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EVALUATION OF THE NITROGEN REGIME OF CHERNOZEM LEACHED UNDER THE ACTION OF DIFFERENT DOSES OF TURKEY WASTE APPLICTION

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Abstract

As a result of field experiments on the experimental field of Penza State Agrarian University (Russia, Penza region, Mokshansky district), it was revealed that with the annual introduction of different doses of litter turkey manure, an increase in the content of alkaline hydrolysable nitrogen in the soil is observed, although by the end of the growing season its content decreases, which associated with the consumption of its mineral compounds by crops. Manure doses from 12 to 36 t/ha increased the content of alkaline hydrolysable nitrogen in the soil from 26.6-29.9 mg/kg at a dose of 12 t/ha to 40.0-53.9 mg/kg of soil at a dose of 36 t/ha. With the annual use of manure, a gradual increase in the content of nitrate nitrogen in the soil is observed. By the end of the growing season, its content in the soil decreased according to the variants, although its content at doses of 24 and 36 t/ha was characterized by high and very high. This indicates that that at high doses of manure, nitrate nitrogen is not completely absorbed by crops and its amount is excessive. With an increase in the dose of semi-rotted manure more than 12 t/ha with a high content of ammonia nitrogen compounds, its increase is observed at the beginning of the growing season, which can affect the formation of the yield of cultivated crops.

Key words*: leached chernozem, turkey manure, alkaline hydrolysable nitrogen, ammonia nitrogen, nitrate nitrogen.*

INTRODUCTION

The use of bird droppings in crop production for fertilizing crops will reduce the amount of accumulated waste from poultry farming and, thereby, guarantee the non-waste of technological processes in agro-industrial production (Chekaev et al., 2015; Schmidt A. et al., 2019). Bird droppings are a valuable fertilizer containing all the essential nutrients needed for plant growth and development. According to the assimilation of nutrients by plants, bird droppings are close to mineral fertilizers. However, its storage leads to large losses of valuable fertilizer qualities of the litter (Agadjihouèdé et al., 2011; Chekaev et al., 2020; Popov et al., 2019).

The most important aspect of poultry manure utilization as a fertilizer is the scientific approach to determine the dose that will give the maximum agronomic and economic efficiency (Agadjihouèdé et al., 2011; Schmidt et al., 2019).

In foreign sources, bird droppings are evaluated as a fertilizer with a high content of nutrients that increase the productivity of cultivated crops (Kantikowati et al., 2019; Mutlu et al., 2020; Uchiyama et al., 2014). To increase its effectiveness and reduce risks for the environment and public health, its preliminary biocomposting is proposed to reduce pathogenic microflora (Barnossi et al., 2020; Tagoe et al., 2008; Kantikowati et al., 2019).

The use of bird droppings as a fertilizer is hindered due to insufficient knowledge of the chemical composition of the droppings, there is no sufficiently substantiated technology for its use in crop rotation, and the specifics of its impact on soil fertility have not been identified (Chekaev et al., 2020; Schmidt et al., 2019).

In this regard, it seems relevant to study the chemical composition of litter fertilizer, determine the optimal doses of application for specific crops in different natural and climatic conditions, and assess the effect of litter fertilizers on soil properties in direct action and in after effect.

MATERIALS AND METHODS

In order to study the effect of different doses of turkey manure on the nitrogen regime of

leached chernozem during the cultivation of spring wheat, on the experimental field of the training and production center of the Penza State Agrarian University (Russia, Penza region, Mokshansky district), studies were carried out according to the following scheme: 1. Without fertilizers (control); 2. Turkey manure 12 t/ha; 3. Turkey manure 24 t/ha; 4. Turkey manure 36 t/ha.

The experience is laid in 3-fold repetition. The area of one plot is 8 m^2. Sowing of spring wheat (variety Granny) was carried out in the second decade of May. The soil of the experimental plot is represented by leached medium-humus heavy loamy chernozem. The content of humus in a layer of 0-30 cm is 6.11-6.48%, alkaline hydrolysable nitrogen is 98-108, mobile phosphorus is 120-128, mobile potassium is 109-116 mg per kg of soil, the reaction of the soil solution is slightly acidic (5.1-5.3), hydrolytic acidity – 4.85-5.57 mEq per 100 g of soil, the amount of absorbed bases is 34.4-36.2 mEq per 100 g of soil.

Bedding turkey manure on straw bedding was used in the experiments. The quality was characterized as semi-overripe. The share of nitrogen in the dry mass of manure was 2.57-2.77%, phosphorus - 3.86-4.58%, potassium - 2.04-4.41%, humidity 48.2-53.2%, organic matter content 37.3-43.1%, ash content 13.8-27.4%, pH - 7.0- 8.7 units

When conducting soil analyzes, the following research methods were used:

- alkaline hydrolysable nitrogen - according to the Kornfield method (modified);
- ammonium nitrogen in the soil in the modification (GOST 26489): the method is based on obtaining a colored indophenol compound formed in an alkaline environment by the interaction of ammonia with hypochlorite and sodium salicylate.
- nitrate nitrogen in the soil by the potentiometric method: the method is based on determining the concentration of nitrates in the soil using an ion-selective electrode in a salt suspension of a 1% solution of potassium alum at a ratio of sample : solution 1: 2.5.

RESULTS AND DISCUSSIONS

Nitrogen is a typical biophilic element, its behavior in the soil is primarily related to biological factors. The main part of nitrogen is not available to plants, as it is found in the soil in the form of complex organic compounds (94-95%). Only a small amount of nitrogen (about 1%) is contained in mineral forms easily digestible by plants. In this regard, the normal supply of nitrogen to plants depends on the rate of mineralization of nitrogenous organic substances and other factors.

Alkaline hydrolysable nitrogen, determined by the Kornfield method, is a combination of mineral nitrogen, represented by the ammonia and nitrate form, a certain amount of nitrogen of organic substances that are part of amino acids and amides, which can be easily mineralized.

According to the results of studies, doses of turkey manure from 12 to 36 t/ha increased the content of alkaline hydrolysable nitrogen in the arable layer of leached chernozem, already in the first year of action.

The selection of soil samples fifteen days after the introduction showed that in the variants with the introduction of manure, the content of this form of nitrogen increased by 18.7-47.7 mg/kg of soil. In the heading phase of spring wheat, two months after the application, the content of alkaline hydrolysable nitrogen in the soil, depending on the doses of manure application, ranged from 122.3 to 144.6 mg/kg of soil, which was higher than the control variant by 19.4-41.7 mg/kg.

By the end of the growing season, when cultivating spring wheat, a slight decrease in alkaline hydrolysable nitrogen was observed in the experimental variants compared to previous determinations. The decrease in the control variant was 11.2 mg/kg (Figure 1).

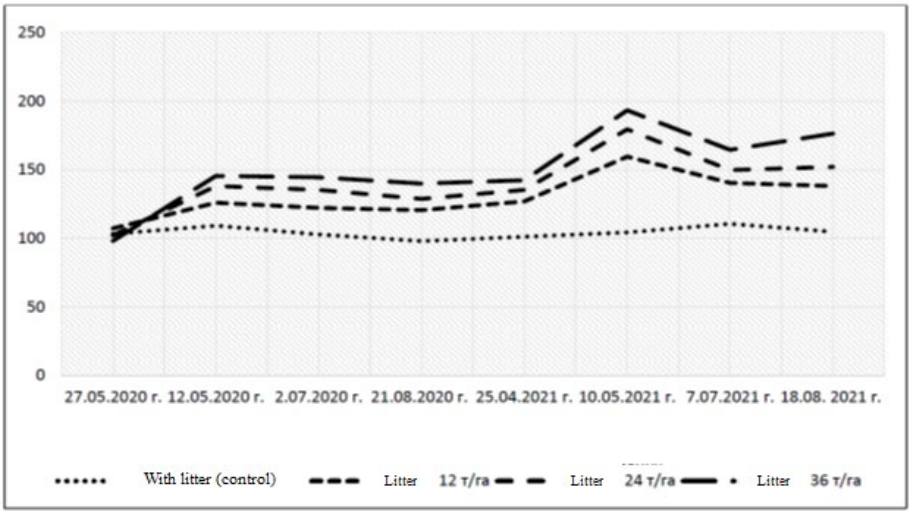

Figure 1. Dynamics of content of alkaline hydrolysable nitrogen in leached chernozem with turkey litter, mg/kg of soil

In 2021, before the introduction of the studied doses of manure, the content of alkaline hydrolysable nitrogen increased compared to the autumn determination in 2020 from 2.4 mg/kg in the variant with a dose of litter of 36 t/ha to 6.6 mg/kg in the variant with a dose of 24 t/ha, which is due to with the processes of mineralization of organic matter of plant residues from the litter.

15 days after the repeated application of the studied doses of manure, an increase in the content of alkaline hydrolysable nitrogen by 32.6-51.0 mg/kg of soil is observed. By the earing phase of spring wheat, with repeated application of the studied doses of manure, a decrease by 19.1-28.9 mg/kg is noted. At the end of the growing season of cultivated crops on plots with different doses of manure, the content of alkaline hydrolysable nitrogen in spring wheat crops ranged from 138.2 to 176.4 mg/kg of soil. On variants with manure doses of 24 and 36 t/ha, the nitrogen content corresponded to the average content.

Thus, with the annual application of doses of manure, an increase in the content of alkaline hydrolysable nitrogen in the soil is observed, although by the end of the growing season its content decreases, which is associated with the consumption of its mineral compounds by crops. Over two years of research, the studied doses of manure increased the content of alkaline hydrolysable nitrogen in the soil from 30.9 mg/kg at a dose of 12 t/ha to 78.2 mg/kg of soil at a dose of 36 t/ha.

The content of ammonia nitrogen in soils depended on the content of these forms of nitrogen in the litter. Before the introduction of the studied doses of manure in 2020, the content of ammonia forms of nitrogen in the soil fluctuated within 4.9-6.3 mg/kg of soil. Fifteen days after the application, the content of ammonia nitrogen in the variants with the studied doses of litter increased from 22.4 mg/kg at a dose of 12 t/ha to 40.9 mg/kg at a dose of 36 t/ha.

On variants with manure doses of 24 t/ha and 36 t/ha, the content of ammonia nitrogen was characterized as very high. In the middle of the growing season of spring wheat, its content decreased and amounted to 19.9 to 23.6 mg/kg of soil in the variants, which was higher than the control variant by 16.7-20.4 mg/kg.

By the end of the growing season, the content of ammonia nitrogen decreased to 5.8-9.2 mg/kg of soil (Figure 2).

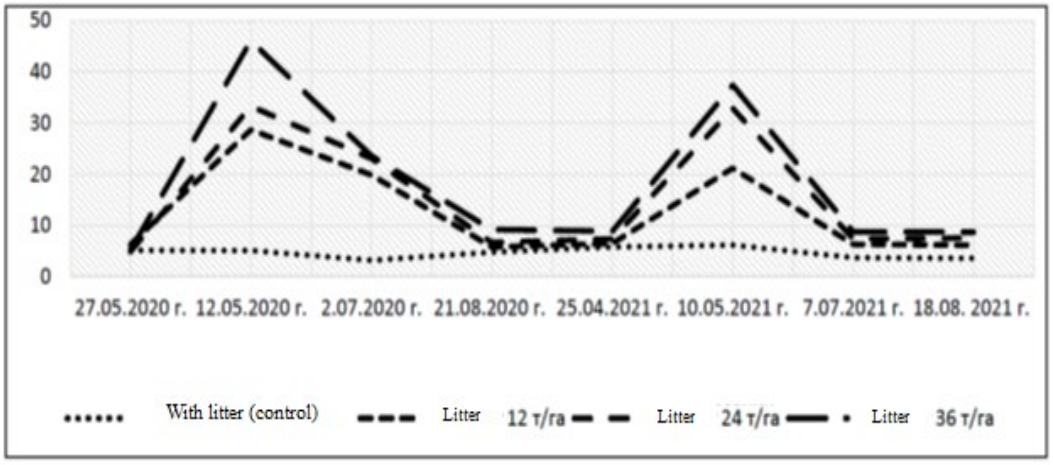

Figure 2. Dynamics of ammonia nitrogen content in leached chernozem with turkey litter, mg/kg of soil

With the repeated introduction of the studied doses of manure in 2021, the content of ammonia nitrogen in the experiments increased by 14.7-28.5 mg/kg compared to the data before the introduction, and in the heading phase its content decreased by 14.7-28.5 mg/kg and was in the range of 6.3-8.8 mg/kg soil.

The maximum values of ammonia nitrogen in the soil are observed within two months after application. By the end of the growing season, its content decreases. During the growing season, the content of ammonia nitrogen decreased and at the end of the growing season, the crops almost leveled off.

With an increase in the dose of litter, the content of ammonia nitrogen increased to a very high content.

The content of nitrate nitrogen in 2020 before the application of manure doses ranged from 12.2 to 15.2 mg/kg of soil (Figure 3).

Fifteen days after application, an increase in the content of this form of nitrogen by 25.9-60.9 mg/kg is noted. In the variant without fertilizers, the content of nitrate nitrogen was characterized as medium, with a dose of manure of 12 and 24 t/ha it was high, and in the variant with a dose of manure of 36 t/ha it was very high.

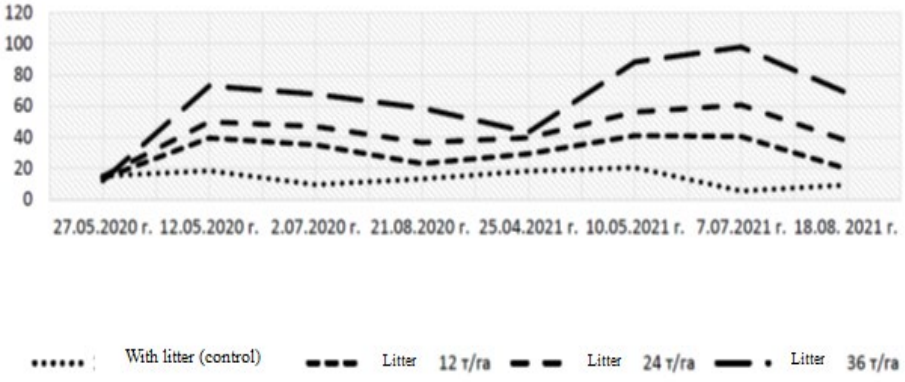

Figure 3. Dynamics of the content of nitrate nitrogen in leached chernozem with turkey litter, mg/kg soil

By the heading phase, the content of nitrate nitrogen decreased by 3.0-5.4 mg/kg, and by harvesting, the content of nitrate nitrogen in the soil ranged from 13.4 mg/kg in the control to 58.8 mg/kg of soil with a manure dose of 36 t/ha.

With a dose of manure of 12 t/ha, its content was characterized as medium, in the variant

with 24 t/ha of manure it was high, and in the variant of 36 t/ha it was very high.

In 2021, before the repeated application of the studied doses, the content of nitrate nitrogen in the soil ranged from 18.4 mg/kg of soil in the control to 43.3 mg/kg at a dose of 36 t/ha. Fifteen days after the second application, the content of nitrate nitrogen in the soil on plots with different doses of manure increased by 11.7-45.0 mg/kg.

By the earing phase of spring wheat, the content of nitrate nitrogen in the soil of the control variant decreased by 15.6 mg/kg, and in the variants with manure doses of 24 and 36 t/ha, an increase by 4.4-9.6 mg/kg was observed.

By harvesting, its content in the variants with manure decreased and ranged from 19.7 to 68.3 mg/kg of soil, while the content of nitrate nitrogen in the control was characterized as low, in the variant with a dose of manure of 12 t/ha - medium, with a dose of manure of 24 t/ha - high, and in the variant with a dose of manure 36 t/ha as very high.

Thus, with the annual use of manure, a gradual increase in the content of nitrate nitrogen in the soil is observed. By the end of the growing season, its content in the soil decreased according to the variants, although its content at doses of 24 and 36 t/ha was characterized by high and very high.

CONCLUSIONS

With the annual application of manure doses from 12 to 36 t/ha, an increase in the content of nitrogen compounds in the leached chernozem is observed. The highest values are observed in the first two months after application, and by the end of the growing season, the content decreases, which is associated with the consumption of its mineral compounds by crops.

The studied doses of manure gradually increase the content of alkaline hydrolysable and nitrate nitrogen in the soil. This indicates that at high doses of manure, nitrogen is not completely absorbed by the crops and its amount is excessive.

The remaining nitrate nitrogen at the end of the growing season would subsequently be lost from the soil due to leaching or denitrification, which leads to unproductive losses.

The content of ammonia nitrogen in the soil increases within two months after application, and by the end of the growing season, its content decreases.

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