UDC 631.82:631.4

Influence of fertilizer systems on stores of joints of nitrogen in sod-podzolic soils

Berdnikov O.[1] Potapenko L.[2], Datsko L.[3], Datsko M.[4]

[1, 2]Institute of agricultural microbiology and agroindustrial production of NAAS, Shevchenko Str., 97, Chernihiv, 14027, Ukraine, [3, 4]Institute of water problems and amelioration of NAAS, Vasylkivska Str., 37, Kyiv, 03022, Ukraine; e-mail: [2]potapienko74@ukr.net, [3]datskoluda@gmail.com, [4]miron_datsko@ukr.net

The purpose. To assess influence of different fertilizer systems on change of nitrogenous regime of sod-podzolic sandy loam soil in short-term field crop rotation. **Methods.** Field — stationary experiments, laboratory — determination of the content of nitrogen of easy hydrolyzable joints according to Cornfield, nitrate and ammonium — using ionometer method, mathematical-statistical analysis. **Results.** Influence is considered of organic, mineral fertilizers and their combination on dynamics of nitrogen of easy hydrolyzable and mineral joints in sod-podzolic soil. Analysis, assessment are realized, and dependence of changes of the content of accessible joints of nitrogen on sort of fertilizers is gained. It is established that the highest stores of nitrogen of easy hydrolyzable joints during vegetation at organic fertilizer system (dung — 20 t/hectare — average during crop rotation) on the average for 2012 – 2014 were 330 kg/hectare, that in 2,7 times above, than in control, or in 1,4 – 1,9 times above, than at other fertilizer systems. The share of mineral nitrogen from nitrogen of easy hydrolyzable joints increases from 12% in control almost up to 30% at importation of dung in dose of 20 t/hectare, that considerably improves nitrogenous regime of sod-podzolic sandy loam soil and nitrogen nutrition of plants. **Conclusions.** Stores of mineral nitrogen and nitrogen of easy hydrolyzable joints depend on sort of fertilizer and speed of its transformation in soil. More mineral nitrogen was accumulated in soil at organic fertilizer systems (dung — 20 t/hectare) and at use of combination of dung and green manure crop — from 15 up to 66 kg/hectare, or more than in 4 times. The highest stores of nitrogen of mineral joints on phases of growth of potato were at importation of fertilizers on green manure crop — 60-99 kg/hectare, dung — 20 t/hectare — 57 – 96, and at the combined system — dung together with fertilizers — 51 – 84 kg/hectare. Increase of share of joints of mineral nitrogen testifies to intensity of processes of molding of organic substance in soil, and at absence growing plants — about an opportunity of vertical migration of mineral nitrogen and increase of ecological load of region.

Key words: *nitrogen nutrition, fertilizer system, nitrogen, nitrogen of* easy hydrolyzable *joints, mineral nitrogen.*

DOI: https://doi.org/10.31073/agrovisnyk201906-03

In the course of agricultural activity, the direction and velocity of processes occurring in soils varies, and as a result, soil properties are changing rapidly, and some towards the deterioration. The introduction of fertilizers into the soil increases the number of mobile components of nutrients, including nitrogen, accelerating their transformation, migration and loss [1, 2].

Nitrogen is the only element of nutrition that is part of the main polymers of any cell and appeared in the soil due to biological activity [3, 4]. The main sources of nitrogen intake and accumulation in the soil are root and post-emergence remnants, by-products of cultivated crops, microbiological activity, organic and mineral fertilizers, which have different effects on the plant, its growth, development and yield [1, 2, 5]. The content of total and available nitrogen for plants, in general, depends on the content of organic matter, which is found in the soil or enters it with poplar-root residues and fertilizers. Lack of nitrogen retains growth processes, and its excess contributes to the formation of excessive vegetative mass [6]. However, an increase in not only gross but also available nitrogen compounds in the soil is a recommended agronomic measure aimed at increasing the yield of crops.

Plant nitrogen optimization is an extremely complex strategy, the miscalculations of which can not only cost the enterprise excessive costs, but even reduce yields and degrade the quality of cultivated products. The specificity of nitrogen supply is that this element has a narrow range between minimum and maximum, which results in harmful effects on plants both by its shortage and the excess [7].

The indicator of nitrogen easilyhydrolyzed compounds, characterizes the content of potentially available to plants of this element, which is associated with the mineralization of the organic part and depends on conditions that affect the biological processes in the soil. Thus, in sod-podzolic soils its share reaches 30-40% of the total, and in the black soil of the Steppe - 20-30% [8]. A quantitative and qualitative assessment of the content of mineral nitrogen in the soil gives the opportunity to more accurately establish the optimal standards for nitrogen fertilizers and adjust the terms of their introduction [8, 9]. Typically, the nitrogen regime of the soil depends on the type of fertilizer and the terms of application.

The purpose of the work is to evaluate the influence of different fertilizer systems on the change of the nitrogen regime of sod-podzolic sandy soils in short-rotation fertile crop rotation.

Materials and methods of research. Required data were obtained during field and laboratory studies, their analysis, generalization and mathematical processing. The research was conducted in a field stationary experiment at the Institute of Agricultural Microbiology and Agro-Industrial Production of the National Academy of Sciences of the Azerbaijan Republic on sod-podzolic sandy soils (Livoberezhnoe Polissya, Chernihiv region). The main agrochemical parameters in the layer 0-20 cm are: the content of humus - 1,1%, the nitrogen of lightlyhydrogenated compounds - 97 mg/kg of soil, mineral nitrogen - 7, mobile compounds of phosphorus - 135, mobile compounds of potassium - 80 mg/kg of soil, pH KCl - 4.9.

The research was carried out in a fruitful short-rotation crop rotation with the placement of crops: clover, winter wheat, potatoes, and wheat. In particular, the content of nitrogen compounds in the soil was investigated in the field of potatoes. In a stationary experiment, along with control (Control), three fertilizer systems with the following variants (medium fertility rates) were investigated:

1 - organic: manure 10 t/ha **(Mn10)**; manure 20 t/ha **(Mn20)**; sideratum lupine narrow-leaved 5 t/ha **(Sd1)**; manure 10 t/ha + sideratum rye in winter **(Mn10+Sd2)**;

2 - mineral: $N_{60}P_{64}K_{71}$ **($N_{60}P_{64}K_{71}$)**;

3 - organo-mineral: sideratum lupine narrow-leaved + $N_{60}P_{64}K_{71}$ **(Sd1+$N_{60}P_{64}K_{71}$)**; Manure 10 t/ha + $N_{60}P_{64}K_{71}$ **(Mn10+$N_{60}P_{64}K_{71}$)**.

Soil preparation, sowing, cropping and harvesting were carried out according to zonal recommendations.

In samples of soil, the nitrogen content of easilyhydrolyzed compounds (hereinafter - **Ne**), - according to Cornfield [10], the content of mineral nitrate and ammoniacal nitrogen (hereinafter **N-NO_3+N-NH_4**) - ionometric method [11], was evaluated for reserves and carried them mathematically-statistical analysis.

Research results. The results of our research indicate that the highest reserves of nitrogen easily hydrolyzed compounds for growing potatoes were on the background of an organic fertilizer system, namely a double norm of manure - 330 kg/ha. Compared to the control of this option, fertilizer reserves increased by 210 kg/ha or 2.8 times (Table 1). An increase in stocks occurred due to the prolonged use of all fertilizer options. According to the mineral fertilizer system of potatoes ($N_{60}P_{64}K_{71}$) and poddering of siderate, the growth of nitrogen of easily hydrolysed compounds was the lowest compared to other variants, but compared to controls at 57 and 48 kg/ha or 47 and 40% higher.

The lowest reserves of mineral nitrogen - 15 kg/ha were in control (Table 1). Studies have shown that the prolonged use of different fertilizer systems in different ways influenced the dynamics of this indicator. The largest amount of mineral nitrogen in the soil was accumulated in dual-manure and manure + siderate variants, namely, the reserves of N-NO_3 + N-NH_4 increased from 15 to 65-67 kg/ha, that is, more than 4 times compared with the control.

Table 1

Nitrogen reserves of easily hydrolyzed and mineral compounds with different fertilizers of potatoes in the soil layer 0-20 cm (average for 2012-2014)

Fertilizer options	Stocks of mobile nitrogen compounds			
	hydrolyzed (Ne)		mineral ($N\text{-}NO_3$+$N\text{-}NH_4$)	
	kg/ha	+/- to control	kg/ha	+/- to control
Control	120	-	15	-
Organic fertilizer system				
Mn10	231	+111	46	+31
Mn20	330	+210	65	+50
Sd1	168	+48	42	+27
Mn10+Sd2	234	+114	67	+52
Mineral fertilizer system				
$N_{60}P_{64}K_{71}$	177	+57	41	+26
Organic-mineral fertilizer system				
Sd1+$N_{60}P_{64}K_{71}$	198	+78	51	+36
Mn10+$N_{60}P_{64}K_{71}$	195	+25	55	+40
LSD_{05}	8		2	

A significant increase in mineral nitrogen stocks also resulted in the continued use of organo-mineral fertilizer systems (Cd1 + $N_{60}P_{64}K_{71}$ and Mn10 + $N_{60}P_{64}K_{71}$ variants), where reserves increased 3.4-3.6 times. The lowest increase occurred with the use of mineral and mineral fertilizer systems, where reserves increased 2.8 and 2.6 times, respectively.

It can be noted that the higher the rate of fertilizers, the greater the fluctuations of nitrogen of easily hydrolyzed compounds occur during the stages of development of potatoes (Fig. 1). In all variants of fertilizer where there is pus to flowering phase there is a decrease in nitrogen reserves of easily hydrolyzed compounds, which is increased in the phase of dying of the bud.

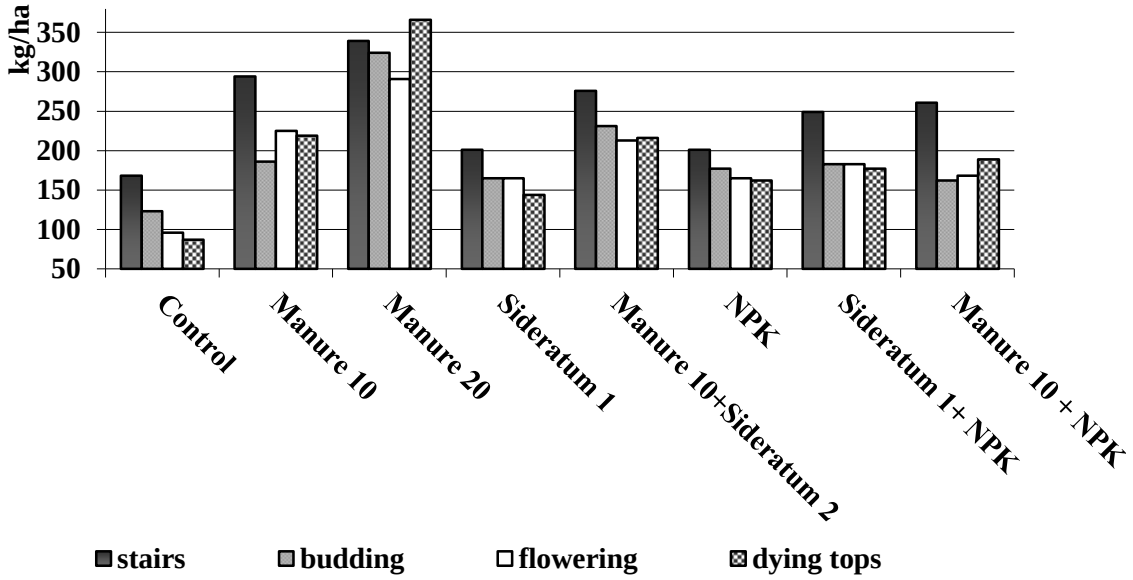

Fig. 1. Nitrogen reserves of easily hydrolyzed compounds in the soil layer 0-20 cm by stages of development of potatoes, (average for 2012-2014)

Under the organic fertilizer system, namely the introduction of double rates of manure, nitrogen reserves of easily hydrolyzed compounds in the sprouting phase - amounted to 339 kg/ha, in the budding phase decreased by 15 kg/ha, and in the flowering phase - by 11% compared to the budding phase, in phase of the dying of the bud increased the content of hydrolyzable nitrogen compounds to 366 kg/ha.

An increase in nitrogen reserves of easily hydrolyzed compounds ensured the application of a single standard of manure, in particular in the seedling phase, this indicator was highest (294 kg/ha), while budding nitrogen compounds decreased by 37 %, followed by an increase, namely during flowering and dying of the bud the nitrogen of the easily hydrolyzed compounds were respectively 225 and 219 mg/kg of soil. With the combined application of 10 t/ha of manure and the mineral system in the ladder phase, the reserves of Nlg were 261, 162, 168 and 189 kg/ha, respectively.

The introduction of a single standard of manure in conjunction with mineral fertilizers and mineral fertilizers in combination with siderate also contributed to the increase of nitrogen of easily hydrolyzed compounds by developmental stages compared to the control.

Observation of the dynamics of mineral nitrogen content showed that at the control and the mineral fertilizer system, its highest kg/ha were at the beginning of the potato vegetation (in the ladder phase) 27 and 49 kg/ha, which decreased by 3.5 and 1 by the end of the growing season, 5 times, respectively (Fig. 2).

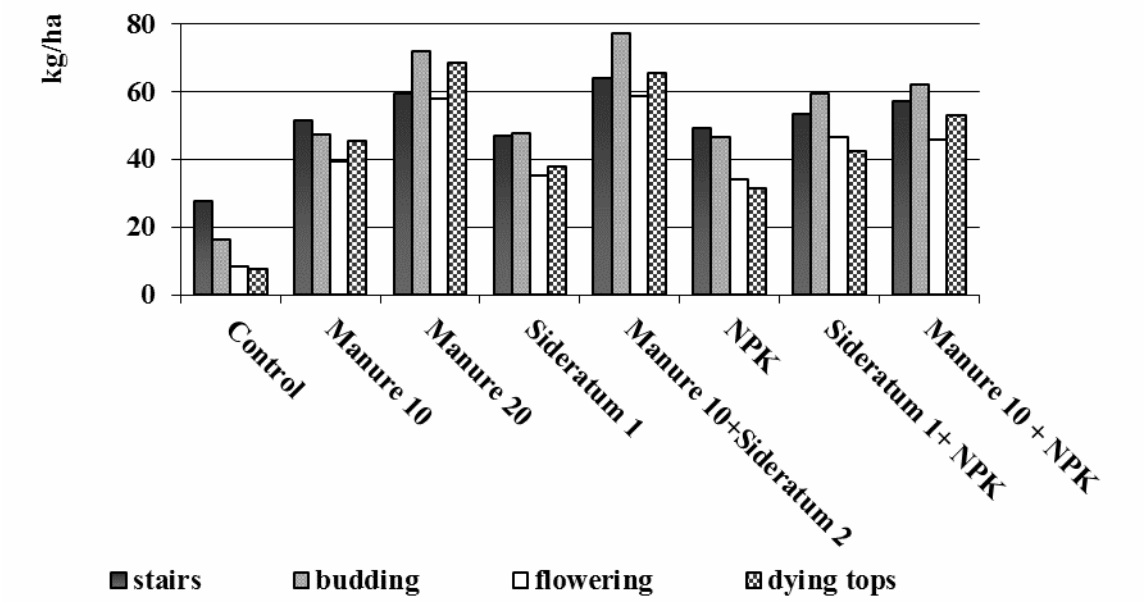

Fig. 2. Stocks of mineral compounds of nitrogen in the soil layer 0-20 cm by stages of development of potatoes, kg/ha

The highest mineral nitrogen reserves during the introduction of siderate together with manure and in the development phases ranged from 58 to 74 kg/ha, Manure 20 from 58 to 72 kg/ha and Manure10 + mineral system - from 45 to 62 kg/ha.

High plowing of agricultural land, saturation of arable land with energy-intensive crops, non-observance of scientifically grounded amount of fertilizing affect the mineralization-immobilization processes in soils and change of nitrogen stock [9, 12, 13].

We conducted a comparative assessment of the effects of fertilizer systems on the ratio of mineral to nitrogen nitrogen of easily hydrolyzed compounds. Studies have shown that for the cultivation of potatoes (Fig. 3), the lowest proportion of mineral nitrogen was observed at the beginning of the growing season (during the seedling phase) and depended on fertilizer systems. The lowest figure was in control and was 16 percent. The proportion of mineral nitrogen increased to 24% due to fertilizer application. A fairly high ratio was also observed for the introduction of siderate and manure in combination with siderate and this figure was 23%.

In the budding phase, there was a redistribution of the ratio of mineral nitrogen to nitrogen of easily hydrolyzed compounds, namely, the highest indicator was for the introduction of Mn10 + $N_{60}P_{64}K_{71}$ and was 38%. For maki Cd1 + $N_{60}P_{64}K_{71}$ and Mn10 + Cd2 these rates were 33 and 34%, respectively.

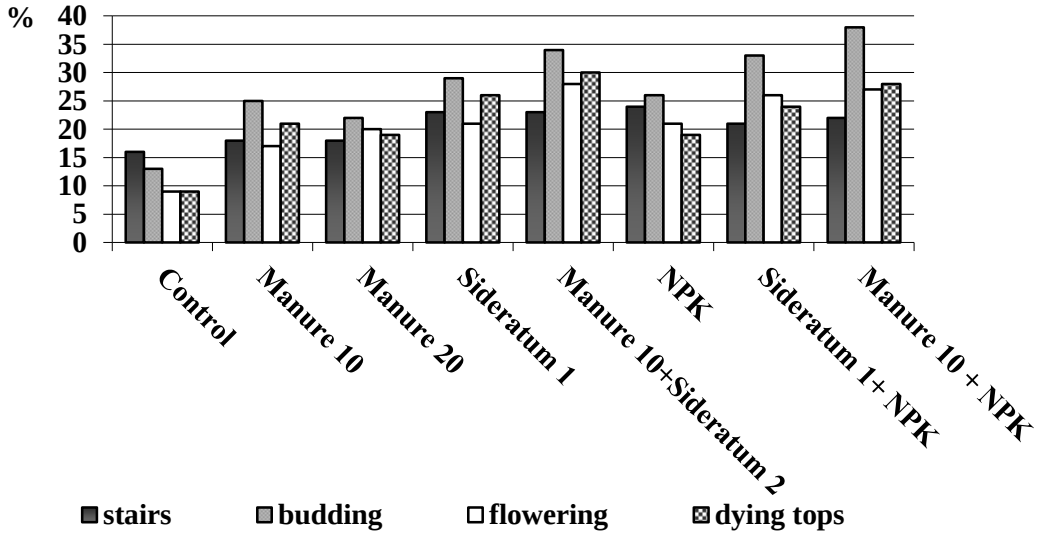

Fig. 3. The ratio of mineral compounds of nitrogen to nitrogen of easily hydrolyzed compounds when growing potatoes in different phases of its development, %

In the flowering and dying phase of the bud, the ratio of mineral nitrogen to nitrogen of the lightly hydrolyzed compounds was low, namely the minimum indicator was 9% in control. The application of manure with siderate and organo-mineral fertilizer system in these phases compared to other variants had the highest rates, which were respectively 28 and 30% and 27 and 28% respectively. At the end of the growing season there is a decrease in the proportion of these compounds, which indicates a decrease in the processes of mineralization in the soil.

Thus, an increase in the proportion of mineral nitrogen indicates the intensity of the processes of mineralization of organic matter and the need to look for other forms and combinations of organic and mineral fertilizers to reduce its unproductive losses.

Conclusions

The nitrogen reserves of the lightly hydrolyzed compounds for potato cultivation are the largest in the organic fertilizer system, namely the continuous application of twenty tons of manure. Compared to the control of this fertilizer system, the nitrogen content of easily hydrolyzed compounds in the soil increased 2.8-fold. Observations on the dynamics of nitrogen reserves of easily hydrolyzed compounds have shown that the higher the rate of fertilizers, the greater the fluctuations in the index change occur during the phases of culture development.

The reserves of mineral nitrogen compounds in the soil also depended on the type of fertilizers and the rate of conversion of nitrogen compounds in the soil. Most of the mineral nitrogen in the soil was accumulated by organic fertilizer systems on the variants Manure20 and Manure10 + sideratum, namely mineral nitrogen reserves increased from 55 to 66 kg / ha, ie more than 4 times compared to the control. The highest nitrogen reserves of the mineral compounds in the phases of potato development were in the cultivation of siderata together with mineral fertilizers and ranged from 60 to 99 kg / ha, double rates of manure from 57 to 96 kg / ha and organo-mineral - from 51 to 84 kg / ha.

Mineral nitrogen is closely related to the type and amount of fertilizers, and with the use of traditional organic manure fertilizer provided a more even supply of plants with nitrogen during the growing season than the combination of different types of organic fertilizers.

The increased ratio of mineral nitrogen to hydrolyzed nitrogen compounds indicates that mineralization and immobilization processes of organic matter and nitrogen compounds are intensively occurring in the soil. This is especially noticeable for organo-mineral fertilizer systems.

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