Evaluation of fertility of irrigated soils in Uzbekistan

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Abstract. The article examines the current productivity status of irrigated soils, encompassing aspects such as mechanical composition, agrochemical properties, salinity levels, and soil quality evaluation. The study highlights that the prevailing condition of the researched irrigated soils primarily comprises heavy sand texture. These soils exhibit a deficiency in humus content, rendering them low in organic matter. Additionally, they are characterized by a notable scarcity of mobile phosphorus and a correspondingly low content of exchangeable potassium. The research further categorizes the soils under investigation into three distinct cadastral groups based on their quality attributes. Through this classification, a comprehensive assessment of the soils' varying characteristics is achieved. Moreover, the study quantifies the average credit score of these soils, indicating their overall quality level, which was found to be 55 points on average. The findings underscore the significance of understanding the intricate interplay between soil characteristics and agricultural productivity. This analysis provides valuable insights for optimizing soil management practices, ultimately contributing to enhanced agricultural output within the studied area.
Keywords. Irrigated soils, productivity, quality assessment, credit score, mechanical composition, humus, salinity.

1 Introduction

In the world, scientific research is being carried out in the priority areas of identifying negative processes occurring in soil layers, including salinization, glaciation, pollution with heavy metals, dehumification and other processes, their prevention and mitigating their consequences [1]. In particular, the prevention of negative processes caused by the increase of anthropogenic influence and global climate changes, the improvement of the ecological and amelioration condition of the soil during the effective use of land resources [2], the significant reduction of soil pollution, the effective use of them by identifying the changes in the properties of the soil under the influence of evolutionary processes, and special attention is paid to scientific research aimed at increasing the productivity of agricultural crops.

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In Uzbekistan, a number of scientific researches aimed at determining the evolutionary changes taking place in the irrigated soils, improving the ecological and land reclamation conditions, improving, restoring and increasing soil fertility are being carried out and certain results are being achieved [3, 4].

A number of decrees and decisions on soil properties, degradation, salinity, etc. are being adopted in Uzbekistan. In all of them, measures aimed at maintaining soil fertility and improving land reclamation in modern ways are being determined [5]. Also, in the decree and decision, measures are defined to increase the effectiveness of the use of land resources of Uzbekistan and the productivity of agricultural land, to establish strict control over the prevention of the use of agricultural land, especially irrigated land for other purposes, as well as to systematize the accounting of the land fund of Uzbekistan [6].

The experts of the Scientific Research Institute of Soil Science and Agrochemistry conducted soil evaluation works on the existing irrigated agricultural land areas in Boyovut district of Sirdarya region [7], and updated the information on the current state of fertility and credit scores of the irrigated soils of this area. In order to determine the productivity and production capacity of irrigated lands in this agriculture, in-depth analysis of quality indicators, i.e. score quality (soil evaluation works), classification by cadastral categories (groups) is an important stage of state land cadastre management [8-10].

The research object i**s** alluvial soils of irrigated irrigated meadow, sedge meadow, sedge meadow and swamp meadow of Boyovut district of Sirdarya region by experts of the Scientific Research Institute of Soil Science and Agrochemistry.

2 Materials and methods

The methodology employed in the soil inspection research draws from a multifaceted approach, integrating various sources of data and techniques to comprehensively assess the soil conditions. The foundation of this methodology lies in the analysis of soil map data related to the specific study areas. This is further supplemented by a synthesis of results stemming from comparative geographical, soil-cartographic, laboratory analyses, camera-analytical studies, and soil-evaluation investigations.

Field and cartographic activities were executed following the guidelines outlined in the "Instructions for conducting soil surveys and drawing up soil maps for the maintenance of the state land cadastre" [2]. Concurrently, the soil evaluation work adhered to the methodologies detailed in the "Methodological instructions for auditing irrigated soils of Uzbekistan" [5].

In the laboratory-analytical and camera-oriented phases of the research, methodologies were employed that were both developed and widely accepted by the Research Institute of Soil Science and Agrochemistry (TAITI). These established techniques serve as a reliable foundation for conducting accurate and consistent analyses of soil samples.

By synthesizing these various approaches and adhering to well-established guidelines and methodologies, the soil inspection research methodologically ensures a robust and comprehensive assessment of the studied areas' soil conditions, paving the way for informed decision-making in agricultural practices and land management.

3 Results and discussion

Zonal-climatologically, Syrdarya region is located in the desert, semi-desert and gray soil regions of Central Asia. Climatic indicators indicate that the territory of the Syrdarya region has hot and dry summers, moderate winters, and large temperature fluctuations between daily and annual temperatures. The average annual air temperature of the region is around +12.9-

14.9 ^{0}. The soil temperature (in the driving layer) is -2.0-0.2 ^{0} in January, on average, the soil surface freezes, which causes difficulties in plowing and washing the soil. The duration of frost-free days is 200-236 days. The first frost occurs in November, and the last frost occurs in February.

Sirdarya region is located in the zone where strong winds cross, and the area is strongly affected by the north and east (Bekabad wind). The main part of the wind blows more from the east and is most common in May-June. The wind speed reaches 3.2 m per second.

The average height of Mirzachol is 250-300 m above sea level, and the highest part is in the southeast, that is, near the beginning of the irrigation canals, and its height is 350 m. The lowest land of the bogs and shorkhoks in the northwest, that is, in Mirzachol, is 230 m above sea level. The Mirzachol plain decreases to the north and northwest.

The relative humidity is not high, the air has the lowest humidity in June-August, and the annual average humidity is around 31-48%. The increase in air temperature during the summer months leads to more evaporation of moisture, which in turn is much more than the annual average of atmospheric precipitation. This phenomenon of nature leads to soil salinization and increased water demand of crops. Despite such negative aspects of the weather, the agrolandscape of the Syrdarya region is favorable for the cultivation of almost all agricultural crops.

The interaction of geomorphological, lithological, hydrogeological and climatic conditions in the territory of Boyovut district caused different directions of soil formation processes in the area. The irrigated lands of Boyovut district are mainly covered with meadow, meadow saz, saz meadow and swamp alluvial soils.

Of the arable land area used for intensive farming in the district, i.e. 32787.0 thousand (as of 2021) hectares, 51.8% is gray meadow, 20.5% is meadow, 19.5% is meadow-gray, 8.1% is swamp. -meadow and 0.1% light-colored gray soils were noted.

Irrigated gray- meadow and meadow soils are the most common in the district, and mainly consist of heavy, light, medium sandy and loamy mechanical composition. Studies devoted to the study of the mechanical composition of soils of different regions of Uzbekistan are covered in the works of L.T.Tursunov [6], I.Turapov and others [5] S.Abdullaev and others [1], R.Kurvontaev [2] and others. Physical-mechanical, hydro-physical and agro-physical properties of desert and irrigated soils of different regions of Uzbekistan were studied in these studies.

According to the mechanical composition of the above-mentioned soils, it was noted that 46.4 ha of clay, 2981.6 ha of heavy loam, 18790.6 ha of medium loam, 9631.9 ha of light loam and 1156.5 ha of sandy loam mechanical composition were noted (Figure 1).

It was observed that 32,596.2 hectares of soils distributed in all massifs in Boyovut district are very low (up to 1%) and low (up to 1.1-2.0%) in 190.8 hectares. With mobile phosphorus, 6210.1 hectares are very low (0-15 mg/kg), 24356.7 hectares are low (16-30 mg/kg), 2190.0 hectares are average (31-45 mg/kg), 30.2 hectares provided at a high (46-60 mg/kg) level. With exchangeable potassium, 285.1 hectares are very low (0-100 mg/kg), 26095.1 hectares are low (101-200 mg/kg), 6102.5 hectares are medium (201-300 mg/kg), 295.8 hectares are high (301-400 mg/kg) and 8.5 hectares were reported to be supplied at very high (>400 mg/kg) levels.

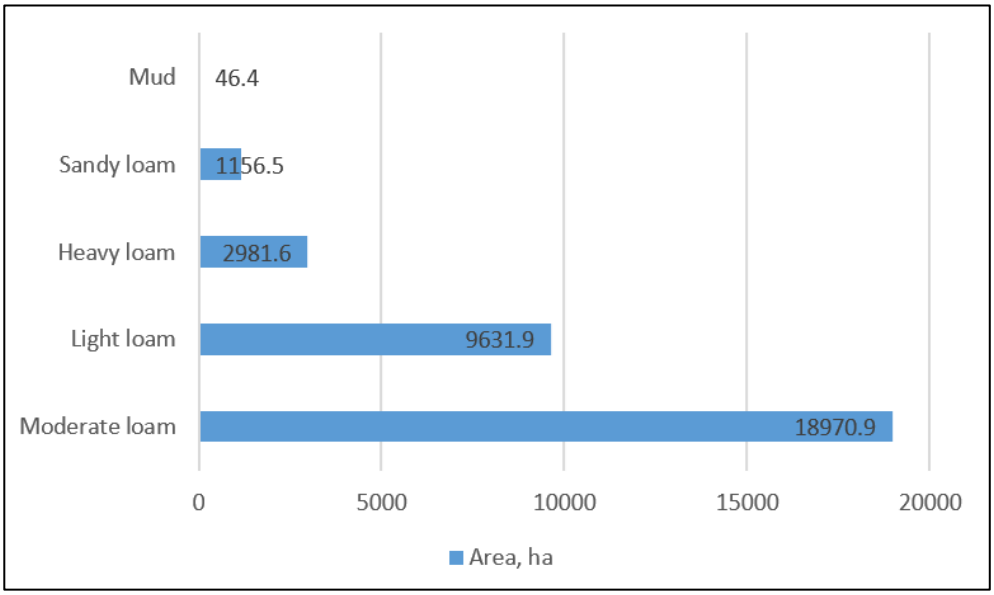

Figure 1. Mechanical composition of irrigated soils distributed in Boyovut district of Syrdarya region, per hectare.

In general, it was noted that 18.9% of the soils distributed in the district belong to the group with very little exchangeable potassium, 74.3% with low, 6.7% with medium and 0.1% with high level (Figure 2).

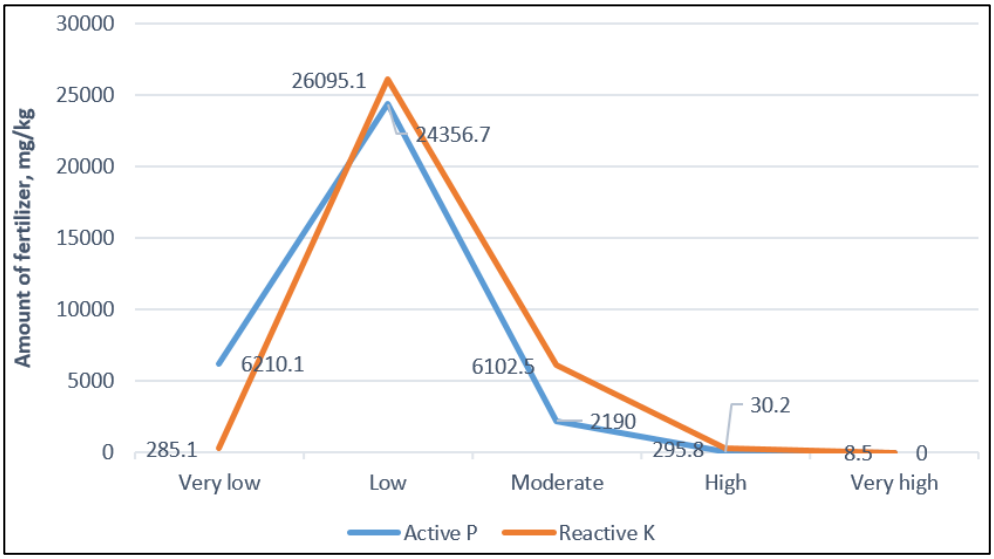

Figure 2. Amount of mobile phosphorus and exchangeable potassium in irrigated soils distributed in Boyovut district of Syrdarya region, per hectare.

In recent years, the deterioration of the ecological condition of natural components, including soils, has been observed on the territory of Uzbekistan. Increasing irrigation and saline leaching rates are leading to an increase in seepage water levels, which in turn is becoming one of the main causes of soil salinization. Soil salinity refers to the high salt content in the soil. Soil degradation due to salinity is a serious problem affecting world agriculture [4, 9, 10]. There is a total of 4.3 million hectares of irrigated land in Uzbekistan, and according to the latest data, 44.7% of irrigated land has varying degrees of salinity.

Considering the fertility and productivity of the irrigated lands, as well as the ecological-reclamation condition, salinization depends on the relief, geomorphological-lithological structure, soil-climate and human-economic conditions of the place (massives). In particular, the damage caused by the salinity of underground ground water to the national economy is extremely large, the cotton yield is reduced by 20-30% in weakly saline soils, by 40-60% in moderately saline soils, and up to 80% in highly saline soils, and cotton in highly saline and highly saline soils. It has been proven in numerous researches and field experiments that sprouts die completely at the first watering. The main reason for this is the "toxic" effect of toxic salts in the soil on plants. Therefore, when assessing the soil-melioration condition of irrigated lands, it is necessary to pay special attention to the salinity level and types of soils, the amount (%) and reserves (t/ha) of salts in the soil layer (0-30 cm) and root layer (0-1 m) will be [1].

According to the results of field-research carried out in the irrigated soils of Boyovut district of Syrdarya region and the data of soil samples taken for chemical analysis, non-saline areas are 11917.2 hectares, low salinity areas are 18031.6 hectares, moderately saline areas are 1948.3 hectares, strongly saline areas are 878, 4 hectares and 11.5 hectares of highly saline areas.

Soil assessment is a comparative assessment of soil quality and natural fertility, taking into account soil properties and characteristics that are largely related to crop productivity, and the result is expressed in points. Soil testing is carried out based on the requirements of agricultural crops, in the conditions of irrigated agriculture, it is widely used mainly in cotton and grain farming. For example, taking into account the requirements of cotton, the credit points determined by the lands are also the basis for the evaluation of the soils where other crops are grown in the cotton complex.

According to the analyzes of the main sections obtained in the data of G.S. Mirkhaydarova, soil fertility and main properties, pollution, ecological condition affect the points poured into the soil. According to the soil properties of Pop district, the soil properties are in the range of 60-46 points, with an average of 53 points. The scores for ecological condition are slightly lower, ranging from 39 to 35, with an average of 37. Total SQI scores ranged from 46 to 38, indicating that these soils are of below average quality. The overall average score for these soils is 42 points and is considered to be of below average quality [3].

In the qualitative evaluation of irrigated soils, its mechanical composition, degree and types of salinity, stony, plastering, erosion processes, leaching, humus, provision of nutrients and a number of other properties are taken into account, and the soils are evaluated (performed) on a closed scale of 100 points .

The division of soils into agroproduction (cadastre) groups - bad, below average, average, good and very good land (classes) allows, first of all, to conduct agricultural production in a scientifically based manner, to make the right choice of agrotechnical and amelioration measures. In the assessment of soils, irrigated soils with the following, i.e., the best, favorable properties, high productivity (productivity) are evaluated with 100 points, in case of deviations from the optimal indicators, reducing coefficients are used in the calculation of credit scores. The average credit rating of irrigated agricultural land types distributed in the massifs of Boyovut district is 55 points.

According to the quality of the irrigated lands suitable for agricultural use, they are grouped into ten classes, five cadastral groups, taking into account the soil fertility potential. The investigated irrigated agricultural land area is 32,787.0 hectares and was grouped into three cadastral groups by quality.

There are lands belonging to class III and IV of the first cadastral group in Boyovut district of Sirdarya region. This group is considered below-average land in terms of soil quality, and includes points assigned to soil differences with a credit score of 21 to 40 points. The characteristics of the lands belonging to this group are relatively stable, and all of them are suitable for irrigation. At the same time, the types of crops grown on these lands are limited. The soils of this cadastral group are saline, wind-eroded, very low and poorly supplied with nutrients. If the quality of soils is compared, their quality level is lower than average and includes soils with 21-40 points.

The total area of irrigated land belonging to the below-average cadastral group in the district is 1087.4 is a hectare. The average cadastral group includes irrigated lands of class V and VI. These lands make up the main part of the irrigated lands and include the types of land actively cultivated and cultivated in agriculture. The total area of land included in the average cadastral group is 21405.5 is a hectare.

The good cadastral group includes irrigated lands of class VII and VIII. These lands are lands of special value in the agriculture of irrigated lands, and the total area of lands belonging to the good cadastral group in the district is 10294.0 is a hectare.

Along with cultural-ameliorative and current works in this category of land in modern agriculture, it is possible to achieve new qualities of the soil by carrying out desalination, melioration and agrotechnical measures against erosion. If the lands of this class are used incorrectly (even temporarily), in addition to stopping the cultivation process, soil degradation will begin, the amount of humus and nutrients will decrease, erosion processes will begin on sloping lands, and soil fertility will decrease.

To determine the yield of an agricultural crop, taking into account the score credit of the field contour, that is, the value of one point according to the crop is multiplied by the score credit of the place. To determine the value of one point corresponding to the yield, the average maximum agricultural crop yield (40 t/ha) obtained for Uzbekistan is divided by the indicator of 100 points (the most fertile soil).

4 Conclusions

The outcomes of the soil analysis conducted in the Boyovut district of the Sirdayo region provide valuable insights into the soil composition of the area. The prevailing soil type in the region is primarily identified as heavy sand. This soil type is characterized by certain deficiencies in key nutrients and organic matter.

Specifically, the soil analysis reveals that the mobile phosphorus content is recorded as very low, indicating a scarcity of this essential nutrient for plant growth. Additionally, the exchangeable potassium levels are classified as low, further contributing to potential nutrient limitations in the soil. Furthermore, the supply of humus, which is crucial for soil fertility and structure, is identified as very low and low, underscoring the need for amending organic matter.

The irrigated agricultural land area that was the subject of the study encompasses a total of 32,787.0 hectares. Through a quality assessment, the area was divided into three cadastral groups based on its soil attributes. The average credit score derived from these assessments stands at 55 points on average.

The findings collectively offer a comprehensive understanding of the soil conditions in the Boyovut district. This insight is crucial for effective land management and agricultural

practices in the region, aiming to address nutrient deficiencies and enhance soil fertility to optimize agricultural productivity.

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