AUXILIARY DISCIPLINES

DOI: https:/doi.org/10.23649/jae.2022.1.21.8

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Received: 02.03.2022; Accepted: 04.03.2020; Published: 11.04.2022

CONTENT OF EXCHANGEABLE POTASSIUM IN HYDROMORPHIC SOILS OF THE KAMENNAYA STEPPE

Research article

Abstract
The conducted studies (2021) revealed an increase in the content of exchangeable potassium in all soils of the complex of waterlogged soils over time. In them, the content of exchangeable potassium fell with depth. In waterlogged soils, regardless of landscape affiliation, in May–June the content of exchangeable potassium was higher than in automorphic soils, in July–August – on the contrary.
Keywords: hydromorphic soils, exchangeable potassium, fertility.

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Получена: 02.03.2022; Доработана: 04.03.2020; Опубликована: 11.04.2022

СОДЕРЖАНИЕ ОБМЕННОГО КАЛИЯ В ГИДРОМОРФНЫХ ПОЧВАХ КАМЕННОЙ СТЕПИ

Научная статья

Аннотация
Проведенные исследования (2021) позволили выявить изменение содержания обменного калия во всех почвах комплекса переувлажненных почв со временем. В них содержание обменного калия падало с глубиной. В переувлажненных почвах, независимо от ландшафтной принадлежности, в мае — июне содержание обменного калия было выше, чем в автоморфных почвах, в июле–августе – наоборот.
Ключевые слова: гидроморфные почвы, обменный калий, плодородие.

1. Introduction

Throughout the history of human development, one of the most urgent tasks remains the preservation and improvement of soil fertility. The main feature of modern soil development is the multi–faceted and multi–faceted anthropogenic impact on the soil formation process [1, P. 7], [2, P. 28], [3, P. 48], [4, P. 26]. As a result of anthropogenic impact on the soil, degradation processes have spread widely, one of which is waterlogging. In connection with the uplift of soil-ground waters in the conditions of the Central Chernozem zone, there were changes in the direction of soil–forming processes.

The transformation of the steppe landscape into agroforestscapes during the XX century contributed to a change in the combination of soil formation factors [5, P. 16], [6, P. 18], provoked an anthropogenic transformation of the properties of chernozems under arable land and a new stage in the evolutionary development of automorphic chernozems into semi-hydromorphic and hydromorphic soils. This had a significant impact on soil fertility.

The research area in the Stone Steppe included the study of soil fertility. An additional tool for regulating the effective fertility of chernozems, according to Cheverdin Yu. I. (2018), is the regulation of the addition parameter of the arable horizon of chernozems, optimization of the addition density. In modern agricultural systems, the formation of agrogenically compacted horizons is noted. A close correlation was established as a result of statistical processing of a large accumulated factual material between the addition density and the supply of batteries: the coefficients of pair correlation between the addition density and nitrate nitrogen r = –0.689±0.194; density and mobile phosphorus r = –0.709±0.188; density and exchange potassium r = –0.762±0.173 [7, P. 185–186].

An important factor affecting soil fertility is the content of nutrients in soils, which are mobile nitrogen, phosphorus and potassium.

2. Materials and methods of research

The following soils were the objects of the study: ordinary chernozem (segregated chernozem) (P–4); meadow-chernozem soil on the plain elevation (hydrometamorphic agrochernozem) (P–2); chernozem–meadow saline soil on the plain depression (P–1); chernozem-meadow saline soil in the hollow depression (P–3) (the last two objects are humus – hydrometamorphic saline soils).

In the soils of all the objects of research, the mobile forms of potassium in fresh soil samples were determined according to the generally accepted method (exchange potassium – according to V. F. Chirikov GOST 26204–91), at depths of 0–20; 20–30; 30–50; 50–70; 70–100 cm, which allows us to judge the soil fertility of the above–mentioned objects.

3. The research results

Automorphic chernozem was characterized by a higher content of exchangeable potassium. In its soil profile, a natural decrease in the content of the amount of exchangeable potassium with depth was noted.

The minimum amount of exchangeable potassium was typical for fallow areas, which is probably due to the fact that the natural composition of the soils of natural biocenoses without annual mechanical mixing of the upper horizons and the annual high intake of root residues led to the stabilization of soil processes and the consolidation of potassium in a non–exchangeable form.

The peculiarities of the water regime and the functioning of the complex of waterlogged soils left their mark on the formation of the elements of fertility. In meadow-chernozem soil on a plain rise (agrochernozem hydrometamorphosed), chernozem–meadow saline soil in a hollow-like decline (humus–hydrometamorphic saline soil) with depth, the content of exchangeable potassium decreases (Fig. 1). In chernozem–meadow saline soil on a plain decrease (humus–hydrometamorphic saline soil), the content of exchangeable potassium also decreases with depth [8, P. 191–192].

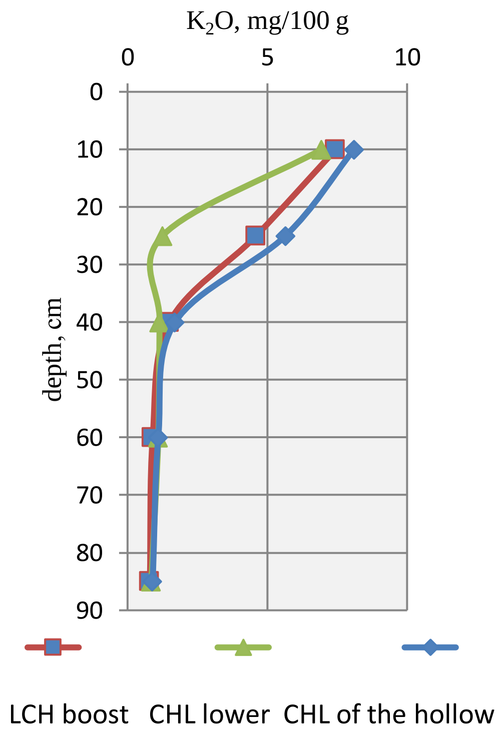

Fig. 1 – The content of exchangeable potassium in the soils of a seasonally waterlogged complex west of l. p. No. 131 (mg/100 g), 2021

Monitoring studies of soil fertility continued in 2021. During the growing season, we observed the content of nitrate nitrogen, mobile phosphorus, and exchangeable potassium in a layer of 0–30 cm of soil at sites with different intensity of soil moisture. These objects were a complex of waterlogged soils of the Stone Steppe, located to the west of the forest strip No. 131 on a relatively flat area of the field, which was mentioned above.

For the growth and development of plants, potassium is also necessary, as is nitrogen and phosphorus. Plants can more easily tolerate hot conditions with a normal potash diet, which is important for regions with frequent droughts [9, P. 117].

The content of exchangeable potassium in the soil is strongly influenced by factors such as humidity and soil acidity. According to Petersburgsky [10, P. 50], the alkalinization of the soil environment reduces the mobility of potassium and, as a result, its availability to plants, acidification has the opposite effect.

Studies conducted by us in 2021 on soil variants with different soil moisture content of the soil profile and different landscape accessories showed that in all variants, the maximum values of the content of exchangeable potassium for the entire growing season were noted in June (Fig. 2). The absolutely maximum value in June (17 mg/100 g) was noted in the meadow–chernozem soil of the plain elevation (P–2) of the soil complex west of the forest strip No. 131 (Fig.2).

At the beginning of the growing season, the maximum reserves of exchangeable potassium were observed in the hydromorphic chernozem–meadow soil of the plain and hollow–shaped depression of the P–1 and P–3 variants – 14.1 and 13.2 mg/100 g, respectively. Equally low reserves on the complex near the 131-forest belt were observed in soils with a lower degree of soil moisture–in the variants P–2 (LCH) and P–4 (CHO) (Fig. 2). In these variants, the scenario of changes in the content of exchangeable potassium is similar. First, in June, it increases to the maximum values, by July it goes down and reaches a minimum in August. For the variants of chernozem–meadow soils of depressions (P–1 and P–3), the picture is slightly different: from May to June, the content of exchangeable potassium remains almost unchanged, and only decreases by the end of the growing season.

As a result of our research, it was found that on variants with the same soil subtype, similar moisture regime, but located on different elements of the landscape, the content of exchangeable potassium differs. The arable section of the watershed plateau is significantly characterized by a higher content of potassium, compared to the slope.

Thus, the amount of potassium available to plants is related to the intensity of moisture in arable soils, as well as their landscape affiliation.

When comparing earlier studies on the content of exchangeable potassium in the soils of the waterlogged complex with later studies, in particular in 2021, we can state an increase in its content in all soils of the complex over time, which, in our opinion, may be due to changes in hydrothermal conditions over the years of research.

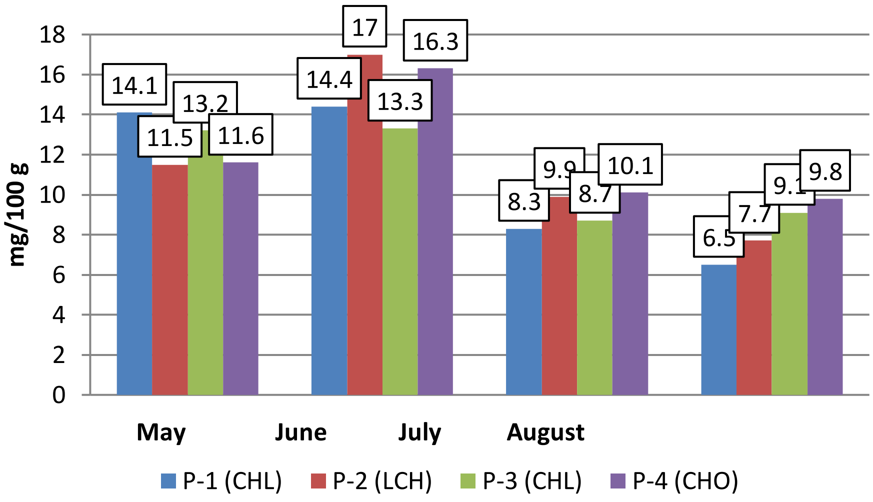

Fig. 2 – Reserves of exchangeable potassium in the waterlogged soils of the complex west of l. p. No. 131 during the growing season, 2021

The maximum content of exchangeable potassium in 2021 was in the soil of the object (P–2)–meadow-chernozem soil on a flat increase in June (17.0 mg/100 g of soil) and July (9.9 mg/100 g of soil), in earlier studies it was less (about 3.6 mg/100 g of soil). So, its content has increased over time quite significantly – 2.8–4.7 times. In May, the maximum content of exchangeable potassium was in the soil of the object (P–1) – chernozem – meadow soil of the plain depression: in 2020 – 14.1 mg/100 g of soil, and in earlier studies–only 1.2 mg/100 g of soil (an increase of 11.8 times over time). The second object in terms of the content of exchangeable potassium in May was the object (P–3) – chernozem-meadow soil of a hollow-shaped depression–in earlier studies 4.8 mg/100 g of soil, in later studies – 13.2 mg/100 g of soil (an increase of 2.8 times). In August, a different pattern was observed – the maximum content of exchangeable potassium was in the soil of the object (P–3) – chernozem–meadow soil of a hollow-shaped depression–in earlier studies, 4.8 mg/100 g of soil, in later studies–9.1 mg/100 g of soil (an increase of 1.9 times). The minimum content of exchangeable potassium was in the soil of the object (P–1)–chernozem-meadow soil of the plain depression: in earlier studies, 1.2 mg/100 g of soil, in later studies (2021) – 6.6–8.3 mg/100 g of soil (the increase over time was 5.5–6.9 times).

4. Conclusions

Thus, the minimum amount of exchangeable potassium was typical for waterlogged areas (chernozem–meadow soil of the lowland depression). The maximum amount is in less waterlogged soils (meadow–chernozem soil on a flat rise). The peculiarities of the water regime and the functioning of the complex of waterlogged soils left their mark on the formation of the elements of fertility. In all soils of the waterlogged complex west of the locality No. 131, the content of exchangeable potassium fell with depth. In our research conducted in 2021 the best availability of exchangeable potassium was observed in arable areas of semi–hydromorphic and hydromorphic soils west of forest strip No. 131 compared to ordinary chernozem (P–4) in May–June. In July–August, the opposite happened – the best security was in ordinary chernozem (P–4). It is possible to state an increase in the content of exchangeable potassium in all soils of the complex over time. The amount of potassium available for plants is related to the intensity of moisture in arable soils, as well as their landscape affiliation.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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