ГЕНЕЗИС И КЛАССИФИКАЦИЯ ПОЧВ

IRSTI 68.05.31:68.05.35

DOI: 10.51886/1999-740X_2023_2_5

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IMPACT OF DEVELOPMENT AND IRRIGATION ON THE SOIL OF THE DRY STEPPE ZONE OF AZERBAIJAN AND THE CLASSIFICATION SYSTEM

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Abstract. In the given article the research results on change of the morphological – genetic structure of the profile, granulometric composition, distribution of the physical clay on profile, supplement of density, gross composition of soil and silty fraction of the virgin [Grey Cinnamonic] and irrigated grey-brown soil [Irrigated Grey- Cinnamonic] in the arid steppe zone of Azerbaijan have been described depending on their agricultural use and antiquity of irrigation. Dependence of their density supplement of the irrigated grey-brown soil on granulometric composition and antiquity of their irrigation was established. The place of the virgin and irrigated grey-brown soil was defined depending on agricultural use and antiquity of irrigation in the system of the international classification of WRB (2014): virgin saturated gleyey calcareous heavy-loamy grey-brown soil - Duric Gleyic Calcic Kastanozems (Loamic); Long- irrigated grey-brown (irrigation-accumulative) (more than 300 years), powerful gleyey cultivated Long- irrigated calcareous heavy-loamy-Gleyic Petrocalcic Kastanozems (Anthric, Loamic).

Key words: grey-brown soil, antiquity irrigation, granulometric composition, supplement of density, gross composition.

INTRODUCTION

Use of the soil resources in agriculture affects the soil-forming process both directly and indirectly through other factors, taking on the leading functions of regulating the interrelation between soil and cultivation crops and natural landscape [1, 2]. The agricultural soils in Azerbaijan differ for a period of development and degree of cultivation [3-5]. The transformation of natural biocenoses into agrocenoses is always accompanied by a change in morphological and physical parameters, as well as the qualitative and quantitative composition of organic residues [6, 7]. A quantitative account of such changes makes it possible to determine the speed and direction of soil formation processes [8-11].

Accounting for the content and reserves of nutrients, their distribution in the soil profile makes it possible to establish the amount of available nutrients for crops, their biogenic accumulation, the direction of migration and participation in the biological circulation of elements, which is very important for increasing agricultural production in the dry subtropical zone of Azerbaijan [12]. The aim of the study is to assess changes in the morphological and agrochemical parameters of soils in the dry subtropical zone of Azerbaijan under the influence of their agricultural use.

MATERIALS AND METHODS

The studies were carried out in 1998-2020 on virgin (Grey Cinnamonic) and irrigated gray-brown soils (Irrigated Grey Cinnamonic, over 300 years). The soil-forming rocks are mainly modern gypseous calcareous deluvial loessial clayey for virgin, boharic and irrigative soils. Cultivation agrotechnics - zonal with some changes for each option.

The climate is subtropical with dry hot summers, the amount of active to is 4500-4848°C, the arrival of FAR is 120-133 kcal/cm^2, the amount of precipitation is 180-330 mm per year; days with air

to> 100-285-330 and soil> 50 -315-360.

The laying of soil sections, their description, the selection of soil samples and the establishment of the preliminary classification name of the soil in the field were carried out according to the Guidelines for Soil Description (FAO, 2012) and according to the methods [13-17]. In soil samples, the following were determined: physicochemical properties [18]. Based on morphological and physicochemical properties, the name of gray-brown soils was given according to the International Soil Classification based on the Abstract Base (WRB, 2015) [19-21].

RESULTS AND DISCUSSION

As it is known, the soils are characterized with the definite appearance and special morphological structure, and even a short-term anthropogenic influence on the soil leads to changes in morphological features, radical genetic changes are created in soil during prolonged irrigation and it affects the direction and intensity of soil formation [22-24].

The parameters obtained on the basis of generalized and statistic study of numerous field investigations of typical sections describe main types of morphological structure of dry steppe zone zones and virgin, boharic, irrigated arid field (table 1).

A statistical analysis of the main morphological indicators allows to get a correct average value of genetic layers (density) of the new soil for solution of the real problem, to show a change rate of the profile in a process of soil cultivation.

An average quadratic inclination (S=4-12 cm), and relative error (P=4-10 %) can be considered an average value. This confirms correctness of the obtained average value. The prolonged and systematic irrigation is a reason for strong change of agrophysical features in the zonal soils.

V.A. Kovda [25] indicates that an application of cultivation in the dry steppe zone arid field condition improves waterphysical features of virgin soils, rises their waterproofing, water penetration, ability to retain moisture reserve in soil.

Table 1 - Average statistical morphological indicators of grey-brown soils in the dry steppe zone

Indictors	Virgin	Boharic	Newly irrigated	Irrigated	Anciently irrigated (over 300 years)
Thickness of layers, cm					
A-Aa	34,7±0,70	37,1±1,00	42,6±1,23	51,5±1,10	66,8±2,19
AO	3,2±0,40	-	-	-	-
A1' A1'p-A1'a	18,5±0,71	19,3±0,42	25,6±0,66	26,1±0,45	27,2±0,57
A1"-A1"p-A1"a	14,8±0,55	17,8±0,80	17,2±1.05	24,2±0,64	25,2±0,57
A1"' a	-	-	-	-	20,3±1,31
Agro- irrigation	-	-	-	-	99,8±4,47
Depth with carbonate, cm	39,0±1,28	46,7±2,36	65,4±2,35	97,1±2,40	-
Layer formation in depth, cm	-	104,6±2,44	113,4±7,68	145,5±6,30	-
Gypsum	102,7±3,38	-	-	-	-
Salt	153,1±7,36	159,2±6,26	-	-	-

Statistical investigation of factual data (table 2). The heavy loamy granulometric composition is characteristic for virgin soils of the dry steppe zone of A-layer. On average < 0.01 mm – 56.7+1.18 %. A quantity of notable claying particles < 0.01 mm is noted in the middle part (25-50 cm) of profile.

This is characteristic for boharic soils. The weak loamy is noted in the one-metre layer, a composition of silt fraction is 28.3±1.08-31.8±0.83 % physical clay is 63.0±1.8-65±1.1. It is accordingly 3.5 % dry steppe zone, more than virgin zonal soils. This is explained with the intensive collection of agroirrigation floats and their heavy composition.

Table 2 - Average statistical data of the granulometric composition in the grey-brown soils in the dry steppe zone zone

Soils	Average depth, cm	Fraction<0,01 mm, %				Fraction<0,001 mm, %				Siltness Degree, %
		X	S	V	Sx	X	S	V	Sx	
Virgin	0-25	56,7	6,76	11,93	1,18	24,2	5,99	24,81	1,04	43
	25-50	64,3	5,36	8,34	0,93	28,6	5,01	17,45	0,88	45
	50-100	60,8	5,21	8,58	0,85	25,4	4,80	18,91	0,68	42
	100-200	58,0	12,17	21,00	2,33	20,4	6,37	31,21	1,23	35
	200-300	56,9	9,79	17,21	2,95	20,6	8,40	40,65	2,53	36
Irrigated	0-25	57,6	4,64	8,04	0,80	25,8	1,71	6,60	0,30	45
	25-50	59,2	7,38	12,45	1,25	27,7	5,41	19,54	0,92	47
	50-100	58,7	8,47	14,42	1,26	26,7	5,52	14,42	0,82	45
	100-200	53,8	11,00	20,40	1,59	24,3	2,93	12,06	0,42	45
	200-300	47,9	11,14	33,21	2,76	16,6	6,63	40,01	1,65	37
Anciently Irrigated (over 300 years)	0-25	63,0	6,66	10,60	0,97	29,2	7,71	26,12	1,12	46
	25-50	65,4	7,30	11,15	1,10	31,8	5,51	11,15	0,83	49
	50-100	64,7	7,90	12,21	0,98	30,6	7,58	27,74	0,94	47
	100-200	59,4	10,64	17,81	1,40	26,0	5,29	20,34	0,70	44
	200-300	57,4	9,29	16,17	1,73	23,0	5,21	22,62	0,97	40

The soils which are irrigated with the transparent ganat and artesian waters have lighter composition along the profile. The noticeable difference of the upper three-meter layer of the irrigated virgin soils is shown for a granulometric composition (table 3).

Table 3 - Distribution of physical clay in the irrigated grey-brown soils of the dry steppe zone (layer 0-3 m) zone

Particles composition <0,01mm,%	Granulometric composition	Virgin		Irrigated		Anciently irrigated	
		quantity number	%	quantity number	%	quantity number	%
0-5	Sand	-	-	-	-	-	-
6-10		-	-	-	-	-	-
11-15	Sandy	-	-	1	0,5	2	0,8
16-20		1	0,7	1	0,5	2	0,8
21-25	Light loamy	1	0,7	1	0,5	2	0,8
26-30		2	1,4	2	1,0	3	1,2
31-35	Average loamy	3	2,0	7	3,7	4	1,6
36-40		4	2,7	10	5,3	5	1,9
41-45		10	6,7	12	6,4	6	2,3
46-50	Heavy	11	7,3	15	8,0	13	5,1
51-55	Loamy	14	9,3	28	14,9	24	9,3
56-60		24	16,0	53	28,3	31	12,1
61-65	Light	45	29,8	30	16,0	64	24,7
66-70	Clayey	25	16,7	18	9,6	59	23,0
71-75		9	6,0	8	4,3	30	11,7
76-80	Average	1	0,7	2	1,0	9	3,5
81-85	Clayey	-	-	-	-	3	1,2
>85	Heavy Clayey	-	-	-	-	-	-
Total		150	100	188	100	257	100
Mode			63,56		58,59		65,34

Sometimes if the granulometric composition is light loamy – 52.2 %, in all cases a composition of the particles (a composition mode is <0.01 mm 63.6 %), then the irrigated soils are heavy loamy 51.2-58.6 % (from 188 cases) regularly rise and a composition of the light loamy (17.9 % from 188 cases) compared to (13.5 % from 150 cases).

The 3-meter layer of the upper stratum formed by irrigation floats of irrigated soils (with turbid water) is light loamy-59.4 % - 257 by chance (composition of the particles<0.01mm-65.3 %). A relative increase in loamy (4.7 % in all cases) and light loamy (5.2 %) is observed depending on irrigation relief in the irrigated soils irrigation period and so on). The profile of virgin soils is distinguished with the density (table 4).

The soil density changes at a large limit in the with some factors (granulometric and micro-aggregate, supply of organic substantive, adopted agrotechnics).

An upper part of profile is considerably humificated and it is characterized with the lower density in all cases; 1.19 g/cm^3 – changing coefficient is 6.88 % (dry steppe zone).

The density usually rises in calcareous layer and it is accordingly 1.414 ± 0.025 and 1.378 ± 0.023 g/cm^3. Density of soil-forming rocks depends on its granulometric composition. Decrease is 1.22–1.34 g/cm^3 in the loessed loamy soil.

The information about the field soils is grouped depending on type and zone of the irrigation period and creates imagination about change of soil density in cultivation processes.

Table 4 - Average statistical indicators of soil density (g/cm^3) zone

Soils	Middle depth, cm	The number of samples	X	S	V	Sx	Average reliable interval till 0,05
dry steppe zone, grey – brown							
Virgin	0 -25	14	1,190	0,080	6,88	0,021	1,145-1,235
	25-50	14	1,352 1,414	0,098 0,115	9,29 6,98	0,034	1,279-1,425
	50-100	15	1,345	0,115		0,025	1,361-1,467
	100-200	14	1,227	0,098	8,51 7,94	0,031	1,279-1,411
	200-300	14				0,029	1,163-1,291
Irrigated	0 -25	10	1,186	0,161	13,54	0,041	1,091-1,291
	25-50	10	1,402	0,093	6,63	0,021	1,355-1,449
	50-100	15	1,403	0,093	6,93	0,020	1,360-1,446
	100-200	18	1,423 1,438	0,145 0,232	10,22 16,16	0,034	1,352-1,494
	200-300	10				0,073	1,275-1,601
Anciently	0 - 25	16	1,178	0,118	10,04	0,029	1,117-1,239
Irrigated	25-50	22	1,302	0,127	9,72	0,027	1,246-1,359
(over 300 years)	50-00	28	1,371	0,117	3,93	0,022	1,326-1,416
	100-200	32	1,406 1,341	0,130 0,103	9,25 7,64	0,023	1,363-1,455
	200-300	22				0,022	1,295-1,387

The density over all layers (irrigation with transparent water) in the irrigated soils is higher than zonal virgin soils (1.40–1.44 g/cm^3) except the ploughed soils which exposed to intensive cultivation during tilling and it regularly rises towards depth. If we compare density of the irrigated soils of the dry steppe zones with virgin soils, we can come to such a conclusion that its decrease occurs under plough layer, but increase happens under tillage. Change of the mineralogical composition of soils under an influence of irrigation is a complex process [26-28]. The general analyses of the silt fractions in the virgin and irrigated soils indicate (table 5) that there are definite differencies in a total composition of the cultivated dry steppe soils of montmorillonum group in the irrigated soils.

The virgin soils and A - layer consist of 56-58 % of SiO_2, and this descends towards soil-forming rocks (49-51 %). The virgin and irrigated soils don't differ for a quantity of Fe_2O_2. Molecul ratio of SiO_2; $R_2O_3$is the silt fractional virgin soils - 3.3-4.3, but it is 3.4-4.0 in the irrigated soils. This ratio and presence of K_2O, MgO in silt fraction is explained by predominance of hydroslude minerals in silt fraction of virgin soils, but by predominance of montmorillonum group in the irrigated soils.

Table 5 - Total chemical composition of soil and silt fractions

Soil section, №	Depth, cm	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	MnO	CaO	MgO	SO_3	P_2O_5	K_2O	Na_2O
Arid field zone, grey – brown, for non – carbonate and humus – free soils, %												
Virgin	0 – 17	57,58	8,07	16,10	0,17	0,36	5,62	3,67	1,03	0,11	Uncertain	Uncertain
	17 – 31	53,31	7,08	15,55	0,09	0,30	8,84	3,31	1,18	0,11		
	31 – 58	51,34	7,07	19,12	0,14	0,32	8,86	1,37	0,18	0,11		
	58 – 85	54,97	7,09	15,42	0,14	0,40	6,98	4,34	1,33	0,11		
	85 – 101	51,11	6,57	14,34	0,13	0,37	6,18	3,69	1,43	0,09		
	101 – 125	53,17	6,63	15,64	0,17	0,37	6,06	3,51	2,07	0,12		
	125 – 170	48,79	6,13	13,95	0,13	0,31	8,06	3,68	2,00	0,09		
Irrigated	0-22	52,66	8,47	17,03	0,55	0,13	5,42	4,73	0,80	0,23	2,15	1,23
	22-43	53,59	6,47	22,07	0,58	0,16	5,21	4,87	0,89	0,23	2,51	1,11
	118-147	55,27	7,76	21,91	0,68	0,09	4,02	4,00	1,01	0,18	2,63	0,91
	147-170	54,61	8,04	20,76	0,76	0,14	3,90	4,76	1,38	0,18	2,22	0,77
	Mineral of silt, %											
	0-22	56,19	9,71	20,74	0,24	0,05	5,26	5,18	0,52	0,05	2,15	1,23
	22-43	57,78	9,44	18,88	0,14	no	2,66	6,50	0,84	0,02	2,40	1,06
	118-147	50,13	11,12	20,59	0,18	no	6,07	4,35	0,76	traces	2,42	0,83
	147-170	49,66	9,87	23,35	0,13	0,07	2,47	4,50	0,72	traces	1,97	0,68

CONCLUSION

Agricultural use and antiquity of irrigation of grey-brown soil in the arid subtropic zone of Azerbaijan significantly influenced the process and peculiarity of the given soil.

On the basis of the received data the place of the virgin and irrigated grey-brown soil in the system of the international classification of WRB (2014), virgin, saturated gley calcareous heavy-loamy grey-brown soil - Duric Gleyic Calcic Kastanozems (Loamic); Long- irrigated grey-brown (irrigation-accumulative) (more than 300 years), powerful gleyey cultivated Long-irrigated calcareous heavy-loamy-Gleyic Petrocalcic Kastanozems (Anthric, Loamic).

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ТҮЙІН

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ӘЗІРБАЙЖАННЫҢ ҚҰРҒАҚ ДАЛА АЙМАҒЫНЫҢ ТОПЫРАҒЫНА ИГЕРУ МЕН СУАРУДЫҢ ӘСЕРІ ЖӘНЕ ЖІКТЕУ ЖҮЙЕСІ

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Бұл мақалада Әзірбайжанның құрғақ дала аймағындағы тың (Grey Cinnamonic) және суармалы сұр-қоңыр топырақтардың (Irrigated Grey Cinnamonic) ауыл шаруашылығында пайдалануға және суару ұзақтығына байланысты топырақ кескінінің морфологиялық-генетикалық құрылымының, гранулометриялық құрамының өзгерістерін, кескін бойында физикалық балшықтың таралуын, құрылымының тығыздығын, топырақтың жалпы құрамы мен сазды фракцияларының өзгеруі бойынша зерттеу нәтижелері көрсетілген. Суармалы сұр-қоңыр топырақтардың түзілу тығыздығының гранулометриялық құрамға және оларды суару ұзақтығына тәуелділігі анықталды. Алынған мәліметтердің негізінде ауыл шаруашылығында пайдалануға және суару ұзақтығына байланысты тың және суармалы сұр-қоңыр топырақтың WRB (2014) халықаралық жіктеу жүйесінегі орны анықталды: тың, қанықкан сазды карбонатты ауыр-құмбалшықты сұр-қоңыр топырақ – Duric Gleyic Calcic Kastanozems (Loamic); ежелден суармалы сұр-қоңыр (суармалы-

аккумуляциялық) (300 жылдан астам), қалың сазды игерілген ежелден суармалы карбонатты ауыр құмбалшықты – Gleyic Petrocalcic Kastanozems (Anthric, Loamic).

Түйінді сөздер: сұр-қоңыр топырақ, ежелден суарылатын топырақ, гранулометриялық құрам, түзілу тығыздығы, жалпы құрам.

РЕЗЮМЕ

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ВЛИЯНИЕ ОСВОЕНИЯ И ОРОШЕНИЯ НА ПОЧВУ СУХОСТЕПНОЙ ЗОНЫ АЗЕРБАЙДЖАНА И СИСТЕМА КЛАССИФИКАЦИИ

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В статье изложены результаты исследований по изменению морфолого-генетического строения профиля, гранулометрического состава, распределения физической глины по профилю, плотности сложения, валового состава почвы и илистой фракции целинных (Grey Cinnamonic) и орошаемых серо-коричневых почв (Irrigated Grey Cinnamonic) сухостепной зоны Азербайджана в зависимости от их сельскохозяйственного использования и давности орошения. Установлена зависимость плотности сложения орошаемых серо-коричневых почв от гранулометрического состава и давности их орошения. На основании полученных данных определено место целинных и орошаемых серо-коричневых почв в зависимости от сельскохозяйственного использования и давности орошения в системе международной классификации WRB (2014): целина, насыщенная глеевая карбонатная тяжело-суглинистая серо-коричневая почва – Duric Gleyic Calcic Kastanozems (Loamic); давноорошаемые серо-коричневые (ирригационно-аккумулятивные) (более 300 лет), мощная глеевая окультуренная давно орошаемая карбонатная тяжело-суглинистая– Gleyic Petrocalcic Kastanozems (Anthric, Loamic).

Ключевые слова: серо-коричневая почва, давноорошаемая почва, гранулометрический состав, плотность сложения, валовой состав.

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