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S. Kocherli[1], M. Mustafayev[1]*, E. Akhmadzade[1],Z. Veliyeva[1],

F. Mustafayev[1], F. Aliyeva[1]*

DEPENDENCIES BETWEEN CHEMICAL, PHYSICAL AND OPTICAL PROPERTIES OF MUGAN PLAIN SOILS

[1]Ministry of Science and Education of the Republic of Azerbaijan, Institute of Soil Science and Agrochemistry, AZ1073, Baku, Mam ed Rahim 5,Azerbaijan,

**e-mail: meliorasiya58@mail.ru; fatma_aliyeva_1988@mail.ru*

Abstract. The article deals with the relationship between chemical, physical and optical properties of Mugan Plain soils. It was determined that the integral reflection coefficient with chemical and physical properties of the main soil types of the Mugan Plain was the least in gray-brown and grass-gray soils, 31.09-40.3%, 31.1-38,0 respectively, depending on the profile. The highest amount of 5% was in gray-meadow and swamp-meadow soils and varied between 42.90-50.55% and 39.20-42.00%. Grass-marsh lands, distributed throughout the territory in the form of tala, are distributed in limited areas of the Mugan Plain, mainly in depressions, in places where groundwater is exposed, in the area of the Kura River. Meadow-marsh soils are characterized by a high content of humus and moisture, on which predominantly water-sensitive plants grow. The amount of humus in the upper layer (0-25 cm) reaches 4.05%, which is associated with the annual rotting of a large amount of plant mass. The amount of humus decreases with depth and reaches 0.90% at a depth of 1 meter. This distribution of humus is due to the fact that the bulk of roots and rhizomes are collected in this part of the soil profile. The reason for the lack of roots in the lower layers is the unfavorable air-water regime in the silt layer due to high humidity and a large amount of iron oxide, which negatively affects plants.

Keywords: integral reflectivity, humus, spectral reflectivity, soil sections, carbonation.

INTRODUCTION

Rational use of Azerbaijan's natural resources requires careful attention to environmental problems, especially soil protection. A significant role in this regard belongs to remote methods of monitoring soil conditions. The correct choice of spectral ranges significantly reduces the time and cost of research. Such a choice must be preceded by significant experimental material on the spectral reflectance coefficients of natural objects. Such experimental studies include the determination and scattering of light by soil, which is associated with the distribution of solar radiation arriving at the soil surface, and, consequently, the heat balance, speed and direction of various processes occurring in soils. Spectral reflectance is one of those soil characteristics that is directly reflected in remote sensing materials.

One of the features of remote indication is the receipt of reliable data for qualitative and quantitative express analysis of the state of the soil cover, as well as the ability to enter this information into a computer program to obtain the necessary information. A significant role in this belongs to laboratory measurements of the spectral ability of soils, which make it possible to establish the specific influence of various factors on the formation of the optical properties of the soil, which can be used in processing remote sensing materials. The quantitative patterns of the influence of individual factors on the reflection of light by soils have not been sufficiently studied and are among the main tasks in the study of the spectral reflectivity of soil and the practical use of this characteristic for the purpose of comparative characteristics of soils and soil color.

The formation of the spectral reflectivity of soils is influenced by a number of factors, because soil type, its structure, humidity, humus content, carbonate content, vegetation cover. physical condition, etc. All these factors have increased variability and lead to significant variations in the reflective properties of the objects under study. Therefore, spectrophotometric information must be extracted taking into account all influencing factors. In this way, it is possible to increase the stability of spectrophotometric information about an object and, consequently, increase the reliability of the information obtained about its properties and condition. To solve the issue of minimizing the error of influencing factors, it is necessary to study the effect of each of them on the reflective properties of objects.

Under natural conditions, the soil structure changes under the influence of applied agricultural technology, irrigation and atmospheric phenomena. Water, on the one hand, contributes to the aggregation of the soil, on the other, it leads to its floating. Structureless soils are characterized by weak water resistance; they float even after a little rain. With prolonged exposure to water, they were covered with a dense crust, the reflective properties in a dry state are quite high. Therefore, the soils under agricultural land, mainly used for cotton, change significantly during the growing season. Moistening reduces the soil brightness coefficient. This occurs due to the fact that the main influencing factor on the refractive index of light at the soil-air boundary is a thin film of water and the phenomenon of total internal reflection of light occurs precisely in this thin layer of soil solution.

Soil is a multi-parameter system that changes in time and space. A change of these parameters in any combination directly affects the optical characteristics of soils. In this article we provide data on some of the main factors directly affecting the formation of soils and their optical properties. Scientists both in our country and abroad have been studying remote methods for monitoring soil conditions [1-5].

MATERIALS AND METHODS

Object and methodology of research

The widespread use of the latest achievements of science and technology in the study of soils is one of the most important tasks of our time. Existing methods for more efficient use of land do not meet the modern requirements of the day. Thus, additional funds have to be spent on performing a large number of labor-intensive field and laboratory work. It is impossible to conduct research in hard-to-reach areas.

Therefore, spectrometric methods are widely used in remote sensing of soils both in our country and abroad. Its advantages are that in a short time it is possible to obtain accurate information about the reflectance of large areas and even study dynamic processes. The lands of the Mugan Plain of Azerbaijan were taken as the object of study. In the research work, the spectral reflectance of soils at a wavelength of 450-750 nm was studied using methods adopted in our republic and abroad, and the spectral properties were studied using an SF-18 spectrophotometer [3, 4, 6].

RESULTS AND THEIR DISCUSSION

The Mugan Plain, which we studied, is part of the Kura-Araz Plain, and sediments of the Caspian Sea, overlain by sediments of the Kur-Araz rivers, play a large role in its formation. The sediments of the Kura-Araz rivers differ sharply in their color. Thus, the sediments of the Araz River are red, and the sediments of the Kura River are gray-brown.

The relief of the Mugan Plain is quite complex. Northern Mugan, its relief and soils owe their origin to the accumulative activity of the Kur and Araz. The forming factor of Central Mugan is only the Araz River. The formation of Northern Mugan is relatively new and its formation continued until recently. As a result of periodic floods of the Kur and Araz rivers, these waters flowed towards the Northern Mugan region Accumulative activity in the region of central Mugan ceased long ago, and the processes that led to the modern relief are of a denudation nature.

It is necessary to mention the ancient origin of the Araz River, which is below sea level. These formations are separated by very large alluvial-accumulative formations, deep dry old channels with high banks and embankments along the channel. A significant part of the Mugan Plain is below sea level. The modern form of the relief is predominantly accumulative, but in the foothill zone surrounding it from the north, the denudation-erosion type of relief prevails. The slope of the surface is 0.003-0.004. Heavy soils are scattered along the edges.

The zone has a dry subtropical climate, characterized by mild winters and hot and dry summers. The average annual air temperature is 140°C, the annual precipitation is 293 mm. The amount of evaporation per year is 900-1000 mm [7, 8].

Such soil and climatic conditions of the zone also affect vegetation. The vegetation consists of semi-desert wormwood, ephemeral grass, and saltwort. However, such soil and climatic conditions of the area make it possible to obtain a bountiful harvest here due to irrigation.

Table 1 - Chemical and physico-chemical indicators of soils

Depth, sm	Hummus, %	$CaCO_3$, %	Amount of absorbed bases, mg/eq	Absorbed cations, mg/eq			Dry residue, %	Grading	
				Ca^{+2}	Mg^{+2}	Na^{+1}		<0.001	<0.01
Gray-brown soils									
0-30	2.65	1.09	27.25	21.85	4.00	1.40	0.135	20.84	68.48
30-50	1.07	3.75	25.75	20.40	4.25	1.10	0.162	32.80	67.56
50-90	1.09	20.05	25.20	13.65	9.75	1.80	0.137	30.24	66.12
90-105	0.97	17.61	17.60	13.15	3.25	1.20	0.122	27.08	45.52
Gray meadow lands									
0-20	1.62	3.63	25.00	16.05	5.75	3.20	0.210	29.89	65.76
20-40	1.52	3.63	27.55	18.00	6.25	3.30	0.290	27.80	65.00
40-55	0.63	9.02	25.25	16.40	6.25	2.60	0.960	36.60	68.92
55-90	0.53	16.96	23.00	10.25	9.25	3.50	1.110	31.80	68.00
Grass-gray lands									
0-25	2.40	9.16	22.00	16.40	3.50	2.10	0.790	20.00	63.20
25-57	1.83	11.18	15.10	17.60	5.50	2.00	0.682	23.40	68.20
57-80	1.07	2.23	2.20	28.20	11.50	2.50	0.522	22.80	61.80
80-110	0.76	12.52	34.30	22.60	9.00	2.70	0.512	26.80	68.20
Wetlands									
0-25	2.05	9.25	29.50	16.50	10.50	2.50	0.730	38.80	77.60
25-45	1.60	13.90	0.30	15.70	12.30	2.30	0.540	29.20	77.10
45-60	1.30	15.31	29.70	16.30	10.70	2.70	0.635	27.30	65.50
60-75	1.01	14.27	29.20	16.20	10.10	2.90	0.590	30.41	60.40
75-100	0.90	15.01	29.70	15.40	11.20	3.10	0.720	26.50	60.20

The soil-forming rocks of the region are alluvial in nature, the soils are predominantly gray-brown, gray-grass, grass-gray, meadow-swamp, and their varieties are widespread. The physicochemical results of the soils in the region show that the soils in the region have different spectral reflectance properties depending on its type, color, composition, etc., and ithas been found that its spectral reflectivity increases with increasing wavelengths [8-11].

Below are some physicochemical properties of soil types in the Mugan Plain (table 1). One of them was gray-brown soils, distributed mainly in the foothills of the Mugan Plain. As a result of laboratory analysis, it was found that the amount of humus in the upper layer (0-30 cm) of these soils is 2.65%, decreases towards the lower layers and reaches 0.97% in the layer 90-105 cm. The amount of carbonates fluctuates in a wide range (1-20%). The distribution of carbonates shows their leaching from the upper layer and accumulation in the lower layers. The absorption capacity of these soils is 17.80-27.25 mg/eq per 100 g of soil. The total amount of calcium is 13.15-27.85 mg/eq, magnesium - 3.25-2.75 mg/eq, sodium - 1.10-1.80 mg/eq. The amount of dry residue in the soil profile is 0.122-0.162%, and as you can see, these soils are slightly saline.

Change in soil attenuation coefficient depending on wavelength.

According to the granulometric composition, these soils are light and medium clayey, the amount of physical clay in the upper layer is up to 68.48%, in the lower layers - 45.52%. In this section, the change in the spectral reflectance of soils depending on different wavelengths is approximately linear. It was found that although the amount of 400 nm wavelength in the top soil layer was 23.0%, it gradually increased to 30.0% at 500 nm, 32.0% at 600 nm, 35.0% at 700 nm and 35 .5% at 750 nm. The integral spectrum reflectance coefficient was 31.0%. In the lower layers, its number increased slightly and reached 40.3% (figure 1).

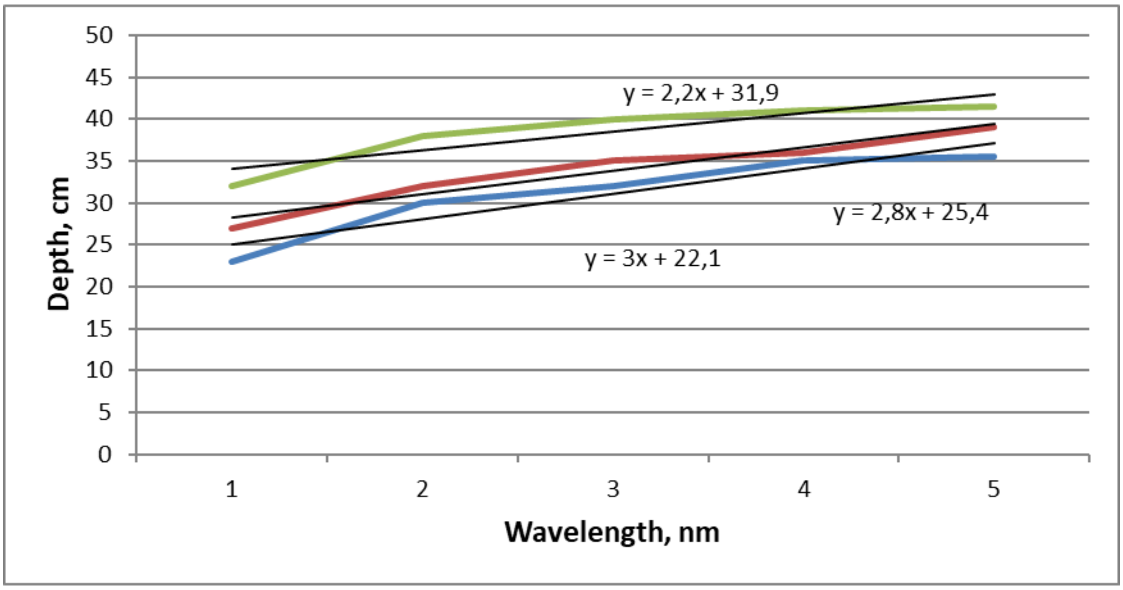
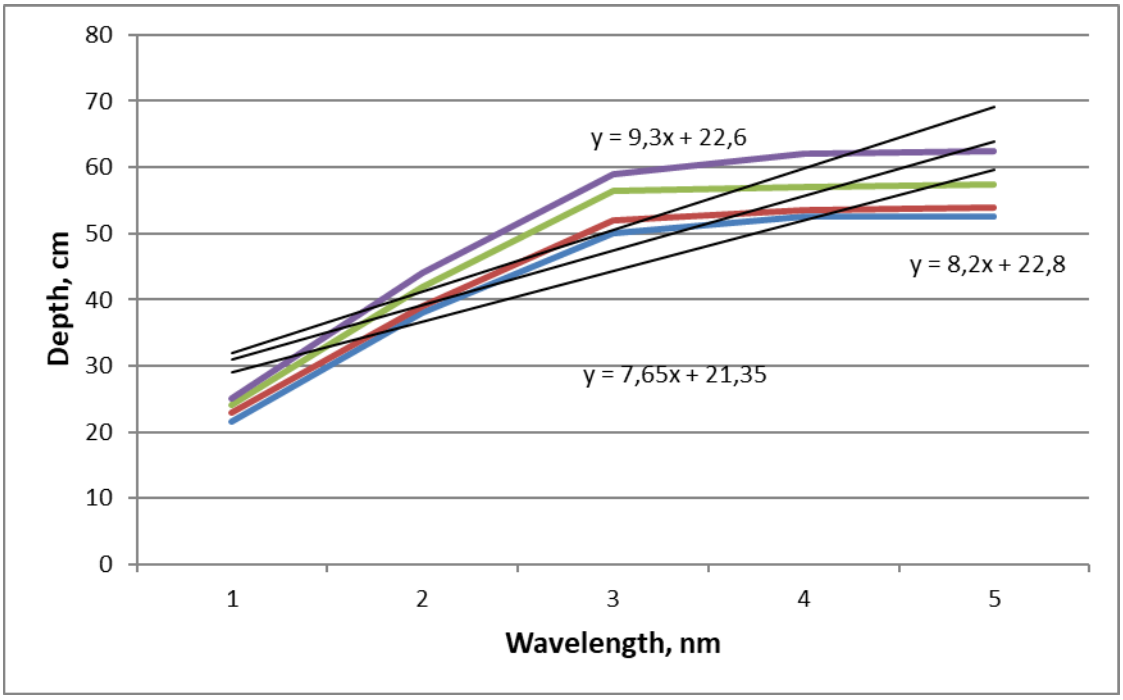


Figure 1 - Variation of reflectance with wavelength in gray-brown soil

One of the common soils in the region is gray meadow soil. In the upper layer (0-20 cm) of gray meadow soils, the humus content is 1.62%, decreasing with depth and falling to 0.53% at a depth of 55.90 cm. The amount of carbonates varies along the profile from 3.63 to 19, 96%, most of them are located in a layer of 55-90 cm. The amount of absorbed bases is 23.00-27.55 mg/eq per 100 g of soil along the profile. Of the amount of absorbed bases there are 10.25-18.00 mg/eq of calcium, 5.75-9.25 mg/eq of magnesium and 2.60-3.50 mg/eq of sodium. The amount of dry residue in the upper layer (0-20) is 0.210%, and in the lower layers its amount increases to 1.110%. According to their granulometric composition, these soils are classified as medium clayey. The amount of physical clay here ranges from 65.00-68.92% [1, 7, 12, 13].

Of course, all the above analysis results are reflected in the spectral reflectance. So, if at a wavelength of 400 nm the spectral reflectance of these soils was 21.5-25.0% depending on the profile, then at the next wavelength it was 38-44%, and at 750 nm - 52.5-62.5%. The integral reflection coefficient was 42.9-50.5%, respectively. One of these soils is grass-gray soils. These soils have gone through an ancient agricultural stage and are more typical of the Mugan Plain. The amount of humus in the upper layers is up to 2.40%, in the layer of 80-110 cm it decreases to 0.76% (figure 2, 3).



Fiqure 2 - Change in reflectance depending on wavelength in gray grass soils

As for the distribution of carbonates, a slight increase in their amount is observed as the lower layers pass through. So, if in the top layer of soil 0–25 cm its amount is 9.16%, then in the layer 80–116 cm its amount reaches approximately 12.52%. The amount of absorbed bases in 100 g of soil is 22.0-42.2 mg/eq, most of which is calcium (16.40-28.20 mg/eq).

Absorbed magnesium ranges from 3.50 to 11.50 mg/eq, and absorbed sodium ranges from 2.0 to 2.7 mg/eq. The amount of dry residue in the upper layer of these soils is 0.79%; in the lower layers it decreases slightly to 0.512%. According to their granulometric composition, these soils are classified as medium clayey. The amount of physical clay ranges from 65.0-68.0%.

As can be seen from the table, it is clear that the spectral reflectance increases. Thus, its amount in the upper layer of 0-25 cm was 22.5% at a wavelength of

400 nm and 36.0% at a wavelength of 750 nm. Moving to the lower layers, its amount gradually increased in all wavelengths and ranged from 23.0 to 42.0% in the 75-100 cm layer, respectively. The integral reflection coefficient of these soils varied along the profile in the range of 31.1-38.5% (figure 4).

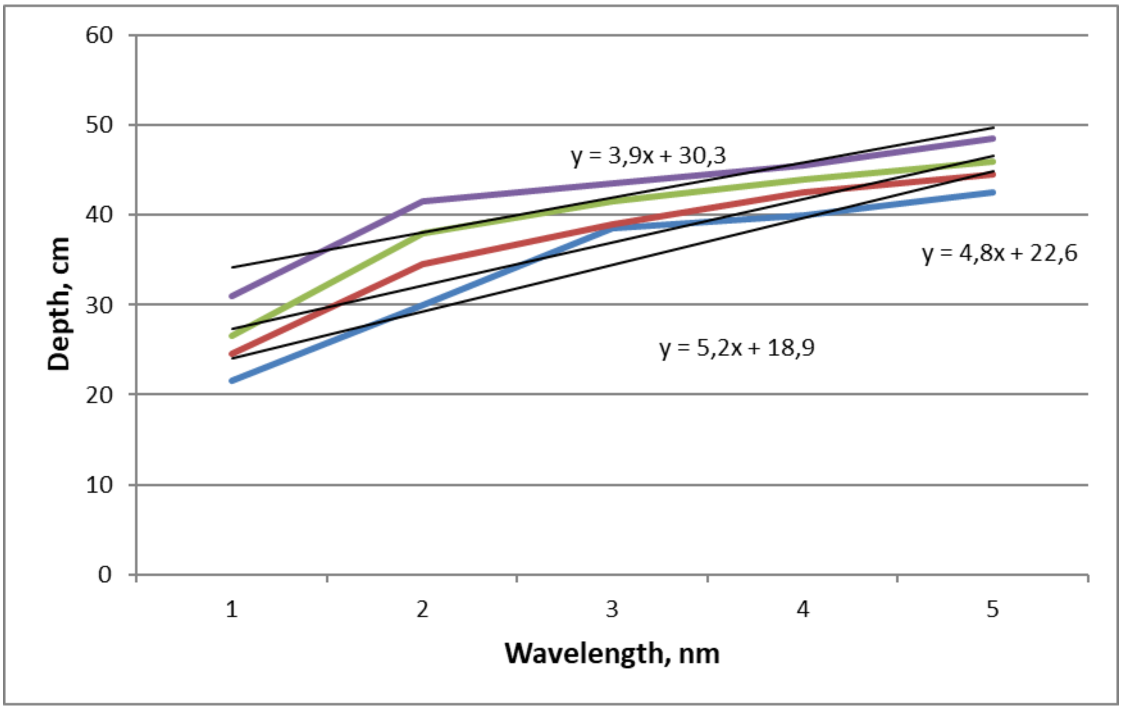


Figure 3 - Variation of reflectance with wavelength in herbaceous gray soils

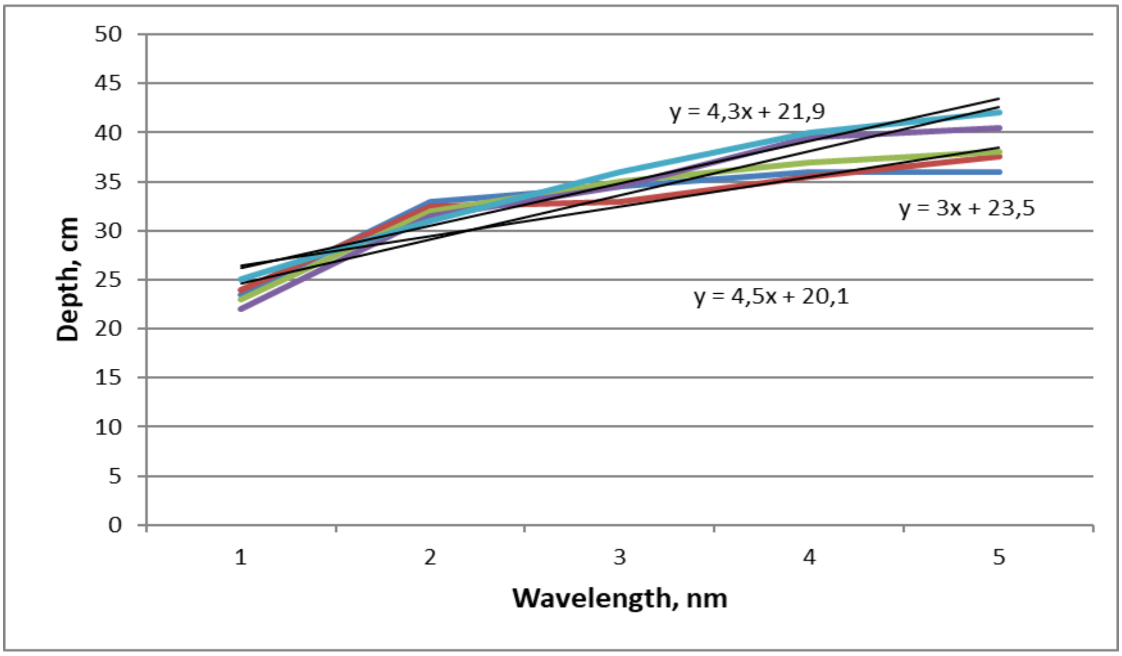


Figure 4 - Changes in reflection coefficient depending on wavelength in meadow-marsh soils

The amount of carbonates ranges from 92.5-15.31%. Absorbed bases fluctuate within a narrow range (29.50-30.30 mg/eq per 100 g of soil). calcium 15.40-16.50 mg/eq, magnesium 10.10-12.30 mg/eq and sodium 2.30-3.10 mg/eq. The soils are moderately saline, the amount of dry residue is 0.540-0.730%. In terms of granulometric composition, these soils are heavy clays of the upper layer (the amount of physical clay is 77.60%), when moving to the lower layers they become lighter and the amount of physical clay in the 75-100 cm layer is 60.20%. The integral reflection coefficient of meadow-bog soils ranged from 39.2-42.0% depending on the depth of the profile [1, 2, 14, 15].

An average monthlytemperature of the soil surface is 1-3,5 ^{0}C in January, 32-35^{0}C in july. The plant cover of the Mughanplainconcerns semidesert type, there are mainly 3 kinds: wormwood, saline, hollow plants. According to the climate-condition the annual heat-loving plants, technical plant–cotton planting here is good. Diversity of the cultureswasformed and they were subjected to variation in a large part of the zone. At present natural cultures canbemet inthe small areas of some places.

The soil cover of the Mughan plain was widely learnt by some researchers. The following soil typesareavailable in the plain: grey-meadow less humic soils: grey-meadow mean humic soils; grey-meadow-highhumicsoils; primary-grey soils; meadow-grey soils. Later, main reasons of the Kur-Araz soils salinizationwereinvestigated by V. R.Volobuyev [4, 8, 14].

The author separatedthe meadow-grey soils into saline-like, solonchak-like, merging, gleying, irrigating species and noted utilizationof these soils under cotton, grain and orchard plants. But in amelioration area M. G. Mustafayev [5], G. Z. Azizov [7] and other specialists directedtheir researches to salinization and solonetzification of soils, investigation of the variasion happening in utilization period.

Thelong researches show that incorrect irrigation of the soils under tillage, need and non-implementationof thesemeasures in time cause the soils salinization and render their negative influence on agricultural plants whicharegrown there. On the other hand, one of the main reasons of the soils salinization is nearness of subsoil waterswithhigh mineralization to the surface. While increasing the salts concentration in soil, development of bothundersoiland land surface organs of plants weakens, productivity reduces. Generally, to achieve the salts decrease insoil, itis advisable to apply irrigative water according to the amount of plants.

The results of the studies show that the integral reflectivity of the soil is directly proportional to dry residue, physical clay, carbonization, salinity and inversely proportional to humus. Thus, with a change in carbonization by 1%, the integral reflection coefficient is 0.93%, depending on the physical clay - 0.352%, depending on the dry residue - 4-6%, which is a direct dependence, and is 4% depending on the amount humus, which is the inverse proportion. The study of integral reflection makes it possible in the future to determine, monitor, etc, its diagnostic features by remotely studying the soil can be used when studying signs. At the same time, it can be used as an auxiliary tool for opening (deciphering) aerospace photographs.

As a result of research, it has been established that the spectral curves of each type of soil are subject to more intense changes in a certain part of electromagnetic waves, depending on its properties.

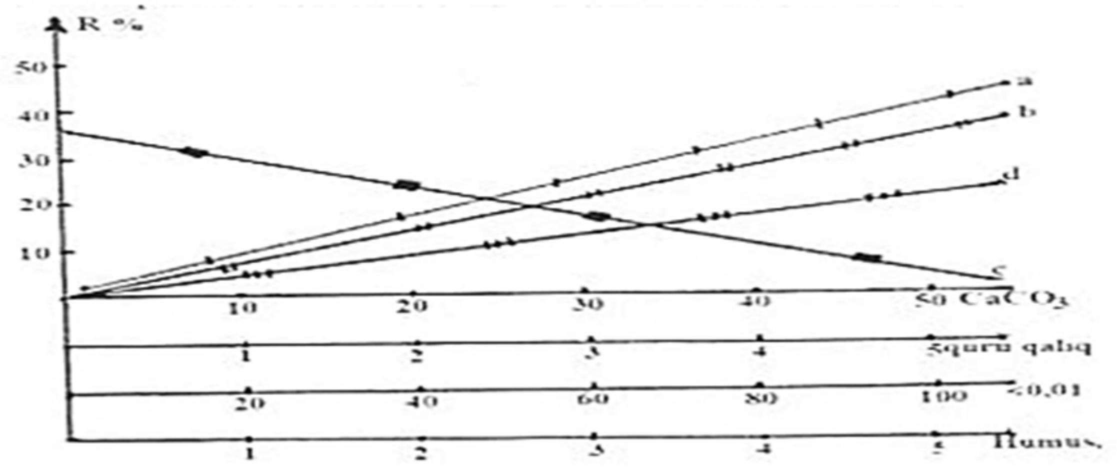


Figure 5 - Relationships between some soil properties and the integral reflection coefficient

It has been established that, depending on the properties of the soil, the integral reflectivity is directly proportional to the dry residue, carbonation and physical clay and inversely proportional to the amount of humus. So, with a change in carbonization by 1%, the integral reflection coefficient was approximately 0.93%, depending on the physical clay - 0.352%, depending on the dry residue - 4-6%, a direct relationship, and it was 4%, depending on amount of humus, it was an inverse proportion (figure 5).

CONCLUSION

Thus, the above studies make it possible to further study the soil using modern methods, determine its internal characteristics, diagnostic signs, carry out certain corrective work on the soil map, etc., which may be important. At the same time, it can be used as an auxiliary tool in determining surface moisture and soil salinity by various characteristics of plant reflection in different ranges of the electromagnetic spectrum, as a software addition to the Normalized Relative Index "NDVIGGIS" in horticulture.

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ТҮЙІН

С. Кочерли[1], М. Мустафаев[1]*, Э. Ахмедзаде[1], З. Велиева[1], Ф. Мустафаев[1], Ф. Алиева[1]*

МУГАН ЖАЗЫҒЫНЫҢ ТОПЫРАҚТАРЫНЫҢ ХИМИЯЛЫҚ, ФИЗИКАЛЫҚ ЖӘНЕ ОПТИКАЛЫҚ ҚАСИЕТТЕРІ АРАСЫНДАҒЫ ТӘУЕЛДІЛІКТЕР

Әзірбайжан Республикасының Ғылым және білім министрлігі, Топырақтану және агрохимия институты, AZ1073, Баку, Мамед Рагим, 5, Әзірбайжан,
**e-mail: meliorasiya58@mail.ru; fatma_aliyeva_1988@mail.ru*

Мақалада Муган жазығы топырақтарының физика-химиялық және оптикалық қасиеттері мен байланысы қарастырылады. Муган жазығының негізгі топырақ типтерінің химиялық және физикалық қасиеттері бар интегралды шағылысу коэффициенті сұр-күрең және шалғынды-сұр топырақтардың кескініне байланысты тиісінше 31,09 - 40,3 және 31,1-38% құрап, төмен екендігі анықталды. Жоғары көрсеткіш (5%) сұр-шалғынды және батпақты-шалғынды топырақтарда құрап, сәйкесінше 42,90-50,55% және 39,20-42,00% аралығында болды. Талдар (жаңадан пайда болған батпақты немесе шөпті аймақтармен баланысты жас шөгінділер) түрінде бүкіл аумаққа таралған шөпті-батпақты топырақтар Муган жазығының шектеулі учаскелерінде, негізінен төмен жерлерде, жер асты

суларының шығатын жерлерінде, Кура өзенінің аймағында кең таралған. Шалғынды-батпақты топырақтар гумус пен ылғалдың жоғары мөлшерімен сипатталады, оларда негізінен ылғалға сезімтал өсімдіктер өседі. Жоғарғы қабаттағы гумустың мөлшері (0-25 см) 4,05% жетеді, бұл өсімдік массасының көп мөлшерінің жыл сайынғы ыдырауына байланысты. Оның мөлшері тереңдікте азаяды және 1 м тереңдікте 0,90% құрайды. Гумустың бұлай таралуы тамырлар мен тамыршалардың негізгі бөлігі топырақ профилінің осы бөлігінде орналасқандығына байланысты. Топырақтың төменгі қабаттарында өсімдік тамырлары болмауының себебі – жоғары ылғалдылық пен темір оксидінің көп мөлшеріне байланысты лайлы қабаттағы қолайсыз су-ауа режимі, бұл өсімдіктерге кері әсерін тигізеді.

Түйінді сөздер: интегралды шағылысу қабілеттілігі, гумус, спектрлік шағылысу қабілеттілігі, топырақ кесінділері, карбонаттылық.

РЕЗЮМЕ

С. Кочерли[1], М. Мустафаев[1]*, Э. Ахмедзаде[1], З. Велиева[1], Ф. Мустафаев[1], Ф. Алиева[1]*

ЗАВИСИМОСТИ МЕЖДУ ХИМИЧЕСКИМИ, ФИЗИЧЕСКИМИ И ОПТИЧЕСКИМИ СВОЙСТВАМИ ПОЧВ МУГАНСКОЙ РАВНИНЫ

[1]Министерство науки и образования Азербайджанской Республики, Институт почвоведения и агрохимии, AZ1073, Баку, Мамед Рагим, 5, Азербайджан,
**e-mail: meliorasiya58@mail.ru; fatma_aliyeva_1988@mail.ru*

В статье рассматривается связь химико-физических свойств с оптическими свойствами почв Муганской равнины. Установлено, что интегральный коэффициент отражения с химическими и физическими свойствами основных типов почв Муганской равнины наименьший у серо-бурых и лугово-серых почв - 31,09-40,3%, и 31,10-38,0 соответственно в зависимости от профиля. Наибольшее количество (5%) приходилось на серо-луговые и болотно-луговые почвы и варьировало в пределах 42,90-50,55% и 39,20-42,00%. Травяно-болотные почвы, распространенные по всей территории в виде талов, распространены на ограниченных участках Муганской равнины, в основном в понижениях, в местах выхода грунтовых вод, в районе реки Кура. Лугово-болотные почвы характеризуются высоким содержанием гумуса и влаги, на них произрастают преимущественно влагочувствительные растения. Содержание гумуса в верхнем слое (0-25 см) достигает 4,05%, что связано с ежегодным перегниванием большого количества растительной массы. Количество его уменьшается с глубиной и на глубине 1 м составляет 0,90% Такое распределение гумуса связано с тем, что основная масса корней и корневищ расположена в этой части почвенного профиля. Причиной отсутствия корней в нижних слоях является неблагоприятный водно-воздушный режим в иловатом слое из-за высокой влажности и большого количества оксида железа, который негативно влияет на растения.

Ключевые слова: интегральная отражательная способность, гумус, спектральная отражательная способность, почвенные разрезы, карбонатность.

INFORMATION ABOUT THE AUTHORS

1. Kocherli Samandar Ali - leading researcher of soil physics laboratory, PhD in Agricultural Science, associate professor, e-mail: kocrlismdr@qmail.com

2. Mustafayev Mustafa Gilman ogly - head of the Soil reclamation laboratory, associate professor, e-mail: meliorasiya58@mail.ru

3. Akhmadzade Elvira Mahammad – senior researcher of soil physics laboratory, PhD in Agricultural Science, e-mail: kocrlismdr@qmail.com

4. Veliyeva Zeynab Muxtar – leading researcher of soil physics laboratory, PhD in Agricultural Science, e-mail: Veliyeva.z1958@qmail.com

5. Mustafayev Farid Mustafa – researcher of Soil reclamation laboratory,
e-mail: faridmustafayev124@gmail.com

6. Aliyeva Fatma Nuraddin – researcher of soil physics laboratory,
e-mail: fatma_alieva_1988@mail.ru