Nitrogen fund of the Chyrchik river basin’s dark serozems and its fractive structure

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Abstract: In this article, the information on the high-grade exposition of the amounts of mineral, easily goulizable, difficult goulizable and non-goulizable compounds of the dark serozems of the Chirchik River Basin of the Tashkent region, as well as changes in the effect of their use in viticulture is presented. These data serve to develop ways of effective and rational management of the Nitrogen Fund of the soils studied.

1. Introduction

The Chirchik River Basin is included in the system of vertical zoning belts of the Tien Shan within the boundaries of the Turan province in terms of soil-climatic zoning. Basin soils are developed in the following three elevation soil regions: serozemss developed mountain range and low mountain areas; and brown mountain - a region of medium mountains with developed forest soils; hungry - high mountainous region with developed brown meadow-steppe soils [1]. Dark serozems are mainly distributed in the highlands of the foothills and in the lowlands. These soils are developed in heavy sands at an altitude of 700-1000 meters above sea level.

According to the Tashkent Region Agro-Soil Map compiled by the Research Institute of Soil Science and Agrochemistry on a scale of 1: 200,000 in 2005, the total area of dark serozems is 140,985 hectares, of which 18,161 hectares are newly irrigated, 10,038 hectares are arable land, and 112 hectares are virgin-follow land. Dark serozemss are used in dry farming, horticulture and viticulture, as well as in the cultivation of fodder crops.

The formation, development, evolution of these soils, the properties and characteristics of these soils and the impact of natural factors such as relief, slope and exposure, water erosion and human activities on them have been thoroughly studied by many researchers [1-10], however, changes in their nitrogen fund and its components under the influence of natural factors and farming have not been studied at all. The soil nitrogen fund of the Republic and its components were studied mainly in irrigated soils until the 90s of the 20th century, and the main source of the results of these studies was H.T. Riskieva's data can be cited. According to these data, the bulk of nitrogen (95-98%) in irrigated soils of the serozems region belongs to the nitrogen of organic compounds. In the irrigated soils of this region, the amount of mineral nitrogen increases from hydromorphic soils to automorphic soils. The amount of non-hydrolyzable nitrogen (60-74%) predominates over other fractions. These soils are characterized by a relatively high amount of easily hydrolyzable nitrogen [11].

van Groenigen et al. [12] point out that the study of soil nitrogen process cycles has always been the focus of soil research. The importance of nitrogen as a nutrient for all biota: its increasing contribution to anthropogenic impact on natural and agro ecosystems; the resulting impact of its loss on the environment; the complexity of the biological, physical, and chemical factors that control nitrogen cyclic processes,
such as the need for a deeper study, understanding, and modification (management) of soil cycles of nitrogen [12].

The study of soil N cycling processes has been, and will be at the center of attention in soil science research. The importance of N as a nutrient for all biota; the ever-increasing rates of its anthropogenic input in terrestrial (agro)ecosystems; its resultant losses to the environment; and the complexity of the biological, physical, and chemical factors that regulate N cycling processes all contribute to the necessity of further understanding, measuring and altering the soil N cycle. Here, we review important insights with respect to the soil N cycle that have been made over the last decade, and present a personal view on the key challenges for future research [12].

Novikov points out that the total amount of nitrogen in the soil does not indicate that the plants are supplied with nitrogen, but its composition is important. All forms of soil nitrogen depend on the genetic characteristics of the soil, granulometric composition, humus reserves, climatic conditions, and in many cases are determined by the agronomic techniques used in the care of crops [13].

Gamzikov summarized the results of research devoted to the study of soil nitrogen reserves. G.P. Gamzikov noted that organic compounds of nitrogen make up the bulk of soil nitrogen (97-99%), 70-90% of which is contained in specific humic substances, and the rest from nonspecific compounds (amino acids, amino acids, bitumen, dead animal and plant remains, living and microorganisms. dead mass, etc.), non-hydrolyzable nitrogen accounts for 75.6-83.4% of total nitrogen, hard hydrolyzable nitrogen 9.7-14.6%, easily hydrolyzable nitrogen 4.8-10.9%, mineral nitrogen 0, 7-1.4%, the natural proportions between the forms of soil nitrogen are largely preserved. At the same time, the quantitative parameters of the mineral and its mobile organic compounds can be increased, the amount of easily hydrolyzed nitrogen determines the level of soil fertility and the potential capacity of nitrogen supply to plants [14, 15].

According to Grebennikov, as a result of many years of use of black soils, the amount of certain categories of soil nitrogen and the ratios between them change very slowly compared to the original reserve soil. At the same time, there is a mobilization of stable compounds of nitrogen in the humus, the most important indicator of this process is the amount of mineral and easily hydrolyzed nitrogen in the root layers of the soil [16].

In the Protsenko studies, the composition of nitrogen fractions of typical black soils varied depending on their location exposures. In the southern slope exposures, the amount of non-hydrolyzable nitrogen in the topsoil was lower than in the northern exposure, while the amount of hydrolyzable nitrogen was higher. As a result of the application of organic fertilizers, the amount of mineral nitrogen increased only in the soils of the southern exposure. As a result of the application of mineral fertilizers, the amount of easily hydrolyzed nitrogen fractions in the soils of the southern exposure increased, while the amount of other fractions did not change [17].

Nannipieri and Paul [18] analyzed the results of a number of studies and noted that despite 70 years of efforts, one of the main goals of soil nitrogen study - nitrogen mineralization volume, biologically assimilated nitrogen concentration and plant need for nitrogen fertilizers - was not sufficiently achieved. Wang et al. [19] conducted research on soils crossing semi-arid and arid meadows at a distance of 3,000 km in northern China. As a result, the amount of C and N has a positive correlation with soil and silt in the soil bed, a negative correlation with sand, and a decrease in the amount of C and N in the soil under drought conditions was detected. It was concluded that these data serve to understand the processes of sequestration of C and N in the soil under the expected global drought conditions [19].

Yangquanwei Zhong, Weiming Yan and Zhouping Shangguan show that the application of nitrogen fertilizers has a strong effect on the C and N cycles by altering certain fractions of them. Soluble organic carbon (DOC) and soluble organic nitrogen (DON) may serve as initial indicators of changes in the S and N cycles [20].

A new realistic conceptual model describing the formation of biologically assimilated nitrogen in terrestrial ecosystems was proposed in 2004 by Schimel and Bennett. According to this concept, high molecular weight organic compounds of nitrogen are mainly transformed into low molecular weight organic compounds as a result of the activity of extracellular enzymes (proteases), which under certain conditions can be assimilated by soil microorganisms and plants. Subsequent low-molecular-weight organic compounds can often form ammonia nitrogen using intracellular enzymes, and the ammonia nitrogen formed replenishes the nitrogen reserves assimilated in the soil [21].
Studies by Gotoh et al. [22] showed that the amount of organic nitrogen forms changes to some extent under the influence of microorganisms when organic material is added to the soil. All organic nitrogen fractions released from the soil under the influence of chemical reagents have been shown to be sufficiently dependent on the amount of nitrogen to be mineralized by the biological method. It is concluded that non-hydrolyzable nitrogen in the soil is also broken down microbiologically to simple nitrogen compounds, replenishing a relatively usable source of nitrogen [22]. Nitrogen is one of the most important nutrients in the ecosystem, and often its availability limits net primary production as well as stabilization of soil organic matter. Long-term storage of nitrogen-containing organic matter in soils has classically been attributed to the chemical complexity of plant and microbial residues that slowed microbial degradation. Recent advances have made it possible to revise this scheme with the understanding that persistent organic matter in the soil consists mainly of chemically labile, microbially treated organic compounds. Chemical bonding to minerals and physical protection are collectively more important for the long-term (ie centuries to millennia) conservation of these organic compounds, which contain most of soil nitrogen, rather than molecular complexity, with the exception of nitrogen in pyrogenic organic matter [23].

Nitrogen is one of the most important ecosystem nutrients and often its availability limits net primary production as well as stabilization of soil organic matter. The long-term storage of nitrogen-containing organic matter in soils was classically attributed to chemical complexity of plant and microbial residues that retarded microbial degradation. Recent advances have revised this framework, with the understanding that persistent soil organic matter consists largely of chemically labile, microbiologically processed organic compounds. Chemical bonding to minerals and physical protection in aggregates are more important to long-term (i.e., centuries to millennia) preservation of these organic compounds that contain the bulk of soil nitrogen rather than molecular complexity, with the exception of nitrogen in pyrogenic organic matter [23].

2. Method
Soil cuts were made on the northern (virgin soil and young vineyards) and southern (perennial vineyards) slopes of Zarkentsoy, located in the Parkent district of Tashkent region, and on the southern sloping vineyards near the village of Champagne. Samples were taken from the genetic horizons of soil sections. The samples were crushed and sieved on 1 mm and 0.25 mm sieves. Analysis of soil samples “Agrochemical methods of soil exploration” (1975), E.V. It was performed according to the methods described in Arinushkina’s "Manual of chemical analysis of soil" (1970). The fractional composition of soil nitrogen was determined in the Shkonde and Koroleva modifications of the Vorobev method. In this method, soil nitrogen compounds are divided into 4 fractions: mineral, easily hydrolyzable, difficult hydrolyzable and non-hydrolyzable fractions. In this method, specific humus substances and nitrogen contained in nonspecific organic compounds are determined.

3. Results and Discussions
The composition of the virgin soil studied on the northern slope of the left bank of the Zarkentsoy in section K-06-TTB. The mechanical composition is medium sand, the amount of physical mud fluctuates in the range of 31.8-46.2% along the cross section. The amount of carbonates is 5.8% in the 0-5 cm grass layer and 10.34% in the grass layer. Across the profile, the amount of carbonates fluctuates in the range of 12.46-12.83% as the amount increases. The amount of humus in the grass layer of 0-5 cm is 3.34%. It fluctuates in the range of 1.45% in the subsoil and 0.47-0.89% in the subsoil. The left bank of the Zarkentsoy in the K-07-TTB section has been turned into a 5-6 year old vineyard on the northern slope. The mechanical composition is medium sand, the amount of physical mud fluctuates in the range of 34.4-45.5% along the cross section. The amount of carbonates in the drive and sub-drive layers is 7.39 and 7.66%, respectively, with the bottom increasing sharply and fluctuating between 10.16-12.99%. The amount of humus in the turf plowing and driving subsoil was 1.98, respectively; 1.50%.
At the K-08-TTB intersection, the right bank of the Zarkentsoy was lowered into a perennial vineyard on the southern slope. The mechanical composition is medium sand, the amount of physical mud fluctuates in the range of 39.0-43.4% along the cross section. The lowest amount of carbonates belongs to the driving layer, which is 6.91%. Its amount increases evenly along the profile along the bottom (8.05-
10.82%), the maximum amount (13.86%) belongs to the layer of 91-131 cm. The humus content in the driving layer is 1.31% and in the sub-driving layer is 1.05%.

At the K-09-TTB intersection, the Champagne Village was planted in a perennial vineyard. Mechanical composition is medium sand, the amount of physical mud is 36.8-42.5% across the cross section. The lowest content of carbonates is 6.12-6.26%, which belongs to the drive and sub-drive layers. The amount of carbonates increased uniformly along the cross section (8.61-10.93%), with the highest amounts (10.93%) belonging to the layers of 85-109 and 109-120 cm. The reaction of the soil medium is weakly alkaline, fluctuating in the range of pH 7.82-7.90. The amount of humus in the driving layer is 1.78%, in the sub-driving layer 1.50%. In the lower layers, its content decreases sharply - 0.87-0.58%.

The amount of nitrogen in organic compounds in the dark serozems of the reserve developed in the northern exposition of Zarkentsoy is 94-95% of the total nitrogen, and in the assimilated dark serozemss - 92-93%. The amount of mineral nitrogen that plants can absorb is 5-7% in these soils.

The amount of total nitrogen in the grass and sub-grass layers of the virgin dark serozems is 2352.0 and 962.0 mg / kg, respectively, in the grass and sub-grass layers. The amount of mineral nitrogen that plants can assimilate is 131.6 and 53.2 mg/kg, respectively, which is 5.59 and 5.33% of the total nitrogen.

The amount of easily hydrolyzable nitrogen is 134.4 and 92.4 mg/kg, which is 9.6 and 5.71% of the total nitrogen, the amount of difficult hydrolyzable nitrogen is 432.2 and 266.8 mg/kg, and the non-hydrolyzable fraction is 1653.8 and 549.6 mg/kg or 70.3 and 57.0% of the total nitrogen.

Redistribution of nitrogen fractions occurred in the soils developed and used in viticulture. At the same time, the mastered (vineyard) soils of the northern exposure are distinguished by the richness of all fractions of nitrogen along the entire cross-section relative to the soils of the southern exposure (vineyards).

The amount of mineral nitrogen in the plowed layer of the northern exposure is 112.0 mg/kg in the under plowed layer and 78.4 mg/kg in the subsoil, and in the southern exposure it is 78.4 and 61.6 mg/kg, respectively.

The northern and southern exposure soils are characterized by close proximity to each other in terms of easily hydrolyzed nitrogen content. The amount of easily hydrolyzed nitrogen in the soils of the northern exposure is 140.0 and 122.4 mg/kg in the upper layers, and 134.4 and 117.6 mg/kg in the soils of the southern exposure.

These soils differ sharply in the amount of nitrogen that is difficult to hydrolyze. The amount of this fraction is 428.4 and 392.0 mg/kg in the plowed and under plowed layers of the northern exposure soils, and 224.0 and 222.0 mg/kg in the southern exposure soils. In both soils, the amount of this fraction of nitrogen gradually decreases downward along the soil cross section.

Soils developed in the northern exposure are superior to the soils of the southern exposure in terms of the amount of non-hydrolyzable nitrogen. The amount of this fraction in the of the northern exposure soils is 959.6 and 713.2 mg/kg, or 60.3 and 54.6% of the total nitrogen, respectively. In the soils of the southern exposure, its content is 583.2 and 348.8 mg/kg, respectively, or 57.1 and 46.5% of the total nitrogen. In both soils, the amount of non-hydrolyzable nitrogen was observed to decrease uniformly towards the lower layers.

The amount of total nitrogen in the plowed and under plowed layers of dark serozems developed in the southern exposition near the village of Champagne in Parkent district is 1260.0 and 1036.0 mg/kg, respectively. In the lower layers, however, it gradually decreases downward and oscillates in the range of 712–460 mg/kg.

The amount of mineral nitrogen that plants can assimilate in the plowed and under plowed layers of these soils is 73.4 and 60.2 mg/kg, respectively, accounting for 5.83 and 5.81% of the total nitrogen. In the lower layers, its content decreases sharply (25.2-38 mg/kg).

The amount of hardly hydrolyzable nitrogen in the upper layers is 257.6 and 193.2 mg/kg, or 20.44 and 18.65% of the total nitrogen, respectively. In the lower layers, its content fluctuates in the range of 145.6-95.2 mg/kg. In this case, the lowest value (95.2 mg/kg) belongs to the lowest layer.

The main part of the nitrogen fund of the studied soils is non-hydrolyzed nitrogen. The largest values of this fraction belong to the plowed and under plowed layers, accounting for 808.6 and 759.8 mg/kg or 64.17 and 68.51% of the total nitrogen, respectively. Its content in the lower layers decreases from 469.9 to 311.6 mg/kg.
The amount of easily hydrolyzed nitrogen in the plowed and under plowed layers was 120.4 and 72.8 mg/kg, respectively, accounting for 9.56 and 7.03% of the total nitrogen. In the lower layers, it decreases downwards (Table 1).

| Section № | Depth, cm | Mineral nitrogen mg/kg | Easily hydrolyzable nitrogen % | Hardly hydrolyzable nitrogen mg/kg | Non-hydrolyzable nitrogen % | Total nitrogen mg/kg |
|-----------|-----------|-------------------------|-------------------------------|----------------------------------|-----------------------------|----------------------|
| North     | 0-5       | 131.6 5.59              | 134.4 5.71                   | 432.2 18.4                      | 1653 70.3                   | 2352 100             |
| K-12-06-  | 5-34      | 53.2 5.53               | 92.4 9.6                     | 266.8 27.7                      | 549.6 57.0                   | 962 100              |
| TTB       | 34-61     | 47.6 6.8                | 84.0 12.0                    | 210.0 30.0                      | 358.4 51.2                   | 700 100              |
| (virgin soil) | 61-83     | 44.8 8.3                | 84.0 15.6                    | 182.2 33.9                      | 227.0 42.2                   | 538 100              |
|           | 83-115    | 39.2 7.7                | 78.4 15.4                    | 180.0 35.3                      | 212.4 41.6                   | 510 100              |
|           | 115-149   | 36.4 8.7                | 67.2 16.0                    | 148.0 35.2                      | 168.4 40.1                   | 420 100              |
| North     | 0-31      | 112.0 6.8               | 140.0 8.5                    | 428.4 26.1                      | 959.6 60.3                   | 1640 100             |
| K-12-07-  | 31-59     | 78.4 6.0                | 122.4 9.4                    | 392.0 30.0                      | 713.2 54.6                   | 1306 100             |
| TTB       | 59-87     | 56.0 7.0                | 92.8 11.6                    | 250.0 31.2                      | 401.2 50.1                   | 800 100              |
| (vineyard) | 87-131    | 50.4 7.6                | 67.2 10.2                    | 207.2 31.4                      | 335.2 50.8                   | 660 100              |
|           | 131-149   | 42.0 7.5                | 53.2 9.5                     | 151.2 27.0                      | 313.6 56.0                   | 560 100              |
| South     | 0-22      | 78.4 7.7                | 134.4 13.1                   | 224.0 23.0                      | 583.2 57.1                   | 1020 100             |
| K-12-08-  | 22-51     | 61.6 8.2                | 117.6 15.7                   | 222.0 29.6                      | 348.8 46.5                   | 750 100              |
| TTB       | 51-73     | 56.0 8.7                | 84.0 13.0                    | 198.8 30.7                      | 305.2 47.4                   | 644 100              |
| (vineyard) | 73-95     | 50.4 10.3               | 67.2 13.7                    | 145.6 29.8                      | 224.8 46.1                   | 488 100              |
|           | 95-131    | 30.8 8.5                | 50.4 13.8                    | 126.0 34.0                      | 156.8 43.2                   | 364 100              |
| South     | 0-25      | 73.4 5.83               | 120.4 9.56                   | 257.6 20.44                     | 808.6 64.17                  | 1260 100             |
| K-13-06-  | 25-64     | 60.2 5.81               | 72.8 7.03                    | 193.2 18.65                     | 759.8 68.51                  | 1086 100             |
| TTB       | 64-85     | 38 5.34                 | 58.8 8.26                    | 145.6 20.45                     | 469.6 65.96                  | 712 100              |
| (vineyard) | 85-109    | 30.1 5.79               | 44.8 8.62                    | 120.4 23.15                     | 324.7 62.44                  | 520 100              |
|           | 109-120   | 25.2 5.48               | 28 6.09                      | 95.2 20.70                      | 311.6 67.74                  | 460 100              |

4. Conclusions
In dark serozems, the amount of nitrogen decreases in a downward direction along the soil section, depending on the amount of humus. Northern exposure soils are richer in nitrogen and its fractions than southern exposure soils. As a result of the use of these soils in agriculture, nitrogen compounds are redistributed across the soil cross section. The main part of the nitrogen fund of the studied soils is non-hydrolyzed nitrogen. The largest indicators of this fraction belong to the plowed and under plowed layer. Its amount decreases towards the lower layers. The sum of the easy and difficult hydrolyzable fractions makes up the hydrolyzed nitrogen. Hydrolyzed nitrogen serves as a direct source of mineral nitrogen formation. In dark serozems, the amount of both hydrolyzable (easy and difficult to hydrolyze) nitrogen decreases downwards along the soil cross section. However, the proportion of hardly hydrolyzable nitrogen relative to total hydrolyzed nitrogen increases downwards, while the proportion of easily hydrolyzed nitrogen decreases conversely.

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