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MODERN ASSESSMENT OF FERTILITY OF DARK CHESTNUT SOILS OF KAMYSTINSKY DISTRICT OF KOSTANAY REGION

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Abstract

The article presents the results of a study on the morphological, nutritional characteristics of arable dark chestnut soils in the Kamystinsky district of the Kostanay region. According to the structure of the morphological profile, dark chestnut soils belonged to medium and low-thickness types, where the thickness of the humus horizon A + B1 is noted within the range of 29 - 45 cm in depth. The accumulation of carbonates and ready soluble salts depends on the parent rocks and the grain-size distribution of dark chestnut soils. In dark chestnut immature soil, there are no carbonates along the soil profile, but gypsum is found at a depth of 36 cm. The line of bubbling from hydrochloric acid is different in ordinary and carbonate genus of dark chestnut soil. The humus content is low, in the plough-layer of soils it ranges

from 1.10 - 3.05%, the supply of nitrate nitrogen is very low, moving forms of phosphorus are medium and low, while potassium content is very high and elevated.

Key words: soil; soil profile; chestnut soils; nutritional characteristics; morphological characters of the soil.

Introduction

Modern soils undergo significant changes in the process of development and use in agricultural production. Long-term use of land as part of arable land leads to widespread soil degradation processes [1-6].

The greatly increased anthropogenic pressure on the soil cover, agricultural landscape and biosphere as a whole over the last century has significantly undermined the normal conditions for their sustainable functioning. It provoked a number of regional and global environmental crises. One of the most dangerous are regional agroecological problems of mass land degradation, qualitative deterioration of their ecological condition and functional capabilities. In a number of cases, they have already reached the level of anthropogenic desertification or a sharp narrowing of the soil and Agro-landscape basis for the sustainable functioning and development of local communities and entire agricultural regions.

Over the past decades, the processes of anthropogenic land degradation have had the most serious impact on the efficiency of the technologies used on them and the profitability of the production of main agricultural crops, largely determining the current agro-ecological state of most lands, the yield actually obtained on them, the recoupment of the costs incurred and the sustainability of the main production parameters. Anthropogenic impact on soils is one of the fastest and most powerful factors in the evolution of soil cover, which changes the chemical, physical and morphological parameters of soils. Such changes makes it possible to assess the trend of soil processes. However, the point of view about the high intensity of agrogenic transformations is not shared by all researchers. In particular, is the problem of agrogenic transformation of dark chestnut soils in the dry steppe zone of Northern Kazakhstan, there is still no consensus on the understanding of a number of issues [7].

Materials and methods

During the 2022 field soil survey, soil profile up to 1.0 m deep was dug and key clarifying points necessary for agroecological assessment of agricultural land in the Kamystinsky district

The soil cover of the Kostanay region is subject to strict latitudinal zoning, caused by a gradual change in bioclimatic factors from north to south. These changes, primarily associated with increased aridity in the indicated direction, makes it possible to identify six soil zones within the region, dividing it into almost equal stripes.

The territory of the Kostanay region occupies an intermediate position between the Ural Mountains, on the one hand, the Kokshetav Upland and the Kazakh small hills, on the other, where within the region there are: a steppe zone with subzones of ordinary and southern chernozems, a dry steppe zone with subzones of dark chestnut, chestnut and light chestnut soils and a desert zone with subzone of brown soils [8].

Ordinary and southern chernozems of the Kostanay region are characterized by a shortened profile, low thickness of the humus horizon, tongue-likeness, fracturing, relatively higher salinity, residual solonetsity, distinct manifestation and increased occurrence of the carbonate horizon. In soils of the chestnut zone, these processes are more pronounced [9].

Chestnut soils of the Kostanay region are characterized by an increased salt content compared to chernozems in the upper part of the profile, associated with a relatively greater mineralization of plant residues and a relatively greater evaporation of soil solutions pulled up from salt horizons.

Brown soils are characterized by extreme complexity and increased salinity, which is associated with the diversity of the topography, the nature of the soil-forming rocks and the dry climate [8]. Among the zonal soils of the Kostanay region, meadow and saline soils are also common.

The purpose of the research is to study the state of soil fertility in the Kamystinsky district of the Kostanay region.

Kostanay region were identified. Using GPS receivers, all soil profiles were numbered and georeferenced.

From some of the soil profile, soil samples

were selected according to genetic horizons, in which the following were determined: humus using the Tyurin method; mobile phosphorus and exchangeable potassium according to the Machigin

method modified by TSINAO GOST 26205-91; nitrate nitrogen ionometric method GOST 26951-86; Soil pH according to the TSINAO GOST 26483-85 method.

Results

A morphological analysis of the soil was conducted under both field and laboratory conditions, and the soils of the Kamystinsky district, which is located in the southern part of the Kostanay region in the moderate-arid steppe and dry steppe zones was studied. The territory of the Kamystinsky district is the northwestern part of the Turgai plateau in the upper part of the Tobyl River. The relief is mainly an elevated plateau-like plain. In the southern part there are many lake basins and ravines, and river valleys. In the western part there is a low area of the Tobyl River. The climate is sharply continental, and annual precipitation is 200-250mm [10].

The soil-forming rocks are yellow-brown, deluvial, eluvial-deluvial, lacustrine-alluvial, often slightly saline, saline, in some place's gravelly loams and clays, as well as ancient weathering crusts, represented by sediments of different grain size composition and salinity.

The natural vegetation cover is represented by wormwood-fescue- feather grass groups with xerophytic mixed grasses: lapchatki, carnation, zopnik, bedstraw, etc.

On the territory of the region, various types of dark chestnut soils are distinguished: ordinary, carbonate, carbonate - solonchak, solonetzic, solonetzic - solonchak, saline solonchak, slightly saline solonchak, drained, plowed, incomplete and under-developed.

Depending on the nature of the relief, the composition of soil-forming rocks and the degree of drainage, the nature of the distribution of soil cover changes. In lowlands and lake depressions, solonetzic and meadow soils of varying degrees of salinity are common.

Below is a description of several sections of the surveyed soils according to morphological description.

Dark chestnut underdeveloped soils are formed on the products of weathering of dense rocks on the gentle slopes of hills, where cartilaginous-gravelly eluvial-deluvial deposits serve as soil-forming rocks. The first soil profile (No.1) was laid on a gently sloping plain, mesorelief - slope up to 7-9 0, Kamystinsky district. The land is arable land (Wheat field).

Morphological description of the soil profile of a dark chestnut, underdeveloped, low-humus, low-thickness, light loamy soil

A _p 0 - 20 cm	Dark gray, lumpy, dusty, the density of the horizon is divided into 2 sub-horizons: 1-11 cm loose and 11-20 cm compacted, fresh, there are small plant roots, there are crushed stones with a diameter of up to 1.5 cm, effervescence does not occur, light loamy, the transition to the next horizon is clear in color.
B ₁ 20 -29 cm	Dark gray with a brown color, lumpy, dense, moist, lightly loamy, the presence of gravel and crushed stone fractions up to 1.5 cm in diameter, plant roots, effervescence does not occur. The transition is gradual.
B ₂ 29-46 cm	Grayish-brown, lighter than the previous horizon, weak humus streaks, moist, lightly loamy, the presence of a small amount of gypsum from 36 cm, effervescence does not occur when on reaction with hydrochloric acid.
C ₁ 46-69 cm	Gray due to the large accumulation of gypsum, lightly loamy, dense, moist, effervescence does not occur. The transition is clear.
C ₂ 69-86 cm	Yellow-brown, structureless sandy loam.

The soil section includes several genetic horizons: A_p, B₁, B₂, C₁ and C₂. The arable horizon, 0-20 cm thick, has a lumpy -silty structure, dark gray color, has fractions up to 1.5 cm in size. Below this horizon is the B₁ horizon, 20-29 cm thick, dark gray with a brown color, dense,

lumpy structure, with the presence of gravel with a diameter of up to 1.5 cm. The thickness of the humus horizon (A + B₁) is 29 cm. Gypsum is observed in B₂ horizon, which increases in C₁ horizon, but carbonates are not found throughout the soil profile. The granulometric composition of

the soil is light loamy, but in the C₂ horizon it turns into sandy loam.

The most common soils are dark chestnut carbonate soils of medium depth. These soils are

Morphological structure of the profile of dark chestnut carbonate medium-deep low-humus heavy loamy soil on cover loams:

A _p 0 - 25 cm	Dark chestnut, medium - fine lumpy-silty, heavy loamy, fresh, slightly compacted, many plant roots, effervescence occurs with HCl from 4 cm depth, transition to the next horizon is gradual.
B ₁ 25 - 45 cm	Chestnut, lighter than the previous horizon, lumpy-silty, heavy loamy, fresh, dense, finely porous, effervescence occurs with HCl, roots of herbaceous plants are found, the transition to the next horizon is gradual with weak humus streaks.
B ₂ 45-80 cm	Light brown with carbonate spots and weak humus streaks, lumpy-silty, heavy loamy, moist, dense, vigorous effervescence with HCL, sparse roots of herbaceous plants, transition to the next horizon is gradual.
C 80-100 cm	Yellow-brown, heavy loamy, vigorous effervescence with HCl, moist, dense, carbonate spots.

The soil is characterized by effervescence on reaction with hydrochloric acid from 4 cm depth in the arable horizon. Horizon Ap has a dark chestnut color, which acquires a faint brownish tint towards the bottom, medium-fine lumpy-silty structure, slightly compacted composition. The differentiation of the soil profile into genetic horizons is weak. Along the soil profile, below the arable horizon, B₁ horizon is located where it is distinguished by a denser structure, chestnut color with weak humus streaks. A distinctive feature of the B₂ horizon is

Morphological description of the profile of dark chestnut ordinary low-power low-humus sandy loam on sandy loam

A _p 0 - 19 cm	Dark gray, lumpy-silty structure, sandy loam, fresh, slightly compacted, roots herbaceous plants, no effervescence with HCl, the transition is clear in color.
B ₁ 19 - 34 cm	Heterogeneously colored dark brown with streaks of humus, lighter than the upper horizon, compacted, moist, lumpy, sandy loam, gradual transition with humus streaks.
B ₂ 34-63 cm	Brown with faint streaks of humus, lumpy, compacted, sandy loam, single roots of herbaceous plants, no effervescence with HCl from 59 cm, transition to the next horizon is gradual.
B _k 63-83 cm	Light brown, loose, moist, effervescence with HCl, sandy loam, carbonates in the form of vague spots, the transition to the next horizon is gradual.
C 83-100 cm	Yellow-brown, compacted, moist, sandy loam

The soil profile includes the following horizons: A_p, B₁, B₂, B_k and C. The arable horizon of the soil profile is characterized by a dark gray color, a lumpy-silty structure, and a weakly compacted composition. Underlying B₁ horizon dark brown in color with streaks of humus, lumpy structure, more compacted than the previous horizon. The

formed predominantly on the leveled and slightly undulating tops of plateau-like hills.

The second soil profile (No.2) was laid on a flat, slightly sloping plain, on arable land.

the presence of a large accumulation of carbonates in the form of spots and white patches, where there is vigorous effervescence with hydrochloric acid. Moving down the soil profile, the C horizon (80-100 cm) has a yellowish-brown color, carbonate spots, and is wetter than the previous horizons. The soil, throughout the profile, has a heavy loamy granulometric composition.

The third soil profile (No.3) was laid on a slightly undulating plain, on arable land.

thickness of the humus horizon (A_p + B₁) is 34 cm. Effervescence from hydrochloric acid begins from a depth of 59 cm in the soil profile. Carbonates in the form of vague spots in the soil section are present in the B_k 63-83 cm. The granulometric composition of the soil is sandy loam throughout the entire profile.

Table 1 - Agrochemical indicators of dark chestnut soils Kamystinsky district

Horizon and depth taken sample in, cm	Humus, %	Nitrate nitrogen, mg/kg (N-NO ₃)	Mobile forms, mg/kg soil		pH	Dense Residue, %
			Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)		
Dark chestnut underdeveloped low-humus, thin, light-loamy soil						
Ap 0-20	2.03	2.10	22.75	441.2	6.22	0.066
B1 20-29	1.07	2.60	3.22	283.0	6.26	0.044
B2 29-46	1.13	2.55	0.38	423.2	6.54	0.080
C1 46-69	0.89	4.50	0.72	251.7	7.90	0.080
C2 69-86	0.78	3.80	0.38	210.4	7.90	0.058
Dark chestnut carbonate medium-deep, low-humus, heavy loamy soil						
Ap 0-25	3.05	2.15	10.73	244.1	7.28	0.042
B1 25-45	1.60	2.20	1.72	257.0	7.40	0.080
B2 45-80	1.59	2.40	1.05	243.0	7.47	0.100
C 80-100	0.79	6.90	Not Detected.	220.4	7.72	0.276
Dark chestnut ordinary low-power, low-humus sandy loam soil						
Ap 0-19	1.10	1.30	12.07	276.4	6.57	0.038
B1 19-34	0.69	2.25	12.57	136.2	6.51	0.028
B2 34-63	0.47	1.10	5.06	99.4	6.41	0.068
B _k 63-83	0.34	2.15	2.05	76.2	7.05	0.068
C 83-100	0.22	2.40	Not Detected.	74.8	7.88	0.146

The studied soils of the Kamystinsky district in the Kostanay region, in terms of humus content, are classified as low and very low-humus soils, where the amount of humus in the upper plow horizon varies within the range of 1.10-3.05%. The dark chestnut low-humus sandy soil in the Kamystinsky district (soil profile No.3) exhibits very low humus reserves. In the upper plow horizon, it contains 1.10%, in the transition horizon 0.69%, in B₂ 0.47%, in B_k 0.34%, and in the parent rock 0.22%. This is associated with a light granulometric composition of the soil. The dark chestnut carbonate soil with heavy loamy granulometric composition (soil profile No.2) in the upper humus horizon contains 3.05% humus. Its distribution throughout the profile is not uniform. In the B₁ horizon, it sharply decreases to 1.60%. In the lower horizons, the humus content is evenly distributed but in very low amounts.

The dark chestnut underdeveloped soil (soil profile No.1) has significantly lower humus reserves compared to the previously described carbonate soil. In the profile, the humus content is 2.03%, rapidly decreasing to 1.07% in the lower horizon and gradually decreasing along the soil

profile.

In the dark chestnut soils, the pH of the soil solution in the upper plow horizon (Ap) fluctuates within the range of 6.22-7.28, reaching pH 7.9 in the parent rock. In the upper Ap, B₁, and B₂ horizons of the profiles of both ordinary and underdeveloped types of dark chestnut soils, this indicator is weakly acidic (pH up to 6.5), and only in the B2 horizon of the ordinary dark chestnut soil, it reaches pH 7.05. In the parent rock, it reaches pH 7.90 in both types of soils. The exception is dark chestnut carbonate soil, where the pH profile in the upper horizons is slightly alkaline and in the lower horizons it is alkaline, depending on the presence of carbonates in this soil.

The soils are not salinized with easily soluble salts in toxic concentrations throughout the profile. The value of the density residue does not exceed 0.1%. The characterized ordinary and carbonate dark chestnut soils contain easily soluble salts in the parent rock at a depth of more than 80 cm to a slight extent (0.146 - 0.276%) with a chloride-sulfate type.

The agrochemical assessment of the studied soils shows that despite the similarity in soil types,

they may differ in their agrochemical properties. The results of agrochemical studies confirm that the dark chestnut soils of the Kamystinsky district are low in nitrate nitrogen, medium and low in available phosphorus, very high in exchangeable potassium. The amount of nutrients also changes along the soil profile.

The dark chestnut underdeveloped low-humus soil in the Kamystinsky district contains a very low amount of nitrate nitrogen. In the upper Ap horizon, its content is 2.10 mg/kg. In the B₁ and B₂ horizons, the nitrate nitrogen content is 2.60 mg/kg and 2.55 mg/kg, respectively. In the C₁ and C₂ horizons, its quantity varies within 4.50 mg/kg - 3.80 mg/kg. The content of available phosphorus in the upper Ap horizon is average, amounting to 22.75 mg/kg. Along the profile, the content of available phosphorus sharply decreases from 3.22 mg/kg in the B1 horizon to 0.72 mg/kg and 0.38 mg/kg in the C1 horizon. The dark chestnut underdeveloped soils of the Kamystinsky district have very high content of exchangeable potassium in the upper horizon (441.2 mg/kg), elevated content in the B₁ horizon (283.0 mg/kg), very high content in the B₂ horizon, and high content in the C₁ and C₂ horizons (251.7 mg/kg and 210.4 mg/kg, respectively).

The dark chestnut carbonate soil in the Kamystinsky district throughout the profile contains a very low amount of nitrate nitrogen. In the upper horizon, its content is 2.15 mg/kg. In the B₁, B₂, and C horizons, the nitrate nitrogen content is 2.20 mg/kg, 2.40 mg/kg, and 6.90 mg/kg, respectively. The content of available

Discussion

In this research, the different genera of dark chestnut soils in the Kamystinsky district of Kostanay areas used for agriculture was studied. The soils are characterized by a low content of organic matter, where the main reasons for the loss of humus and nutrients are a decrease in the supply of plant residues, increased processes of mineralization, erosion, and others. Soils vary in the degree of supply of nutrients. The content of nitrate nitrogen in the arable soil layer is in the range of 1.30-2.15 mg/kg, which corresponds to a very low level of provision with this nutrient. Along the soil profile, this indicator slightly increases, which is explained by the mobility of nitrates, where they can be washed out by precipitation into deeper layers of soil. The amount of mobile phosphorus in the arable soil layer varies between 10.73-22.75 mg/kg, which refers to the average and low

phosphorus in the upper Ap horizon is low, at 10.73 mg/kg, in the B₁ and B₂ horizons, it is 1.72 mg/kg and 1.05 mg/kg, and it is not detected in the lower C horizon. Exchangeable potassium in the dark chestnut carbonate soils in the upper Ap and B₁ horizons is elevated (244.1 mg/kg and 257.0 mg/kg, respectively). In the lower B₂ and C horizons, the content of exchangeable potassium is also elevated (243.0 mg/kg and 220.4 mg/kg, respectively).

The dark chestnut underdeveloped soil in the Kamystinsky district contains a very low amount of nitrate nitrogen throughout the profile. In the plow horizon (Ap), the nitrate nitrogen content is 1.30 mg/kg. In the B₁, B₂, and B_k horizons, the nitrate nitrogen content is 2.25 mg/kg, 1.10 mg/kg, and 2.15 mg/kg, respectively. In the lowest C horizon, the nitrate nitrogen content is also very low, at 2.40 mg/kg. The content of available phosphorus in the dark chestnut soil in the Ap and B₁ horizons is low, amounting to 12.07 mg/kg and 12.57 mg/kg. Along the soil profile, the content of available phosphorus decreases and corresponds to a very low content in the B₂ and B_k horizons (5.06 mg/kg and 2.05 mg/kg, respectively). In the C horizon, phosphorus is not detected. In the upper horizon of the studied soil, the content of exchangeable potassium is 276.4 mg/kg, the B₁ horizon is characterized by medium content - 136.2 mg/kg, and the lower B₂, B_k, and C horizons have low content of exchangeable potassium, 99.4 mg/kg and 74.8 mg/kg of exchangeable potassium, respectively.

supply of soils with this element; in the underlying horizons their content decreases sharply, which is due to the composition of the soil-forming rocks. In the studied soils, the content of exchangeable potassium corresponds to a very high and increased level of soil availability.

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Conclusion

Analyzing the morphological and physico-chemical indicators of the dark chestnut soils in the Kamystinsky district, it is noteworthy that despite the uniformity of these indicators, they exhibit a range of distinct features. Dark chestnut soils are characterized by a low to medium thickness of the humus horizon A+B1 (29-45 cm), the presence of carbonates (in ordinary dark chestnut and dark chestnut carbonate soils) or the absence of carbonates (in dark chestnut underdeveloped soils), and the depth of carbonate occurrence.

The studied soils, depending on the parent

material, display varying particle size distributions, different levels of organic matter, and varying amounts of nutrients. Based on organic matter content, dark chestnut soils are classified as having low to very low humus content (1.10-3.05%)

Based on the results of morphological and physico-chemical studies, the dark chestnut soils of the Kamystinsky district can be classified as arable and suitable for cultivation, provided that practices for maintaining and replenishing fertility are improved, including the use of fertilizers.

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ҚОСТАНАЙ ОБЛЫСЫ ҚАМЫСТЫ АУДАНЫНЫҢ ҚАРА-ҚОҢЫР ТОПЫРАҒЫНЫҢ ҚҰНАРЛЫЛЫҒЫН ҚАЗІРГІ ЗАМАНҒЫ БАҒАЛАУ

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Түйін

Мақалада Қостанай облысы Қамысты ауданының егістік қара-қоңыр топырағының морфологиялық, агрохимиялық көрсеткіштері бойынша зерттеу нәтижелері келтірілген. Морфологиялық кескіннің құрылымы бойынша зерттелген қара-қоңыр топырақ орташа және аз қалыңдылықты түрлерге жатады, мұнда А+В1 қарашірінді қабаттың қалыңдылығы 29-45 см терендікте байқалады. Карбонаттар мен тез еритін тұздың жиналуы топырақ түзетін жыныстарға және қара-қоңыр топырақтың гранулометриялық құрамына байланысты. Толық дамымаған қара-қоңыр топырақта топырақ кескінінде карбонаттар байқалмаған, бірақ гипс кескінінің 36 см терендігінде кездеседі. Тұз қышқылының қайнау сызығы қара-қоңыр топырағының кәдімгідей және карбонатты тектерінде әртүрлі. Қара-қоңыр топырақтың тектерінің жыртылған қабатында қарашірінді мөлшері төмен, ол көрсеткіш 1,10-3,05% аралығында ауытқиды. Топырақ нитратты азотпен - өте төмен, жылжымалы фосформен - орташа және төмен, алмаспалы калиймен - өте жоғары және жоғары қамтамасыз етілген.

Кілт сөздер: топырақ; топырақ кескіні; қара-қоңыр топырақ; топырақтың агрохимиялық көрсеткіштері; топырақтың морфологиялық белгілері.

СОВРЕМЕННАЯ ОЦЕНКА ПЛОДОРОДИЯ ТЕМНО-КАШТАНОВЫХ ПОЧВ КАМЫСТИНСКОГО РАЙОНА КОСТАНАЙСКОЙ ОБЛАСТИ

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Аннотация

В статье представлены результаты исследования по морфологическим, агрохимическим показателям пахотных темно-каштановых почв Камыстинского района Костанайской области. По строению морфологического профиля темно-каштановые почвы относятся к средне и маломощным видам, где мощность гумусового горизонта А+В1 отмечается в пределах 29-45 см глубины. Накопление карбонатов и легкорастворимых солей зависит от почвообразующих пород и гранулометрического состава темно-каштановых почв. В темно-каштановой неполноразвитой почве по профилю почвы отсутствуют карбонаты, но обнаруживается гипс на глубине с 36 см. Линия вскипания от соляной кислоты разная в обычном и карбонатном родах темно-каштановой почвы. Содержание гумуса – низкое, в пахотном горизонте почв его колеблется от 1,10-3,05%, обеспеченность нитратным азотом – очень низкая, подвижными формами фосфора – средняя и низкая, калия – очень высокая и повышенная.

Ключевые слова: почва; разрез почвы; каштановые почвы; агрохимические показатели почвы; морфологические признаки почвы.