UDC 631.7
AGRIS P10

https://doi.org/10.33619/2414-2948/98/13

INVESTIGATION OF IRRIGATION EROSION IN PSEUDOPODZOL YELLOW SOILS OF THE LANKARAN DISTRICT

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ИССЛЕДОВАНИЕ ИРРИГАЦИОННОЙ ЭРОЗИИ ПСЕВДОПОДЗОЛЬНЫХ ПОЧВ ЛЕНКОРАНСКОГО РАЙОНА

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Abstract. Inclination, length, form and exposition of the slopes affect the irrigation erosion process in the Lankaran district. The artificial rain in a different intensity was created in the tea plantations of the experiment farm of the tea and citrus plants in Lankaran branch in order to study a reason of the surface washing creation in irrigation erosion of the tea plantations more accurately. It was known that a tea plantation in which the rows were built along the slope in 1975, the liquid flow was 125.0 m^3/ha, while the rain intensity was 1.0 mm/min., the liquid dissolved dissolved substances flow was 240.0 m^3/ha, 2.90 t/ha in the tea plantations built in 1990, while an amount of the leached soil was 0.80 t/ha. Firstly, conduction of the surface smoothing work is recommended in order to prevent from irrigation erosion in irrigated areas with a slope more than 0.02°. Generally, the surface smoothing work is fundamental and current, and it is divided into two places. The current smoothing work begins from preparation of soil for sowing every year and this measure doesn't require more funds. The fundamental smoothing work is performed for fundamental smoothing of the irrigated sowing areas. At this time an inclination of the areas shouldn't be more than 0.01. It is recommended to conduct the fundamental smoothing work, then current smoothing work in the areas where the inclination is more than 0.01. Fight against irrigation erosion, definition of the water and irrigation norm, water consumption and realization in the irrigated areas are main problems. The irrigation norm should be determined before for each plant watering. Beside the aforesaid, the technical means (pipes that are made from different materials), including different brands (Fregat, Kuban, KSID-50, Volzhanka, DDA-100 M and so on) rainmaker aggregates, various progressive irrigation methods (artificial precipitation, subsoil irrigation, drip watering, aerosol irrigation, etc.) should be used.

Аннотация. В Ленкоранском районе на процесс ирригационной эрозии оказывают большое влияние наклон, длина, форма и видимость склонов. Для более точного изучения причин поверхностного смывания в результате ирригационной эрозии на чайных плантациях создан искусственный сильный дождь. Дождь различной интенсивности был вызван в Ленкоранском филиале на чайных и цитрусовых плантациях. Стало ясно, что при интенсивности дождя в 1,0 мм в минуту в 1975 году чайная плантация имела утечку воды 125,0 м^3/га, количество смытой земли — 0,80 т/га, в 1990 году соответственно 240,0 м^3/га, 2,90 т/га. Если склон больше 0,02°, то советуется выравнять поверхность земли. В общем выравнивание поверхности земли делится на две части: 1. основное и 2. текущее. Текущее выравнивание земли начинается с работ по подготовке земли для посадки и это мероприятие больших средств не требует. А основные работы выравнивания проводятся с целью основного выравнивания пахотных земель. В это время склон земельных участков не должен превышать 0,01°. А если превышает, то должны вестись работы по выравниванию. На поливаемых участках против ирригационной эрозии важно учитывать потребление воды. Норма полива каждого растения должна определяться заранее. Помимо вышеуказанного технического оборудования для полива, надо еще учитывать использование труб, приготовленных из разных материалов, в том числе должны использоваться дождеполивающие агрегаты («Фрегат», «Кубань», «КСИД-50», «Волжанка», «ДДА-100м» и др.), разные успешные методы полива, аэрозольный полив и другие.

Keywords: Lankaran district, irrigation, erosion, granulometric composition, tea plantation, pseudopodzol yellow soils, furrowed irrigation.

Ключевые слова: Ленкоранский район, ирригационная, эрозия, гранулометрический состав, чайная плантация, псевдоподзолидированные желтые земли, бороздной полив.

One of the important factors for the agricultural development is soil resource. The soil resources in our country as in other countries of the world are limited and they are exposing to unintended anthropogenic effect year after year. From this point of view there is a great need for soil research.

It is known that one of the factors that make the soil unusable is water erosion. 504000 hectares (32.8%) of the total fund (153900 ha) in Lankaran have been differently eroded. Approximately 7.2% area of Lankaran soils (11100 ha) are strong; 7.7% (11800 ha) moderate and 17.9% (27500 ha) were weakly eroded. But non-eroded areas form 67.2% (103500 ha) of the total soil fund [3, 7].

One the water erosion is irrigation erosion. This kind of erosion is formed because of application of water, mainly flood irrigation more than norm in the watering period.

Development of the irrigation erosion negatively affects all the economic indicators of agriculture, and it is a reason for decrease of the agricultural plants productivity. In this regard, labor and cost involved in crop production rises. Therefore, growing of plants is considered unprofitable in the highly eroded soils.

Irrigation erosion occurs in the irrigated areas where the inclination is more than 0.02 [10]. A reason for creation and development of such type of erosion is granulometric, structural composition, covering percentage of the plants, water and irrigation norm and not obeying the rules along with the zone inclination. That's why water-physical characters, agrochemical composition is deteriorated and the important nutrients necessary for growing and development of the plants are washed and floated into the rivers, lakes, or the depression places along with the soils with normal genetic layers that were formed for thousand years. The last results of this process show themselves in productivity of the plants which are grown in the fertile and productive soils. The productivity of the plants which are grown in the areas where irrigation erosion develop is 3-5 times low, compared to the areas where irrigation erosion isn't observed and the areas which are cultivated with high agro-technical rules. Therefore, the peasant farming is damaged.

The research showed that this type of erosion in the areas where the inclination is more than 0.02° is 270000 hectares or it occupies 3.1% of the republic zone.

Object and method of the research

Non-eroded and moderately eroded pseudopodzol yellow soils have been taken as a research object. It is clear from the results of the soil analysis that the productivity and quality of the soil in the moderately eroded soils decreased compared to non-eroded soils.

Study of the soils in the Lankaran zone have been fulfilled based on the research methods in the field and laboratory.

During the research the definite routes were defined and the places where the soil sections are applied were specified in the field condition.

The soil sections in the field were numbered, the soil density, granulometric composition, color, structure, hardness, and some morphological indications were noted.

To specify the soil types, it is important to know a granulometric composition of soil and an amount of humus, nitrogen, nutrients which can be assimilated. The soil samples on genetic layers of the soil sections have been taken and the analysis was performed in the laboratory of the Soil Science and Agrochemistry Institute. The diagnostic indicators were defined because of the analyses, the fertility parameters of soil, nutrients and so on were studied depending on erosion degree.

The following methods and ways were used in the research period. The eroding degree of soils were determined based on S. S. Sobolev and K. A. Alakbarov's methods of destruction of genetic layers and plant cover.

Granulometric composition of soil was fixed by N. A. Kachinsky; structural and aggregate composition by N. I. Savvinov; humus by I. M. Tyurin; total nitrogen by Kledal method.

Experiment part

As in some regions of the republic, the irrigation erosion is characteristic for the irrigated sowing plots of Lankaran. According to the information of State Soil and Mapping Committee of the republic (2012) a total area of the irrigated soils in Lankaran is 9533 ha, 5729 ha of them is under sowing, 3504 ha under perennial plantings and etc. [7, 9]. Generally, Lankaran district is characterized as a district with more irrigated areas in the Lankaran natural province. Here, there is tea, orange and other plants along with the grain, fruit and vegetables.

The analysis shows that except the grain plant, the tea, orange and other perennial plants are irrigated with furrow method and this process occupies a vegetation period of the plants (May-September). Because an amount of the precipitations in this zone is little, but the possible evaporation is more. The perennial information of the Lankaran meteorological station clearly shows it. So, an amount of the precipitations is 1402 mm, but the annual possible evaporation is 870 mm here during the year. A quantity of the precipitations is little (40-42 mm), but the possible evaporation is 122-158 mm [8] in the relatively warm period of the year. This process causes aridity of the air condition in the same period. Therefore, a need is created for daily watering of the plants in the zone.

The non-normalized irrigations are fulfilled without considering inclination of the zone, granulometric and structural composition of soils, and water and watering norm in the areas of the agricultural plants here as in the other irrigated zones of the republic. That's why the soils intensively exposed to irrigation erosion (Figure 1, 2).

It should be noted that the formation and development of irrigation erosion in desert conditions is investigated with reference to many methods. One of them is investigated in field conditions by measuring the depth of soil washed from the soil surface after each irrigation. Thus, after each irrigation, irrigation erosion is weak if it washes up to 15 cm, and severe if it washes more than 20 cm [10].

Except the abovementioned research method, the temporal flow pitches are put in the field condition and an amount of soil that is washed out from the single area is investigated by accounting. It should be noted that the thorough information about creation and study of irrigation erosion in the irrigated soils of Azerbaijan was given by prof. K. A. Alakbarov. The stationary research on this process were investigated in the cotton areas that is grown in the Shamkir district. Then, the employee of the institute of Erosion and Irrigation described creation and development of irrigation erosion during conduction of the soil-erosion research in some or other administrative districts of Azerbaijan. S. M. Nurullayev performed [4, 11] large stationary research in Zagatala, Goychay, Yevlakh and Absheron, studied creation and development of irrigation erosion and prepared corresponding fight measures against this process.

Figure 1. A view which reflects thinning of tea bushes and destruction of irrigation norm in the area of the tea plantation in the pseudopodzol yellow soils (it was built in1975) (Khanbulan village)

It is seen from the above analysis that the research on irrigation erosion in the Lankaran zone weren’t performed. We investigated creation and development of irrigation erosion in this research object. For this purpose, we selected a single observation area in the tea plantation of the Khanbulan village and determined a quantity of the soil that is washed from effect of non-normalized water consumption. The carried-out observations and calculations showed that 33.0 m^3/ha of soil from the tea plantation area of which inclination is more than 5° under an influence of non-normalized flooding for only one time exposed to erosion. Such process is also characteristic for the areas where the other irrigation norm and water consumption weren’t applied. In 2020 the typical area was selected in the tea plantation of the Khanbulan village in Lankaran and an impact of different water consumption on creation and development of irrigation erosion in the pseudopodzol yellow soil area was studied. The results of the observations indicated that a quantity of the soil that is moderately washed out from the area where the water consumption is little, is 15.5 m^3/ha, but an amount of the soil that is washed out from the area where water is spent more in a torrential form, rose 2.5 times and was 38.75 m^3/ha compared to the firstly observed area. All these basically affected the productivity of the described area [2, 3].

The carried-out analysis of the calculation works showed that a productivity of the green tea plant from non-eroded area is 40.0 quintals on average, but it is 20.5 cwt/ha in the moderately eroded area. An amount of the sulb flow was determined on the basis of the water samples taken depending on impact of the different water consumption (Table 1).

Table 1

EFFECT OF VARIOUS WATER CONSUMPTION ON SOIL IRRIGATION UNDER TEA PLANT

Research place	*Soil name*	*The slope of the terrain, in degrees*	*Experiment measurements*			*Experiment variant*	*Irrigation norm m^3/ha*	*Water consumption, l/sec*	*An amount of leached soil, g/l*
			Furrow length, m	*Distance of the space between rows, m*	*Area of the experiment pitch, m^2*				
The first irrigation 25 May, 2020									
Khanbulan village	Pseudopodzol yellow soil	5.0	150.0	1.50	225.0	Control	—	—	51.40
		5.0	150.0	1.50	225.0	Second	400.0	2.5	43.50
		5.0	150.0	1.50	225.0	The third	400.0	2.0	30.10
Second watering, 15 June, 2020									
Khanbulan village	pseudopodzol yellow soil	5.0	150.0	1.50	225.0	Control	—	—	58.70
		5.0	150.0	1.50	225.0	Second	400.0	2.5	40.30
		5.0	150.0	1.50	225.0	The third	400.0	2.0	27.60
Third watering, 01 July, 2020									
Khanbulan village	pseudopodzol yellow soil	5.0	150.0	1.50	225.0	Control	—	—	50.40
		5.0	150.0	1.50	225.0	Second	400.0	2.5	37.20
		5.0	150.0	1.50	225.0	The third	400.0	2.0	26.50

Note: The water consumption applied to the experimental areas was realized by Tomson's 45° — water transmitter

The research consequences showed that a quantity of the sulb flow in one liter of the water in a torrential form was relatively less, i.e. 51.40 g/l, but this amount was 43.50 g/l in the area where 2.5 l/sec. of water was spent, it was 30.10 g/l in 2.0 l/sec of water consumption (the first irrigation in 2020). Under an influence of three irrigations averagely 54.40 g/l of soil was washed on the first variant, it was 40.33 g/l on the second version and 28.01 g/l on the third version (Table 2).

Table 2

IMPACT OF DIFFERENT WATER CONSUMPTION APPLIED UNDER TEA PLANTATION ON A QUANTITY OF WASHING AMOUNT OF SOIL (2020)

Research place	*Soil name*	*The slope of the terrain, in degrees*	*Experiment variant*	*Water consumption, l/sec*	*The amount of soil washed during irrigations applied per year, in g/l*			*Average of there irrigation, g/l*
					I	*II*	*III*	
Khanbulan village	Pseudopodzol yellow soil	5.0	Control	non-normalized water consumption	51.40	58.70	50.40	54.50
		5.0	Second	2.5	43.50	40.30	37.20	40.33
		5.0	The third	2.0	30.10	27.60	26.50	28.01

Along with the abovementioned, the irrigation methods in the pseudopodzol yellow soils and an effect of water consumption on granulometric and some agro-chemical compositions of soils were investigated. The research results were given on Table 3.

Table 3

EFFECT OF IRRIGATION METHOD AND WATER CONSUMPTION ON GRANULOMETRIC AND SOME AGRO-CHEMICAL COMPOSITIONS
(Before irrigation in numerator, but after irrigation in denominator)

Research place	*Name of the soil and degree of erosion*	*The slope of the area*	*Use of land for cultivation*	*Irrigation methods and water consumption, l/sec*	*Number of samples*	*Depth, in cm*	*Granulometric composition: Particle size, in mm, Quantity, %*		*The resulting difference*		*Humus*	*Total nitrogen*	*Humus, the resulting difference*	*Total nitrogen, the resulting difference*
							<0.001	<0.01	<0.001	<0.01	%		%	
Khanbulan village	Pseudopodzol yellow soil, non-eroded	5°	Tea plantation	Furrow irrigation, non-normalized water consumption	1	0-5	21.40 / 18.30	64.10 / 61.40	3.10	2.70	2.80 / 2.20	0.18 / 0.13	0.60	0.05
						5-10	23.60 / 21.40	66.20 / 64.20	2.20	2.00	2.36 / 1.90	0.16 / 0.12	0.46	0.04
						10-15	27.70 / 25.70	69.40 / 67.60	2.00	1.80	2.00 / 1.50	0.15 / 0.11	0.50	0.04
		5°		Furrow irrigation, 2.5 l/sec water consumption	2	0-5	20.40 / 18.90	74.30 / 73.40	1.50	0.90	2.70 / 2.00	0.17 / 0.13	0.70	0.04
						5-10	22.30 / 21.30	78.20 / 77.45	1.00	0.75	2.40 / 1.90	0.15 / 0.12	0.50	0.03
						10-15	26.90 / 26.30	80.00 / 79.40	0.60	0.66	2.30 / 1.70	0.14 / 0.11	0.60	0.03
		5°		Furrow irrigation, 2.0 l/sec water consumption	3	0-5	24.30 / 23.40	73.10 / 72.60	0.90	0.50	2.55 / 2.10	0.16 / 0.15	0.45	0.01
						5-10	24.70 / 23.90	76.40 / 76.00	0.80	0.40	2.00 / 1.70	0.13 / 0.11	0.30	0.02
						10-15	26.10 / 25.60	78.10 / 77.75	0.50	0.35	1.89 / 1.69	0.12 / 0.11	0.20	0.01

The Table analysis shows that the granulometric composition and an amount of humus and total nitrogen noticeably changed depending on applied water consumption though the zone is at the same (5°) inclination, at the same time, in the same watering method (irrigation with furrow method) and under the same planting (tea plantation). So, an amount of the silt particles (<0.001 mm) on the part of soil surface (0-5 cm) in the non-normalized water consumption applied by the furrow method was 21.40%, a quantity of the physical clay was 64.10%, but after irrigation a quantity of such particles was accordingly 18.30% and 61.40%. Such regulation was characteristic for other densities (5-10 cm and 10-15 cm). The least change or decrease for granulometric composition was observed in irrigations that were applied in 2.0 l/sec. of consumption, reduction in such consumption compared to non-normalized water consumption on the silt (0.001 mm) particles (on the surface 0-5 cm) was 0,90%, on the physical clay it was (0.01 mm) 0,50%. The same state was characteristic for humus and total nitrogen on the upper part of soil. The analysis results showed that the humus quantity on the upper part of soil (0-5 cm) in the non-normalized (flooding) was 0.60%, but an amount of total nitrogen reduced 0.05%, these indicators were accordingly 0.45% on humus in 2.0 l/sec. of the water consumption on total nitrogen and it wasn't more than 0.02. All these show an importance of irrigation of the tea plantations with low water consumption (2.0 l/sec).

Figure 2. Non-eroded area in the tea plantation plot in the pseudopodzol yellow soils (it was built in 1975)

One of the factors which affects decrease of productivity in the tea planting areas is development of irrigation erosion in the areas where the plant is grown (especially irrigated). When more water is applied to the tea planting areas, the upper fertile layer of soil is washed out and its agro-chemical characters deteriorate, productivity gets reduced. We investigated an effect of irrigation erosion on productivity of the green tea plant along with other issues in the research period (2019-2021). The carried-out results were given on Table 4. There is a great importance of rational revelation of each work to fix a basis of taking high profits. As it is known that at this time main parameters of economic rationality, especially profitability should be considered. For this purpose, a quantity of the product, the proceeds from its sale and the cost incurred in return must be taken into consideration.

Table 4

EFFECT OF IRRIGATION EROSION ON PRODUCTIVITY OF THE GREEN TEA PLANT

Research place	*Name of the soil*	*Soil erosion rate*	*Average productivity by years, cwt/ha*			*Medium*	*Decrease relative to unwashed areas*	
			2019	*2020*	*2021*		*cwt/ha*	*%*
Khanbulan village	Pseudopodzol yellow soil	Non-eroded	37.20	42.40	41.60	40.40	—	—
		Moderately eroded	18.70	21.50	21.30	20.50	19.90	49.26

Considering the same factors on economical rationality and with reference to existing literature, an effect of different water consumption on tea productivity was investigated.

$$R=\frac{MG-MX}{MX}\times 100\%$$

Here, R is an economical rationality (profitability coefficient), MG — total income from product sale, MX — a sum of the costs for crop production [5].

A consequence of the economic calculation was given on Table 5. The table analysis show that an average productivity of tea crop reduces depending on washing degree of the soil. So, an average 3-year (2019-2021) productivity of the green tea leaf in the non-eroded area was 40.40 cwt/ha, but it wasn't more than 20.50 cwt/ha in the moderately leached areas. All these affected economical rationalities.

Table 5

IMPACT OF IRRIGATION EROSION ON ECONOMICAL RATIONALITY OF TEA PLANT

Research place	*Name of the soil*	*Soil erosion rate*	*Average yield, cwt/ha*	*Selling price of 1 cwt product, manats*	*Total income, in manats*	*Cost incurred, manats*	*Profitability, %*
Khanbulan village	Pseudopodzol yellow soil	Non-eroded	40.40	100.0	4040.0	2656.0	52.11
		Moderately eroded	20.50	100.0	2050.0	2656.0	−22.82

An analysis of Table 5 shows that the average productivity of each hectare in the area of the non-leached tea plantation was 40.40 cwt, a sale value of 1 cwt of crop was 100.0 manats, total income was 4040.0 manats, profitability was 52.11%, productivity of the moderate irrigation erosion was 20.50 cwt/ha. Total income was 205 000 manats, but profitability decreased — 22.82%.

The zone inclination, granulometric, structural composition of soils, covering percentage of the plant cover, not following the irrigation norm and rules were reason for formation and development of irrigation erosion.

That's why the water and irrigation norms before watering works in the irrigation areas should be fixed; the smoothing works must be performed in the inclined areas to prevent the irrigation erosion.

Gathering of the organic substances in the soil accelerates while irrigation is correctly performed, the agro-technical measures are highly conducted and one of the main characters of the irrigation agriculture is that irrigation increases an activity of biological processes, chemical rotation and it accelerates the substances circulation, therefore the fertilizer solution rises, and it prevents starting of physiological aridity.

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Работа поступила в редакцию 10.12.2023 г.

Принята к публикации 19.12.2023 г.

Ссылка для цитирования:

Akbarova U. Investigation of Irrigation Erosion in Pseudopodzol Yellow Soils of the Lankaran District // Бюллетень науки и практики. 2024. Т. 10. №1. С. 96-105. https://doi.org/10.33619/2414-2948/98/13

Cite as (APA):

Akbarova, U. (2024). Investigation of Irrigation Erosion in Pseudopodzol Yellow Soils of the Lankaran District. *Bulletin of Science and Practice, 10*(1), 96-105. https://doi.org/10.33619/2414-2948/98/13