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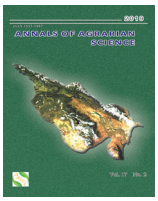

A local way of solonetz solonchak soils reclamation in Ararat valley by using factory wastes and natural minerals

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A B S T R A C T

The reclamation of solonetz-solonchak soils of Ararat valley has been performed by a local way. The required ameliorants as the hydrochloric acid (industrial waste) and the activated plaster (natural mineral) have been used only towards planting stocks rows, 2m x100m =200m^2, which makes 0.32 ha and in this case the amount of the required ameliorants is reduced for 3.1 times. Only the 600-800m^2 has been reclamated from one ha of land area. The expences for ameliorants purchase and transport have been reduced for 12-16 times. In current conditions it is suggested to reclamation the solonetz-solonchak soils by the local way, which will result in saving of financial resources.

Keywords: Solonetz-soloncak soils, Local reclamation, Industrial wastes, Hydrochloric acid, Natural minerals, Heat-treated plaster.

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Introduction

The development of agriculture, the usage of agricultural soils and the increase of their fertility have great importance for the land poor Republic of Armenia.

The cultivated soils area of the Republic makes 500 000 ha, and only 80. 000 ha of it is in kindly climatic conditions, that is, in Ararat valley. The main type of soils under cultivation in this area are the irrigated meadow-brown soils (53000 ha), which though make the 10 % of the Republic's cultivated soils, provide more than 40% of agriculture gross production.

There are about 25th.ha of solonetz solonchak soils of different degrees near the irrigated meadow-brown soils, which can be cultivated only by means of chemical reclamation [1].

Till the 1990s, 5400 ha of solonetz solonchak soils were cultivated by means of sulphuric acid and ferrous sulfate. The mentioned ameliorants were imported from the former Republics of the Soviet Union, but their import lasted till 1990.

Since independence of Republic of Armenia the drastic changes in the sphere of edaphic reserve management influenced both land conservation and their effective use.

Since 1990s, the meliorative-ecological balance of the soil-water-plant system was disrupted because of land privatization and other objective and subjective reasons. A significant amount of land plots was lost in the agricultural circulation, which was in result of the increase (50-150 sm) of the permissible level (300sm) of ground waters and the high level of hydrocarbonate-magnecial-sodium mineralization of that waters, etc. The ground waters level increase was due to the poor activity of horizontal and vertical underground drainage.

The year by year deterioration of soils reclamative state is also connected with the low level of land use in the Republic, with the utilization of waters having low irrigation factor, as well as with improper human treatment [2].

In result of the above mentioned negative factors, large areas of meliogenic and adjacent irrigated meadow-brown soils of the Ararat Valley have been exposed to secondary salinity-alkalinity and, consequently, there are for about 40th. ha of primary and secondary saline-salonized soils, which improvement depends on considerable financial expenses. In the given situation it is necessary to develop new systems for soils reclamation, which will be based

on local stuff or waste reserves base, and will have a crucial influence, both from economic and ecological point of view.

To the list of above mentioned ameliorants belong the 30% hydrochloric acid wastes of "Nairit" scientific production association, the industrial waste of finished cement dust, which contains 10% of free CaO and 40 % of fixed CaO, as well as land plaster, which solubility and the ameliorative effectiveness increases in result of heat treatment.

Objectives and methods

We reclimated the saline-alcaline soils of "Armavir" experimental-reclamative station in Armavir region and of the area of Zartonq community by means of local way of amelioration. For this purpose, hydrochloric acid of 30% and heat-treated plaster were used.

This method has been used only during the reclamation of the area under planting stocks, which makes an area of 1,5m x 1,5m=2,25m^2, and, in this case, only the 600-700m^2 area of hectare check plot is reclamated, that is, from 1/14 to 1/16 part of the required ameliorant is used, and consequently, the use of the financial resources is saved for 14-16 times.

In case of stocks planting system change, the ameliorative area may slightly change, and accordingly, the invested financial resources will differ.

In the one hectare check plot of Armavir region's Zartonq community the hydrochloric acid (30%) was used by rows, in beds with 2m width and 100m length. In the **200** m^2 reclamated area 16 fruit planting stocks should be planted, and then again, after each 5m hills were made with 2m width and 100m length towards the rows**.**

So, 16 check plots with 2m width and 100m length were made in a 1 hectare area. With this approach, we have planned to reclamate only the 3200m^2 × 10000m^2, which leads to the amount decrease of necessary ameliorant and hutch water for 3.1 times.

Before getting ameliorants land levelling was performed and soil samples were taken from 1 m depth. They were taken from 5 soil profiles of 0-25, 25-50, 50-75 և 75-100 sm depth.

Results and analysis

The soil mechanical composition, the chemical composition of water extract and the content of exchangeable sodium and potassium were studied by laboratory research, which allowed to calculate the amount of the necessary ameliorant of hydrochloric acid and heat-treated plaster for the reclamation of a hectare check plot and the norm of the hutch water.

The results of laboratory research, which are the average data of 5 soil profiles of 0-100m layer, are shown in Table 1.

Table 1. *The chemical composition of soil under study according to water extract and the amount of exchangeable Na and K in 0-100sm of soil layer*

Soil layer, sm	pH	Salts	Water-Soluble ions in meq/100g soil							Exchang.	
			CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na+K	Na	K
0-100	9,3	1,320	1,320	2,01	15,15	3,30	0,30	0,11	19,80	11,4	1,8

According to the mechanical composition the soil under study is heavy loam, and 1.35 coefficient is used for the calculation of required amount of the ameliorant. The required ameliorant amount has been calculated as follows:

1. HCl(30%)=3,65 t/ha ×1,35×3,33=16,4 t/ha, 1meq HCO_3+for the exchangeable sodium neutralization, in a meter layer (0-100sm) HCO_3 + exchangeable Na =13,41meq-3,0meq (permissible border in soil) = 10,4 ×16,4 t = 170,6 t/ha HCl(30%)
2. Heat treated plaster= 8,6 t/ha+1,35=11,6 t/ha 1meq) HCO3+ for the exchangeable Na sweetening, for 1ha it will make` 11,4 t/ha × 10,4 meq=120,6 t/ha

The required ameliorants amount data are shown in Table 2.

Table 2. *The amount of the required ameliorant and hutch water, by using local way of chemical reclamation*

Variant	In meq/100g soil			1meq HCO_3+ exchang. Na	For 1ha t/ha	For 2,25m^2, kg	Required hutch water, m^3	
	Total HCO_3	Exchang. Na	Total				hq/ա^3	2,25ա^2
HCl (30%)	2,01	11,40	13,41	10,4	170,6	38,4	47,85	10,8
Heat- treated plaster	2,01	11,40	13,4	11,6	120,6	27,14	47,85	10,8

In calculation process the 3 meq, which is the residual amount of HCO_3+ exchangeable Na in reclamated soils, is excluded from the 13,41 meq.

38.4 kg of HCl (30%) or 27.14 kg of heat-treated plaster is required for the occupied area of one nurcery plant (2.25 m^2).

The hydrochloric acid was also used for small check plots (2m×100m=200m^2), and for 1 ha it was given to 16 rows. The scheme of the stocks planting is as follows: the distance between rows is 6m and the planting stock distance is 6m. In this case, only the 3200m^2 of the hectare is reclimated and the amount of the required ameliorant is reduced for 3 times.

On the basis of the data, shown in Table 3, it is obvious that the soil 1 meter layer has been improved due to the used ameliorants, that is, HCl , heat-treated plaster and further leaching, the soil reaction has changed from strongly –alkaline to moderately alkaline, there is no CO_3^2 toxic ion in the soil, the Cl has been reduced from 15.15 meq to 0.31-0.62 meq/100g in soil, the water soluble Na-K is 1.81-1.88, and the exchangeable Na is in acceptable limits, that is, 2.60-2.80 meq/100g in soil.

Thus, the soil meter level has been improved and optimal conditions have been created for cultivated plant growth and development due to the chemical reclamation, made by a local way. It is necessary to apply irrigation-leaching regime in the process of agricultural reclamation (by increasing the irrigation amount for 30-40%), which will result in the decrease of water soluble Na amount, by reaching acceptable limits (<0,75 meq/100g in soil).

The change of the cation-exchange capacity during reclamation process is shown in Table 4.

The edaphic carbonates` $CaCO_3$, $MgCO_3$ have been decomposed by creating calcium and magnesium salts, which get into exchangeable reaction with the soil exchangeable sodium and push it out.

After reclamation the Ca amount prevails in soil, by reaching 52,8-54,0%, the Mg amount has slightly increased (3,0-3,9%), but the Na amount has changed from 39,3% to 10,1%.

During the last few years grain stillage is used as an industrial waste in the process of local way of reclamation [3, 4] and also ammonium sulfate is used, which is received in result of smoke gas extortion [5].

Thus, in current financial conditions it is possible to save the required expenses per one ha for 10-15 times by local way of melioration and to use the area for the gardens cultivation.

Table 3. *The chemical composition of reclamated saline-alkaline soil according to water extract and exchangeable Na and K*

Version	Soil layer, sm	pH	Salts, %	Water soluble ions, meq/100g							Exchang.	
				CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na+K	Na	K
Saline-Alk. soil	0-100	9,3	1,320	0,62	2,01	15,15	3,30	0,30	0,11	19,80	11,40	1,80
HCl (30%)	0-100	8,0	0,177	none	1,40	0,31	0,62	0,40	0,13	1,81	2,80	2,00
Heat treated plaster	0-100	8,1	0,203	none	1,26	0,62	0,91	0,60	0,16	1,88	2,90	1,80

Table 4. *The change of the cation-exchange capacity during local way of reclamation of solonetz-solonchak soils (0-100 cm in layer)*

Version	Soil layer, sm	pH	Salts, %	Water soluble ions, meq/100g							Exchang.	
				CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na+K	Na	K
Saline-Alk. soil	0-100	9,3	1,320	0,62	2,01	15,15	3,30	0,30	0,11	19,80	11,40	1,80
HCl (30%)	0-100	8,0	0,177	none	1,40	0,31	0,62	0,40	0,13	1,81	2,80	2,00
Heat treated plaster	0-100	8,1	0,203	none	1,26	0,62	0,91	0,60	0,16	1,88	2,90	1,80

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