernozem soil, under different crops depending on tillage and fertilization, mg of K_2O per 1 kg of soil

Soil layer, cm	Corn for silage		Spring barley		Perennial herbs		Average	
	plowing	min processing	plowing	min processing	plowing	min processing	plowing	min processing
Control								
0-15	382	392	370	386	374	365	375	381
15-30	386	368	372	366	377	354	378	363
0-30	384	380	371	376	376	360	377	372
$N_{90}P_{60}K_{60}$								
0-15	397	419	387	411	392	409	392	413
15-30	405	384	391	390	403	387	400	387
0-30	401	402	389	400	398	398	396	400
$N_{90}P_{60}K_{60}$ + manure 12 t/ha								
0-15	436	485	426	463	417	470	426	473
15-30	484	438	452	418	435	423	457	426
0-30	460	462	439	441	426	447	442	450
$N_{90}P_{60}K_{60}$ + straw 2,4 t/ha								
0-15	434	459	406	447	408	459	416	455
15-30	458	436	424	418	431	423	300	426
0-30	446	445	415	433	420	441	358	441
$N_{90}P_{60}K_{60}$ + manure 12 t/ha + straw 2,4 t/ha								
0-15	474	558	430	489	420	481	441	509
15-30	505	444	433	414	437	430	458	429
0-30	500	501	432	452	429	456	450	469
LSD_{05} for processing								
0-15	*2,91*		*2,10*		*1,65*		-	
15-30	*2,06*		*2,21*		*1,79*			
LSD_{05} for fertilization								
0-15	*4,59*		*3,33*		*2,62*		-	
15-30	*3,26*		*3,50*		*2,83*			

The highest content of non-exchangeable potassium was noted in the soil layer of 0-15 cm for the application of mineral fertilizers, manure and straw and the use of minimal tillage (558 mg/kg of soil, which is 84 mg/kg more than for plowing). The introduction of mineral fertilizers contributed to its increase by 15 mg/kg for plowing and by 27 mg/kg for soil protection tillage. The soil layer of 15-30 cm contained this form of potassium from 386 to 505 mg/kg for plowing and 368-414 mg/kg for minimum tillage. As the doses of fertilizers increased, the potassium content in all soil layers increased. Without fertilizers for plowing, its content on average was 384 mg/kg, with full organic-mineral fertilization - 500 mg/kg, and for soil protection tillage, respectively, 380 mg/kg and 501 mg/kg.

During the cultivation of spring barley and perennial grasses, the tendency to increase this form of potassium was similar. Thus, in the first case, the highest content in the soil layer 0-15 cm was in the last version of fertilizer - 489 mg/kg with minimal tillage, which is 13.7% more than with plowing. When growing perennial

grasses, this option was also characterized by a high potassium content - 481 mg/kg, which is 14.5% more than when plowed.

The upper layer of the soil, due to the concentration of fertilizers and the largest mass of roots in it, with minimal tillage, had a larger amount of non-exchangeable form of potassium. Since during plowing, more fertilizers are placed in a layer of 15-30 cm, so more potassium was there.

Minimal tillage was preferred in variants where no fertilizers were applied. So, in the control, for the cultivation of spring barley, the top layer of the soil with minimal tillage contained 392 mg/kg of potassium, which is 10 mg/kg more than for plowing. The predecessor of barley was winter wheat, the main mass of roots of which is concentrated in the upper layer of the soil. In the early stages of growth, root secretions make up 7-10% of the above-ground mass of plants, and during the growing season - 25% of the total mass, and the total amount of root exudates is close to the economic yield and even exceeds it [4].

Conclusions.

Soil protection technologies, in contrast to traditional ones, contribute to a better mobilization of potassium. Obviously, the transition of the exchangeable form of potassium into the non-exchangeable form contributes to the accumulation of the latter in this soil. Under favorable conditions, the non-exchangeable form turns into the exchangeable form and is a source of nutrition for plants.

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Анотація. *Викладено вплив різних способів обробітку лучно-чорноземного вилуженого ґрунту на вміст необмінного калію. Установлено, що мінімальний обробіток порівняно з традиційною оранкою, підвищує вміст цієї форми калію, покращуючи умови для його мобілізації у доступну форму.*

Ключові слова: *лучно-чорноземний ґрунт, мінімальний обробіток, необмінний калій, кореневі ескудати, мобілізація.*