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Research Article

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Improving Soil Productivity Using the Modern Method of Drip Irrigation

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Abstract

The present study aims to describes physicochemical properties of the slope mountain brown soils under perennial plantings technology in order to increase the productivity of soils and, in particular, saving water resources by using modern drip irrigation. For this purpose, watering of orchards located on the slope mountain brown soils of the southeastern of the Greater Caucasus were investigated. Chemical characteristics of the soil sampled from the studied area, in upper layer vary among gyroscopic humidity 6,18-6,23%, humus 4,03-4,30%, total nitrogen 0,252- 0,238%, total phosphorus 12,22-13,33 mg/kg; CO_2 5,58%; $CaCO_3$ in relation to CO_2 - 12,70%; Ca in 100gr soil – 30,5 mg/kg; Ca-84,72-87,14%; Mg-12,86-15,28%. Moreover, according to morphological characteristics of selected samples collected the studied region, mechanical texture of this soil is heavy clay. Amount of physical clay in the upper layers of this soil vary between 67,20-69,20%, and amount of clay vary between 34,40-39-20%; whereas in the lower layer, this amount vary between 65,20-77,20%; 29,60-32,80%, respectively. Structural texture of this soil and amount of structural parts higher than 1mm in the upper layer of the soil also varies between 61,72-62,33% and 68,05- 68,80%, between the upper and lower layers, respectively. Overally, results show that soil cover and climatic conditions of the studied area emphasize on a modern irrigation method with less need to freshwater.

Keywords: Drip irrigation; Granulometric texture; Fertile; Soil ulmin (humus); Chemical properties

Introduction

During present decades, the water shortage increased due to limited water resources in the world which led to using modified techniques for maximizing water use efficiency and improving agricultural productivity and quality, especially in arid regions [1]. Of the essential concern of the world is water shortage for crop production [2]. On this basis, development of new technologies and methods to minimize water consumption is considered so important alternative [3]. The efficiency of water use is an economically considerable subject for irrigation project directors. Agriculture productivity is the essential criteria to evaluate irrigation systems efficiency [4]. By additional irrigation, the productivity increase. Demands for irrigation will be increase a lot in close future years to moderate the results of climate change and more repeated and heavy dehydration as the most crucial decreasing factor in yield productivity [5].

Based on State Programs, adopted recently in order to meet the population's demand for food products, appropriate measures were taken to promote the production of agricultural products in the agrarian sector, which led to significant results in the development of traditional agricultural lands in the country, as well as promoting population employment and reducing poverty created [6].

Many countries in the world are seeking new irrigation techniques to conserve irrigation water for agricultural crops and provide them with the proper moisture. Such methods include rainfall irrigation, aerosol irrigation, drip irrigation and so on.

These techniques are of great importance for improving the irrigation system and reducing irrigation water, human labor, electricity, and other resources. Studies show that the economically advantageous of drip irrigation methods described above are in the highlands with high slopes. For this purpose, more efforts had been done based on modification of irrigation methods [7].

Therefore, the three designs of drip irrigation systems to maximize water and fertilizers use efficiency under mountain slope brown soil was studied in the preset research.

Materials and Methods

Description of Study Area

The study area stretched for about 1,200 kilometers (750 mi) from west-northwest to east-southeast, between the Taman Peninsula of the Black Sea to the Absheron Peninsula of the Caspian Sea (https://en.wikipedia.org/wiki/Greater_Caucasus): from the Western Caucasus in the vicinity of Sochi on the northeastern shore of the Black Sea and reaching nearly to Baku on the Caspian. The climate of the Caucasus varies both vertically (according to elevation) and horizontally (by latitude and location). Temperature generally decreases as elevation rises. Average annual temperature in Sukhumi, Abkhazia at sea level is 15°C (59°F) while on the slopes of Mt. Kazbek at an elevation of 3,700 metres (12,100 ft), average annual temperature falls to−6.1°C (21.0°F). The northern slopes of the

Greater Caucasus Mountain Range are 3°C (5.4°F) colder than the southern slopes (https://en.wikipedia.org/wiki/Caucasus_Mountains). Figure 1 shows the geographical location of the studied area.

Figure 1: Geopgraphycal location of the study area

At present, a climatic warming is observed in the Caucasus Mountains, which is predicted to have a strong and profound impact on water availability throughout the region [8].

Hence, the purpose of the present research is to determine the optimal irrigation methods and achieve high productivity based on experiments on perennial irrigation practices using drip irrigation technology in Nagorno-Shirvan [6,9].

So, physical properties of soils include (granulometric composition, hygroscopic moisture, dry and wet soil structure,as well as chemical composition (general nitrogen, CO_2, potassium, phosphorus, Ca and Mg, absorbed humus, and pH values) which altogether compose the physicochemical properties of soils are investigated [3,6].

On the southeastern slopes of the Greater Caucasus, Shamakhi region, in the developmental phases of the apple plant, the following three variants were applied in control - ambient conditions: drip irrigation (0.8 l / h), drip irrigation (1.2 l / h), drip irrigation (1,6 l / h), irrigation with droplets (2,0 l / h), 0-20, 20-40, 40-60, 60-80 and 80 degrees with the characteristic of the genetic layers of soil profile. Samples were taken from the 100 cm layer and the granulometric composition of the soil based on the current methodology, hygroscopic moisture, humus, and absorbed bases (Ca, Mg, K), neutrality (pH) is determined [10,11].

The gray-brown soils are used as the main fund of the mountain farming zone and used under cereals and feed crops.

These soils are located at an altitude of 800-1200 m above the sea level, making the transition between mountain gray-brown soils, mountainous and forested lands. These soils have developed in the conditions of tails, and the various types of carbonate species washed away from typical substances are found under the sparse forest and shrubs.

Dark brown soils are characterized by thick, brown color of the humus layer, the structure of the clay, carbonaceous illudial layer, humus accumulation on the top floor and some other morphological features [6].

This terrain is characterized by complex relief conditions, fragmentation of areas, high slopes, deep gullies and dykes. The continental climate for the zone of land has shown annual falling rainfall of 400-500 mm.

In the field of practice, several sections have been set up to study the physico-chemical properties of gray-brown soils. The morphological description and indicators of those characteristics that are more specific to the terrain are given below.

The morpholoid description of the 4th number is as follows:
4 0-27 - dark brown, resistant, top-kernel, clay, wheat, damp, plant root and roots, passage clear, HCl boils.
27-42 - dark brown, cyanic, gilding, lilac, wet, multicolored roots and roots, worm lines, clear, HCl - dark brown [10, 11]
42-70 - light brown, clay, quartz, solid, damp, plant roots and roots, relative to the passage, carbonate layers and moisture from the effect of HCl [10, 11].
70-105 - light brown, clay, unstructured. solid, moisture, herbaceous roots, carbonate layers and spots, passage clear, boils off from HCl [10, 11].
105-134 - light,gray, unstructured, solid, moisture, boosts the effect of HCl. From the morphological description of the cut, it appears dark brown on the top layer and turns into a light brown and light gray color [10, 11].

Table 1: Granulometric properties of gray-brown soils

cuttings №	Depth, cm	Dimensions of fractions, mm						
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
3	0-20	0,91	9,09	20,80	11,20	18,80	39,20	69,20
	20 -30	0,52	10,68	17,20	18,40	26,00	27,20	71,60
	30-56	0,62	9,38	16,80	20,40	21,20	31,60	73,20
	56-92	0,43	3,97	19,20	18,80	24,80	32,80	76,40
	92-130	0,31	5,69	16,80	19,60	27,20	30,40	77,20
4	0 - 27	0,09	7,91	24,80	15,20	17,60	34,40	67,20
	27 - 42	0,14	5,06	25,60	15,60	16,40	37,20	64,20
	42 - 70	0,05	7,15	20,80	17,60	21,20	33,20	72,00
	70 - 105	0,07	3,93	22,00	19,20	22,00	32,80	74,00
	105 - 134	0,12	7,43	27,20	18,80	17,20	29,20	65,20

Table 2: Chemical characteristics of gray-brown soils

Cuttings №	Depth, sm	Hicroscopic moisture, %	Humus %	Total nitrogen %	P_2O_5, mq/kq	CO_2,%	According to CO_2 görə $CaCO_3$ %	Spilled bases in mq/ekv 100gr soil			Possible reasons %	
								Ca	Mg	Total	Ca	Mg
3	0-20	6,18	4,3	0,252	12,22	-	-	30,5	5,5	36,0	84,72	15,28
	20 -30	5,95	3,5	0,196	11,11	-	-	32,0	6,0	38,0	84,21	15,79
	30-56	6,65	2,8	0,168	8,89	-	-	29,0	5,5	34,5	84,06	15,94
	56-92	6,08	1,5	-	7,78	-	-	28,0	5,0	33,0	84,85	15,15
	92-130	7,32	0,8	-	5,55	-	-	26,0	4,5	30,4	85,53	14,47
4	0 - 27	6,23	4,03	0,238	13,33	5,58	12,70	30,5	4,5	35,0	87,14	12,86
	27 - 42	6,42	2,59	0,154	11,11	6,15	13,97	31,5	6,0	37,5	84,00	16,00
	42 - 70	6,35	1,24	0,070	10,00	6,52	14,81	29,0	5,0	34,0	85,29	14,71
	70 - 105	6,35	0,88	0,056	-	6,90	15,68	-	-	-	-	-
	105 -134	6,84	0,46	0,028	-	6,71	15,25	-	-	-	-	-

Table 3: Structural composition of gray-brown soils

Cuttings№	Depth, sm	The size of the fractions, inmm							
3		>7	7-5	5-3	3-1	1-0,5	0,5-0,25	<0,25	>1
	0-20	30.62	16.40	8.00	6,70	14,00	16,43	7,85	61,72
	20 -30	28.56	14.55	13.20	12,00	11,70	10,89	9,10	68,31
	30-56	22.83	10.99	15.70	12,53	11,22	17,90	8,83	62,05
	56-92	24.10	14.51	18.76	11,43	13,95	10,11	6,54	68,80
4	0 – 27	27,67	17,96	9,00	7,70	16,88	14,79	6,00	62,33
	27 - 42	29,93	10,20	14,55	13,00	9,63	13,70	8,99	67,68
	42 - 70	27,15	11,11	12,00	14,20	13,70	14,00	7,84	64,46
	70 - 105	26,37	14,70	11,10	14,71	14,00	12,12	7,00	66,88
	105 - 134	29,10	16,00	13,10	9,85	10,99	13,41	6,95	68,05

The hashroscopic moisture of the soil surface is 6.18-6.23% , humus 4,03-4,30%, total nitrogen 0.252-0.238%, total phosphorus 12,22-13,33 mg / kg; CO_2 5.58%; $CaCO_3$ -12.70% by CO_2; Ca -100 qr in soil -30.5 mg / kg; Ca84, 72-87.14%; Mg- varies between 12.86 and 15.28%.

The morphological features of the 3 and 4 slices taken from gray-brown soils show that the mechanical composition of these soils is heavy.

As shown in Table 1, the amount of physical clay in the upper and lower layers is between 67.20-69.20 and 65.20-77.20; respectively. Also, the amount of clay is 34.40-39.20% and from 29.60 to 32.80%.

Table 2 shows the Chemical characteristics of the gray-brown soil. The number of structural particles exceeding 1 mm in the upper and lower layer of the soil varies between 61.72 and 62.33%, and 68.05 and 68.80%, respectively as shown in Table 3 .

Results

According to Mustafaev and Alakbarov it can be concluded that the studied area has lost its fertility and productivity due to the widespread erosion process in the terrain [6].

As shown by the authors, the planting characteristics are sharply broken. Aliyev and Qiyasi points out that their structural composition sharply deteriorates, as their resistance to water degradation reduce in the degraded mountain-brown soils [11]. Thus, in the upper layer of moderately eroded soils, the number of structural particles exceeding 1 mm is 72.42-78.30%, the number of aggregates is 8.77-7.12.67%, structural particles is 61.21-70 in heavily eroded soils, 25% and aggregates vary from 6,10-8,54%. In the upper layers of the average degree of erosion of these soils, aggregates of 5-3 mm are between 2.72-4.88% and severe degrees of erosion was reported from 2.02 to 3.04%. The erosion process causes deteriorate of the structure and aggregate composition of soils and their degradation.

Conclusions

It could be concluded that irrigation water saving is more possible with drip irrigation system comparing to other traditional one (which is particularly depended on soil type, genotype, climate data and other factors) [12, 13].

Overally, results show that soil cover and climatic conditions of the studied area are very suitable for planting pears, plums, cherries and other trees. In the studied area, the trees is suggested to irrigated mainly by drip irrigation. So that applied irigation method plays a key role in preventing the development of irrigation erosion and saving water in the water shortage condition.

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