Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

Current State of Gray-Brown Soils of the Desert Zone of Uzbekistan and their Rational Use

Gafurova Lazizakhon Akramovna[1], Razakov Abdumalik Mannapovich[1], Madrimov Rajabboy Masharipovich[2], Nabiyeva Gulchekhra Mirergashevna[1], Ergasheva Olimaxon Xaliqjonovna[1]

[1]National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan.
[2]Institute of Hydroingeo GP, Tashkent, Uzbekistan.

ABSTRACT: Gray-brown soils, widespread in the desert zone of Uzbekistan, in irrigated agriculture occupy a relatively small area. Despite this, they are a reserve for expanding their area under the food culture of the republic. Data on the current state, as well as changes in their morpho-genetic properties under the influence of anthropogenic factors during irrigation, and ways of their rational use on the Ustyurt, Tashsaka plateau and the Malikchul plain are presented.

Keywords: Ustyurt, Malikchul, Tashsaka, gray-brown, gray-brown – meadow, humus.

Introduction

Gray-brown soils, formed in certain lithological-geomorphological conditions, are geographically widespread in Uzbekistan. They are located in the northwestern part of the republic: in Ustyurt, Tashsaka, Avtobachi, Karakul, Bukhara, Devkhan plateaus, in foothill plains of Bukantau, Auminztau, Altintau, Tamditau, Kuldzhuktau, Malikchul and in soils formed on skeletal-fine grained alluvial sediments of subaerial deltas of Zeravshan and Kashkadarya rivers. Gray-brown soils having low level of fertility are discussed in details in research works by S.A. Shuvalov, E.V. Lobova, K.Sh. Faizov, B.V. Gorbunov, N.V. Kimberg, A.Z. Genusov, I.R. Feliciant, A.M. Rasulov, R.K. Kuziev, M.D. Muratov, L.T Tursunov, L.A. Gafurova, M.M. Greenberg, A.M. Razakov, V.G. Popov, V.E. Sectimenko, H.H. Tursunov, S.P. Mikhailov, A.Zh. Kushakov et al. However, the issues of rational and practical use of gray-brown soils, their morpho-genetic features, given in general terms, from the point of view of their evolution and variation during irrigation are not yet covered fully [1,3,4 5,8,9,10,14,15,16,17].

Research results and discussion. Construction of reservoirs and irrigation networks in the republic in the 60-80s of the last century and the development of virgin lands had a significant impact on the ameliorative state of gray-brown soils. Initially virgin gray-brown soils of the automorphic series turned to hydromophic ones under the influence of

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

anthropogenic factor and the changes in moisture regime during irrigation [2,7]. Depending on the distribution area, the parent rocks of gray-brown soils are gypsum-bearing eluvial, eluvial-deluvial, deluvial-proluvial deposits of shell limestone, marl and sandstones (Ustyurt, Tashsaka, Avtobachi plateaus, the Kyzylkums). On foothill plains, such as Malikchul, gray-brown soils are formed on skeletal-fine-grained, deluvial-proluvial deposits. Such a wide diversity range of parent rocks is, on the one hand, a determining factor for the morphological and genetic features of gray-brown soils and, in particular, for their mechanical composition. On the other hand, the zonal properties of gray-brown soils, namely, soils of moderate subboreal and subtropical warm desert subzones, have significant differences in soil formation processes and morphogenetic characteristics [9, 10, 14].

The main landscape-forming plant groups of gray-brown soils in accordance with climatic conditions determine their zonal properties. So, for the northern part of the Ustyurt plateau, which belongs to a temperate subboreal subzone of the desert, a sagebrush – biyurgun – boyalych aggregation, which forms soil–plant complexes, is typical. For the southern half of the Ustyurt plateau and for more southward located territories like the Malikchul plain, Avtobachi plateau, Tashsaka, Karakul and others, a sagebrush–biyurgun groups are typical mixed with kyrk-bugum, tas-biyurgun and more salt-tolerant glasswort. The soil cover is composed of gray-brown typical and immature soils of various thicknesses and development, forming a combination of different thickness levels [9]. It should be noted that the common feature for all gray-brown typical soils in the profile structure is the presence of a crustal compacted horizon, with polygonal fractured surface and a layered-lamellar sub-crustal horizon.

A compacted reddish-brown cloddy soil with signs of clayization is located below. In gray-brown immature soils, the brown compacted horizon is either not manifested or, if so, to a very weak degree. The lower part of the soil profile is represented by a gypsum horizon with columnar or finely crystalline forms.

The thickness of the fine-grained part of gray-brown soils can vary from 30-40 cm to 80-100 cm, depending on the formation and development conditions of the profile [9,10,11].

Due to extreme scanty xerophyte-ephemeral vegetation, which forms a relatively small amount of organic matter and to arid climate, gray-brown soils are characterized by low humus content. The dry and hot climate of the desert contributes to the rapid mineralization of plant litter, which has high ash content. The removal by vegetation of ready soluble salts from the lower horizons to the upper ones under the autophonic regime contributes to the development of saline gray-brown soils. The type of salinization is predominantly chloride-

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

sulfate one, in some places it is sulfate-chloride one. Salt maxima are confined to genetic horizons with a high content of gypsum accumulations. Along with this, in the upper horizons of these soils there is an increased carbonate content, as many authors indicate, due to a biogenic origin. The carbonate content in soils varies over a wide range - from 4 to 13% (Table 1). In the supra-gypsum and gypsum-bearing parts of the profile, the content is the least. The low humus content and poorness of colloidal-silt particles determine the low absorption capacity of gray-brown soils, 3 - 7 mg-eq per 100 g of soil. Absorbed calcium (as in all gray-brown soils) accounts for the largest part of the total absorbed bases - 34-55% with a maximum in the upper part of the profile. The proportion of absorbed magnesium is 22 - 58% with a maximum in the supra-gypsum part of the profile. Gross phosphorus in gray-brown soils is from 0.05 to 0.12%, and potassium - 1.08 - 1.60%. Moreover, their greatest amounts are located in the middle part of the profile – in horizon B. Mobile forms of soil phosphorus are provided from weak to medium level - 17 - 26 mg/kg of soil, and high potassium –from medium to high level - 308 -557 mg/kg of soil.

As mentioned above, irrigated gray-brown soils, although they occupy a small area of distribution, are significantly susceptible to changes in time and space when exposed to anthropogenic factors, which is manifested both in morphogenetic properties of the profile and in chemical composition. Based on the irrigation time, newly irrigated and newly developed soils are distinguished in gray-brown soils. Old-irrigated gray-brown soils occupy small areas, since under intensive irrigation accompanied by a change of moisture regime from automorphic to semi-hydromophical one, depending on formation conditions, they rapidly transform into gray-brown-meadow soils. On the Karakalpak Ustyurt, the virgin gray-brown northern soil was compared with the newly irrigated gray-brown soil of the farmland. A long-term farming works (for 10-15 years) on gray-brown soils using fresh water with a mineralization of 0.8 g/l radically transformed the quantitative and qualitative composition of ready soluble salts, decreased the alkalinity and removed the signs of magnesium alkalinity. Effective fertility indices increased - the humus content increased from 0.77% in the upper part of the profile to 1.79% in the arable horizon (section 389). But at the same time, the salinity and lack of mobile potassium are maintained, the amount of which is not restored even up to the level in virgin soil. As for the content of CO_2 carbonates in the irrigated soil, when compared to virgin soil, a decrease from 11.3 to 8.9% was observed in the upper part of the profile. As for mechanical composition, some heaving occurred in the middle of the profile due to dusty-silt particles. Due to a long-term irrigation in the arable horizon, a slight increase in physical clay occurred, which led to the transform of medium loam to heavy loam.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

A study of irrigation experience at the Ustyurt desert station of the Karakalpak branch of the Institute of Natural Sciences of the Academy of Sciences of Uzbekistan showed that there is a decrease in total alkalinity and total amount of salts under the effect of medium-mineralized irrigation water on soil [3,9,17]. The primary salt maximum is washed out, but due to the secondary salinization process, a new salt maximum is formed in the arable horizon. At the same time, the qualitative content of salts changes in the direction of increasing sulfates. No significant changes in soil fertility are observed, the content of organic matter slightly increases, and, to a lesser extent, the content of nitrogen; the content of mobile forms of phosphorus and potassium decreases, due to their removal by vegetation. In general, at the stage of new irrigation, gray-brown soils are poor in all forms of basic elements of plant nutrition - nitrogen, phosphorus and potassium. On the foothill proluvial plain of the Malikchul, in the Navoi region, for many years of irrigation (10 - 50 or more) newly developed, newly irrigated and old-irrigated gray-brown soils were formed (sections 31,12,27) under the influence of soil-forming processes. Long-term irrigation and crop cultivation fundamentally transform the natural profile of soil, namely, an arable horizon, $A_п$, followed by the formation of humus horizon, $A_п + B_1$, which transforms in the process of amelioration and agro-irrigation. At the same time, ready soluble salts and carbonates are washed deep into the profile. Intensive irrigation in conditions of poor drainage of the territory at shallow occurrence of a water-resistant horizon typical of gray-brown soils, eventually leads to the formation of Ag horizon with its inherent features. The lower part of the profile remains moistened for most of the year, which dramatically changes the water regime of soil with the subsequent intensification of oxidation-reduction processes. Under more unfavorable ameliorative conditions, when the outflow of groundwater is significantly slowed down, the initial meadow forming turns into waterlogging, which can intensify the transformation of ready soluble salts in upper horizons under exudation and lead to secondary soil salinization that negatively affects the development of cultivated vegetation. The initial gray-brown soils of the Malikchul plain are represented by medium and light loams, the humus content is 0.300 - 0.500%, the availability of mobile phosphorus and potassium is low. In newly developed gray-brown soils, against the background of a heavier mechanical composition, a slight increase in humus content is observed - up to 0.650% over the entire profile in the arable horizon as well as an insignificant amount of mobile phosphorus and potassium.

In the old-irrigated gray-brown soils of the Malikchul plain, the arable horizon already contains 0.944% of humus, and the underlying horizons B_1 - 0.843%, B_2 - 0.570%. With an

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

increase in the content of organic matter in old irrigated soil analogues, a slight decrease in mobile phosphorus occurred - down to 15.5 mg/kg of soil, and mobile potassium remained almost at the same level as in newly developed soil - 200 mg/kg (Table 1).

Table 1

Chemical and mechanical composition of gray-brown soils

Section, No.	Depth of horizons, cm	Humus,%	Nitrogen,%	C/N	CO_2, carbonates %	phosphorus, mg/kg	potassium, mg/kg	Phys. clay (<0.01 mm)	Mechanical composition
M.M. Greenberg, 1984; Virgin gray-brown northern soil. The Ustyurt plateau									
390	0-4	0.760	0.050	8.6	10.3	22.0	557.0	30.4	Medium loam
	4-9	0.770	0.040	10.2	11.3	26.0	446.0	34.2	Medium loam
	9-26	0.700	0.040	9.7	8.6	2.0	422.0	43.3	Medium loam
	26-46	0.380	0.030	8.8	6.6		289.0	38.9	Medium loam
	46-80	0.260	0.020	9.4	4.9			13.0	Sandy loam
	80-90	0.230	0.010	14.8	5.4			15.9	Sandy loam
A.Zh. Kushokov, 2007 Virgin gray-brown soil. Malikchul									
1	0-8	0.500	0.051	5.7	8.60	26.14	181.0	23.85	Light loam
	8-20	0.300	0.031	5.6	9.22	18.65	168.6	40.43	Medium loam
	30-50	0.100	0.009	6.4	9.12	12.70	128.0	11.65	Sandy loam
R.M. Madrimov. A.M. Razakov. 2018. Virgin gray-brown Soil, Tashsaka Plateau									
1	0-1	0.487	0.034	8.3	10.60	8.4	358.8	39.4	Medium loam
	1-8	0.568	0.038	8.6	9.50	6.4	308.2	49.1	Heavy loam
	8-21	0.487	0.030	9.4	6.05			31.5	Medium loam
	21-41				3.10			23.8	Light loam
	41-60				3.10			22.5	Light loam
A.Zh. Kushokov. 2007 Newly developed gray-brown soil. Malikchul									
31	0-20	0.650	0.062	6.4	9.67	27.31	200.0	37.62	Medium loam
	35-54	0.400	0.046	6.2	9.23	10.80	196.4	36.40	Medium loam
	54-70	0.310	0.031	7.2	8.20	9.25	170.7	32.05	Medium loam
	70-100	0.120	0.012	6.0	8.56	8.38	158.2	32.36	Medium loam
M.M. Greenberg. 1984 Newly irrigated gray-brown northern soil. The Ustyurt plateau									

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

389	0-20	1.790	0.120	8.8	8.9	49.0	258.0	39.8	Medium loam
	20-46	0.470	0.030	10.1	8.4	8.0	157.0	48.0	Heavy loam
	46-62	0.200	0.020	7.3	3.8		96.0	17.6	Sandy loam
	62-74	0.200	0.010	9.7	3.3		96.0	16.1	Sandy loam
	74-92	0.170	0.010	7.0	4.4			19.7	Sandy loam
A.Zh. Kushokov. 2007. Newly irrigated gray-brown soil. Malikchul									
12	0-26	0.560	0.055	5.9	13.4	31.00	185.4	30.2	Medium loam
	26-50	0.490	0.048	5.9	12.97	16.24	174.7	34.4	Medium loam
	50-88	0.300	0.030	5.8	12.54	10.16	169.2	43.5	Medium loam
	110-140	0.170	0.020	4.9	12.00	8.54	154.6	38.9	Medium loam
R.M. Madrimov. A.M. Razakov. 2018. Newly irrigated gray-brown soil. The Tashsaka Plateau									
2	0-26	0.447	0.034	7.6	5.02	2.9	149.3	29.9	Light loam
	26-40	0.447	0.032	8.0	5.67	1.6	134.8	34.0	Medium loam
	40-70	0.183	0.021	5.0	3.53			10.8	Sandy loam
	70-90				1.58			6.7	Consolidated sand
	90-100				9.67			50.6	Heavy loam
A.Zh. Kushokov. 2007 Old-irrigated gray-brown soil. Malikchul									
27	0-30	0.944	0.056	9.7	10.58	15.5	200.0	59.79	Heavy loam
	30-60	0.843	0.053	9.2	10.79	12.4	193.4	61.26	Heavy loam
	60-90	0.570	0.042	7.9	10.90	6.28	160.2	68.42	Clay
	100-130	0.320	0.025	7.4	9.89	5.62	152.8	35.32	Medium loam
R.M. Madrimov. A.M. Razakov. 2018 Newly irrigated gray-brown-meadow soil. The Tashsaka Plateau									
12	0-22	0.528	0.038	8.0	5.02	10.0	149.3	12.8	Sandy loam
	22-36	0.406	0.031	7.6	5.02	6.8	149.3	11.8	Sandy loam
	36-60	0.264	0.024	6.4	5.20			13.6	Sandy loam

One cannot ignore the fact that the irrigation time significantly affected the heaving of mechanical composition of gray-brown soils to a depth of 90 cm (heavy loamy soil and clay) which is not typical of virgin gray-brown soils of the Malikchul plain. The morphological description of old irrigated gray-brown soils, testifying to the development of this part of the profile in combination with the reduced chemical composition, especially with the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

quantitative humus content, suggests the formation of an anthropogenically cultivated agro-irrigation horizon in gray-brown soils as a result of their evolution.

The evolution of gray-brown soils under anthropogenic impact was most clearly seen on the Tashsaka plateau of the Pitnyak massif in the Khorezm region, where the Tuyamuyun reservoir was built in the border zone with Turkmenistan. Studying soils in the gate-key order, taking into account hypsometric surfaces on the Tashsaka plateau, made it possible to identify the basic patterns of soil formation in its various parts. Under intensive irrigation on the Tashsaka plateau adjacent to the Tuyamuyun reservoir over a period of 50-60 years, radical changes occurred in the soil cover, seen in the transform of automorphic gray-brown soils to semihydromophic and hydromophic ones. If all factors are taken into account, then three time stages of soil formation can be distinguished:

1. Automorphic stage. The groundwater level is deeper than 5 m. The virgin soils development period covered the time until 1960.
2. Semi-hydromophic stage. The period of a gradual rise in groundwater level covered the time from 1960 to 1990.
3. Hydromophic stage. Groundwater level reaching the day surface - moistening, bogging and salinization, covered 1990 – 2018 years (Fig. 1)

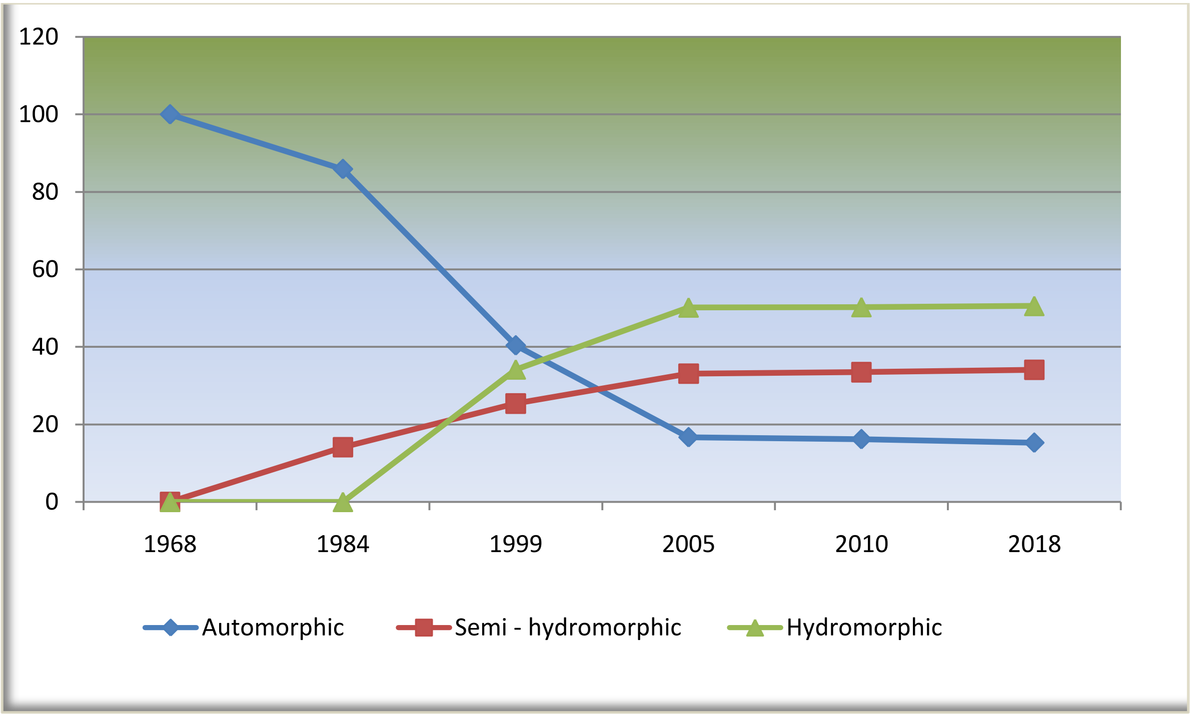

Figure.1. Time – history of the wetting regime of gray – brown soils for the period of 1968-2018

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

Over the entire period, one can trace the transform of virgin gray-brown soils to irrigated gray-brown–meadow, meadow, and swampy–meadow soils. If in the irrigated gray-brown soils (section 2) there are still signs of original virgin soil – the brownishness, carbonate content, then in gray-brown-meadow soils (section 12) they disappear and the signs of meadow and swamp formation appear. To some extent, there is an increase in gross and mobile phosphorus. As for potassium, only its gross form is increased, and its mobile part is almost two times less compared to the virgin analogue. Variation-statistical processing of research results showed that in unirrigated gray-brown-meadow soils, in comparison with virgin soils in the newly irrigated soils of Tashsaka plateau, an increase in humus content in the arable horizon occurs. It should be noted that quantitative changes in humus content directly related to soil cultivation lead to qualitative transforms, that is, fulvate type of humus is transformed into fulvate-humate type [1.12]. Humus substances are fixed in soils due to calcium humates and fulvates in the arable horizon, and in the underlying horizons due to free fulvic acids connected with sesquioxides and an aggressive 1-a fraction.

Conclusion. Gray-brown soils of the desert zone, as a zonal type, occupy the vast territory of Uzbekistan and are formed in various lithological and geomorphological conditions. Of total area of gray-brown soils (11 million hectares), only about 140 thousand hectares, or 1.3% of total area, are involved in irrigated farming. Despite this, in the future they constitute a considerable reserve for food crops development in the Republic. Irrigation and farming on gray-brown soils, radically changing soil morphogenetic properties, lead to significant changes in physical properties with subsequent redistribution of chemical elements, an increase in organic matter content. Under long-term irrigation, a cultivated agro-irrigation horizon is formed, which in combination with other soil properties determines the potential and effective fertility and productivity. For the effective use of these lands in irrigated farming, it is necessary to implement high technological, water-saving agro technical methods to prevent secondary salinization, swamp formation, and karst-suffusion phenomena characteristic of gray-brown soils.

Taking into account the properties of soils, the crop selection is of no small importance. It is more rational to use soils of an automorphic series for garden crops and vineyards, and semi-hydromophic soils (after land ameliorative measures and agricultural engineering) - for cotton, grain and leguminous crops, alfalfa, while observing crop rotation.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 5243 - 5252
Received 05 March 2021; Accepted 01 April 2021.

REFERENCES

1. Gafurova L.A., G.M. Nabiyeva, T. R.Matkarimov. R.M. Madrimov, A.M. Razakov, Evolution, Transformation And Biological Activity Of Degraded Soils. International Journal of Advanced Science and Technology ISSN: 2005-4238 Vol. 28, No. 14, 2019. p. 88-99
2. Gafurova L.A., Madrimov R.M., Razakov A.M., Nabiyeva G.M. Ekologiya, genezis, transformatsiya i evolyutsiya pochv Pitnyakskogo oazisa // Kollektivnaya monografiya. ISVN 978-5-98482-089-9. Moskva 2019. S. 101-120.
3. Gafurova L.A., Razakov A.M., Madrimov R.M. Dinamika izmeneniya i nekotoriye osobennosti sero-burix pochv Tashsakinskogo plato. Materiali Respublikanskoy nauchno-prakticheskoy konferensii. Urgench-Xiva, 2006, S.201-204.
4. Gafurova L.A., Saidova M.E., Ergasheva O.X., Kadirova D.A., Dauletmuratov M.M. Modern ecological - biological condition of salt-affected soils in the Aral sea area. International Journal of Advanced Science and Technology ISSN: 2005-4238 Vol. 28, No. 14, 2019. p. 533-540
5. Grinberg M.M. Osobennosti pochv severnoy chasti Karakalpakskogo Ustyurta i vozmojnosti ix ispolzovaniya. Avtoref. Diss… k.s-x nauk. T.1984
6. Kimberg N.V. Pochvi pustinnoy zoni Uzbekskoy SSR. “FAN”, Tashkent, 1974, 188s.
7. Kuziyev R.K, Sektimenko V.Ye, Pochvi Uzbekistana “EXTRE MUM PRESS”, 2009,352s
8. Qo‘shoqov A.J. Malikcho‘l tog‘ oldi tekisliklarini sug‘oriladigan sur tusli qo‘ng‘ir tuproqlaridagi sho‘rlanish jarayonlari va shakllari. Avtoref.diss.... b.f.n.-T.2007.
9. Madrimov R.M., Razakov A.M., Pitnak vohasi tuproqlarining hozirgi holati va ulardan foydalanish yo‘llari. UzPITI, Respublika ilmiy-amaliy anjumani materiallari. Toshkent-2011.95-96, b.
10. Pervushevskaya G.V. Kuziyev R.K. O pogrebenпых sero-burых pochvax Kizilkumov. Trudi IPA AN UzSSR, vыр. 20, Tashkent, 1981,S.65-81
11. Popov V.G. Pochvenniy pokrov Karakalpakskogo Ustyurta i yego ratsionalnoye ispolzovaniye. “FAN”, Tashkent, 1986,152s.
12. Popov V.G., Sektimenko V.Ye., Razakov A.M.,Grinberg M.M. Usloviya pochvoobrazovaniya, pochvi i nekotoriye voprosi osvoyeniya Karakalpakskogo Ustyurta. Trudi Instituta pochvovedeniya i agroximii. Vip.28. Problemi osvoyeniya pustini Ustyurt. Izd. “MEXNAT”.Tashkent,- s.35-53

13. Popova T.P., Kuziyev R.K. Sero-buriye slaborazvitыye pochvi nagoriy. Trudi IPA AN UzSSR, vыp.18, 1979. S.122-141.
14. Razakov A.M., Gafurova L.A., Madrimov R.M. Sur tusli qo'ng'ir tuproqlarni evolyutsiyasi va ulardan foydalanish // Upravleniye zemelnimi resursami i ix otsenka: noviye podxodi i innovatsionniye resheniya. Materiali Rossiysko- Uzbekskoy nauchno-prakticheskoy konferensii, posvyashyennoy 100 letiyu Natsionalnogo universiteta Uzbekistana imeni Mirzo Ulugbeka. Moskva-Tashkent. 2019., S 396-400.
15. Razakov A.M., Gafurova L.A., Sektimenko V.Ye., Madrimov R.M., Nabiyeva G.M. Evolyutsionno – geneticheskiye aspekti pochvoobrazovaniya sero-burix pochv pustinnoy zoni Uzbekistana i vozmojnosti ix ispolzovaniya // Jurnal "Pochvovedeniye i agroximiya" №4 (dekabr) Almatы. 2019. S45-57
16. Razakov A.M., Madrimov R.M. Sero-burыye pochvi Tashsakinskogo plato, ix otsenka i povisheniye plodorodiya. Materiali mejdunarodniye konf., posvyashyennoy 100-letiyu U.U. Uspanova. Almati, Tetis, 2006, S.176-177.
17. Rasulov A.M. Pochvi Karshinskoy stepi, puti ix osvoyeniya i povisheniya plodorodiya. "Fan", Tashkent, 1976, 152s
18. Faizov K.Sh. Pochvi pustinnoy zoni Kazaxstana. "Nauka", Alma-Ata, 1980, 320 s.