

## STUDY OF THE EFFECT OF CHEMICAL AMELIORANTS ON THE IMPROVEMENT OF AGDASH REGION SOILS

S.K. Ibrahimov, R.H. Jamalova \*

Azerbaijan State Oil and Industry University, Baku, Azerbaijan

**Abstract.** The paper is devoted to the improvement of the degraded lands of Agdash region (Azerbaijan) by chemical melioration method. The article provides extensive information on the technology of preparing several new ameliorants based on solid household waste for soil cover and salinity removal of Agdash region. The effect of these ameliorants on soil processes during washing was studied under experimental conditions. As a result of the conducted researches, it was determined that with the application of chemical meliorants at different rates, the degree of salinization was reduced from 1.81% to 0.63-0.83% according to the dry residue and from 7.95% to 3.14-5.15% due to the amount of absorbed sodium during the washing melioration measure carried out in the salted and salinized soils of Agdash region located in the Kura-Araz lowland.

**Keywords:** Chemical melioration, salinity, salinization, granulometric composition, absorbed bases, ameliorant.

**Corresponding Author:** Rana Jamalova. Azerbaijan State Oil and Industry University, Azadlig ave. 20, Baku, Azerbaijan, Tel.: +994 50 687 47 75, e-mail: [rena.camal@inbox.ru](mailto:rena.camal@inbox.ru)

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### 1. Introduction

The rapid development of oil and non-oil industries in Azerbaijan has given a strong stimulation to the improvement of the living conditions of the population. In such a situation, in order to reduce dependence on foreign countries, ensuring the food security of the republic population is one of the main issues set up before the state. The solution to this problem can be achieved by improving the soils in the territory of the republic, increasing their eco-ameliorative status and agronomic characteristics (Azizov, 2003; Mammadov, 2003a; Mammadov *et al.*, 2005a; Urazaev, 2000; Smith & Wood, 1990).

In recent years, important government orders have been issued for the development of agriculture (Law of the Republic of Azerbaijan; National program of the Republic of Azerbaijan; Collection of environmental legislation of the Republic of Azerbaijan). These orders are mainly aimed at increasing soil fertility. Certainly the increase in soil fertility will have a positive effect on the productivity of agricultural products.

If to take into account that approximately 40% of the irrigated soils in the territory of the republic are lands subjected to varying degrees of salinity and salinization, first of all it is necessary to carry out reclamation works on these lands (Mammadov, 2003b; Ismayilov, 2004; Mammadov, 2002; Mammadov *et al.*, 2005b; State land cadastre and monitoring science-production center of the Republic of Azerbaijan; Stofella & Kahn, 2001; Ibragimov *et al.*, 2019; Ibragimov & Ramazanova, 2019; Alosmanov & Ibrahimov, 2018).

The paper is devoted to analysis and solution of this problem.

The purpose of the study is preparation of chemical ameliorants suitable for the soil conditions and for the ecological restoration of the soils of the Agdash region, Kura-Araz

lowland, the determination of the usage dose in practical experimental conditions and the study of the desalination process in the soil during the washing carried out with their application.

## 2. Composition and methodology of the research

All conducted research is divided into two parts: field and laboratory experiments. These studies were conducted on the basis of well-known methodologies within the pre-prepared program (Dospekhov, 1968).

The degree of soil salinization and the amount of salts in the soil were determined based on the data of complete water weight analysis of soil samples taken from the area before and after washing. Soil moisture was determined by weight thermostat method, water permeability was found out in the Nesterov device, dry soil volume weight – by N.A. Kachzynski method. The granulometric composition of soils processed with 1N HCl solution was determined by N.A. Kachzynski method. The amount of absorbed sodium was determined by the K.K. Hedroys method, and the amount of absorbed calcium and magnesium was defined by the Trilon method. The amount of total gypsum was determined by weight method, and carbonates were determined by Scheibler's gasometric method. The density of the solid soil phase was determined according to S.I. Dolgov's pycnometric method. The pH of the soil solution was determined with a pH meter, and the amount of humus was determined by the Tyurin method.

The experiment was carried out in 5 variants according to the following scheme:

1. Washing with plain water; 2. Washing by applying 10 tons of R5 ameliorant per hectare; 3. Washing by applying 20 tons of R5 ameliorant per hectare; 4. Washing by applying 10 tons R6 ameliorant per hectare; 5. Washing by applying 20 tons of R6 ameliorant per hectare

Since the ameliorants prepared are not patented, complete information about their chemical composition cannot be provided. It can only be said about ameliorants that both of them are wastes formed in the process of extracting nutrients from solid household waste under the influence of active oxidants. The amount of calcium-containing substances in R6 meliorant is slightly higher than R5.

The experimental washing was carried out in special containers with a height of 30 cm and a diameter of 5 cm in the following order:

The soil sample, dried at room conditions, was crushed and passed through a 1 mm sieve and mixed well. Soil mixed with chemical ameliorant is filled into special containers with a filter bottom. To ensure the density of the soil sample is  $1.4 \text{ g/cm}^3$ , the containers are lightly tapped and their density is determined by weight method based on the height of the soil layer. During the experiment, a water level of 5 cm is always maintained above the soil layer.

## 3. Analysis and discussion

The experimental washing was carried out with soil taken from the territory of Gumlag village, Agdash region, having a salinity level of 1.76% based on dry residue (Table 2).

As it can be seen from the table data, the total salinity rate of the soil of the experimental area is 1.751%. Sulfate anion is dominant with 1.198% among the anions, and among cations the priority belongs to magnesium cation - 0.149%, the amount of

chlorine anion is 0.082%, and the amount of calcium and sodium cations is 0.250 and 0.060%, respectively. For this reason,  $\text{CaSO}_4$  and  $\text{MgSO}_4$  salts dominate among the salts in the soil (Table 3).

0.915% of the 1.751% primary salts in the soil are harmful salts, which is 52.07% of the total salts. The amount of water-soluble gypsum in the soil is 0.826%, and the amount of  $\text{MgSO}_4$  is 0.744%. The amount of harmful  $\text{NaCl}$  and  $\text{Na}_2\text{SO}_4$  varies around 0.152 and 0.019%, respectively.

As a result of the analysis data, it was determined that the soils of the experimental area are moderately carbonated and gypsum. The pH of the soil solution is equal to 8.1. Soils with alkaline properties are weakly acidic. The amount of sodium absorbed appears to be 7.95% of the total absorbed bases. The amount of absorbed magnesium is 24.69%, and the amount of calcium is 67.36%.

Due to the granulometric composition, the soils of the experimental area have a heavy mechanical composition. Thus, the amount of physical clay, i.e. particles < 0.001 mm in size, in the soil sample is 46.12% (Table 1).

**Table 1.** Results of granulometric composition analysis of soils of Gumlag village, Agdash region, in %

№	Date	No of Well	Amount of fractions in 100 g of dry soil in %						Total of fractions < 0.001 mm
			1-0,25 mm	0,25-0,05 mm	0,05-0,01 mm	0,01-0,005 mm	005-0,001 m	< 0,001 mm	
1	29.04.22	2	0,41	18,91	34,56	12,56	20,16	13,40	46,12

The experimental washing experiment was carried out on 29.04.2022. As a result of the washing, it was determined that it is possible to reduce the degree of soil salinization to 1.251% based on the dry residue during washing with plain water. By applying a washing rate of 4000 m<sup>3</sup>/ha, the amount of sulfate ion in the soil decreased from 1.198% to 0.874%, and the amount of chlorine ion – from 0.082% to 0.025%. The amount of magnesium ion decreased from 0.04% to 0.109%.

During washing with chemical meliorants, it was possible to wash almost 50% of the salts in the soil to the lower layers with a washing rate of 4000 m<sup>3</sup>/ha. As it can be seen from the table data, it was possible to reduce the degree of salinization from 1.81% to 0.83% based on dry residue by applying 10 tons of R5 meliorant per hectare. Compared to washing with plain water, the amount of sulfate ion in this option has decreased to 0.541%, and the amount of chlorine ion has decreased to 0.006%. The residual amount of calcium cation was 0.208%, and the residual amount of magnesium cation was 0.015%.

Increasing the rate of meliorant by 2 times had a slight effect on the reduction of the amount of salts during washing. By applying 20 tons of R5 meliorant per hectare, the degree of salinization in the washing option was 0.69%. The residual amounts of sulfate and chlorine ions were 0.491 and 0.004%. The amount of magnesium and calcium cations decreased from 0.149 and 0.250% to 0.024 and 0.172%, respectively.

During the experiment, the best result in terms of washing efficiency was observed in the washing options with the application of R6 meliorant. By giving 10 t and 20 t of R6 meliorant per hectare, it was possible to reduce the degree of soil salinization to 0.77 and 0.63%, respectively, according to the dry residue. At this time, the amount of sulfate ion decreased from 0.528% and to 0.434% depending on the rate of meliorant. The amount of chlorine ion was 0.004% for both rates. In these variants, a slight increase in

the amount of calcium cation and a decrease in the amount of magnesium was observed after washing (Table 2).

**Table 2.** Water weight analysis of soil samples taken from the territory of Gumlag village, Agdash region, after chemical washing, mg/eq %

No	Variants	The norm of meliorant, t	Washing rate, m <sup>3</sup> /ha	HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Total of the anions	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	Total of salts, %	105°C dry residue, %
1.	Primary soil	–	–	0,012 0,20	0,082 2,32	1,198 24,97	27,49	0,250 12,50	0,149 12,40	0,060 2,59	1,751	1,76
2.	Washing with plain water	–	8000 4000	0,021 0,34	0,025 0,84	0,874 18,21	19,39	0,122 6,12	0,109 9,08	0,094 4,19	1,244	1,251
3.	Washing by applying R5	10	4000	0,015 0,24	0,006 0,18	0,541 11,26	11,68	0,208 10,41	0,015 1,27	– –	0,785	0,830
4.	Washing by applying R5	20	4000	0,017 0,28	0,004 0,12	0,491 10,22	10,62	0,172 8,62	0,024 2,00	– –	0,708	0,69
5.	Washing by applying R6	10	4000	0,012 0,20	0,004 0,12	0,528 11,00	11,32	0,202 10,12	0,014 1,20	– –	0,760	0,77
6.	Washing by applying R6	20	4000	0,012 0,20	0,004 0,12	0,434 9,05	9,37	0,167 8,37	0,012 1,00	– –	0,629	0,63

NaCl was completely washed out in all variants of washing using a chemical ameliorant. The amount of NaCl decreased from 0.152% to 0.049% in washing with plain water alone. In this version, the amount of Na<sub>2</sub>SO<sub>4</sub> has increased to 0.238%. Almost complete washing of Na<sub>2</sub>SO<sub>4</sub> was observed in both meliorant applied variants. The amount of water-soluble gypsum decreased from 0.826% to 0.383% in the variant washed with plain water, and this decrease was insignificant in the variants using chemical meliorants.

**Table 3.** Amount of residual salts after chemical washing of soil samples taken from the territory of Gumlag village, Agdash region, in %

No	Variants	The norm of meliorant, t	Ca(HCO <sub>3</sub> ) <sub>2</sub>	CaSO <sub>4</sub>	MgSO <sub>4</sub>	Na <sub>2</sub> SO <sub>4</sub>	MgCl <sub>2</sub>	NaCl	Total of salts	Including	
										Harmful salts	From the total, %
1.	Primary soil	–	0,016	0,826	0,744	0,019	–	0,152	1,757	0,915	52,07
2.	Washing with plain water	–	0,028	0,383	0,545	0,238	–	0,049	1,243	0,842	67,74
3.	Washing by applying R5	10	0,019	0,692	0,065	0,011	–	–	0,786	0,076	9,66
4.	Washing by applying R5	20	0,023	0,567	0,113	–	0,006	–	0,709	0,119	16,78
5.	Washing by applying R6	10	0,016	0,674	0,064	–	0,006	–	0,760	0,07	9,92
6.	Washing by applying R6	20	0,16	0,554	0,053	–	0,006	–	0,629	0,061	9,70

The effect of the washing process on the main constituents of the soil is given in table 4. As it can be seen from the table data, a decrease in the amount of CaCO<sub>3</sub> was

observed in all washing options. The amount of water-insoluble gypsum decreased from 1.366% to 0.134% in the case of washing with plain water. In the options where meliorant is applied, the residual amount of gypsum varies around 0.462-0.540%, depending on the type of meliorant and its dose applied to the soil.

The soil salinity rate increased slightly to 8.61% in the option of washing with plain water, and salinity was almost eliminated in all the options where ameliorant was applied. The best indicator was obtained in the washing variant, which was carried out by application of 20 tons of R6 meliorant per hectare. In this variant, the degree of salinization decreased from the initial 7.95% to 3.14% as a result of washing (Table 4).

**Table 4.** Indicators of the main constituents of the territorial soils of Gumlag village, Agdash region, mg/eq%

No	Variants	pH	Hummus	CaCO <sub>3</sub>	CaSO <sub>4</sub> ·2H <sub>2</sub> O	Absorbed bases			
						Total of absorbed bases, mg/eq	From total in %		
							Ca	Mg	Na
1.	Primary soil	8,1	2,40	7,17	1,366	24,20	16,30 67,36	6,10 24,69	1,80 7,95
2.	Washing with plain water	8,0	1,05	7,15	0,134	20,90	12,90 61,72	6,20 29,67	1,80 8,61
3.	Washing by applying R5	7,4	1,15	7,04	0,431	19,40	15,50 79,90	2,92 14,95	1,00 5,15
4.	Washing by applying R5	7,2	1,25	6,99	0,504	20,05	17,60 87,78	2,00 9,98	0,90 4,49
5.	Washing by applying R6	7,3	1,4	7,09	0,462	20,60	17,80 86,41	2,00 9,71	0,80 3,88
6.	Washing by applying R6	7,2	1,7	6,90	0,540	20,70	18,45 89,91	1,60 7,73	0,65 3,14

The following conclusions were obtained by analyzing the data gained from the conducted studies.

#### 4. Conclusion

As a result of research, it was determined that the natural climatic conditions of Agdash region, located in the northwestern part of the Shirvan plain, allow one only irrigation farming in these areas. Mainly, gray-meadow soils with heavy granulometric content are widespread in the region. Since the soils of the area are subjected to various degrees of salinity and salinization, complex melioration measures should be implemented in order to clean these soils from salts harmful to plants. It is important to carry out chemical reclamation measures in the main part of the irrigated areas. It is determined that the developed new R5 and R6 chemical meliorants are fully suitable for the ecomeliorative improvement of these lands. The data obtained from the experiments show that it is possible to reduce the degree of salinization of the upper layer of the soil to an acceptable level by applying 10 and 20 tons of R5 and R6 chemical meliorants per hectare. Although the amount of residual salts is above the norm, as a result of the positive

effect of ameliorants, the amount of gypsum in the content of residual salts has been increased. While the amount of harmful salts remaining in the soil is 67.74% during washing with plain water, this amount varies between 9.6-16.8% in the options where ameliorant is applied. The possibility to achieve complete elimination of salinization as a result of applying and washing carried out by applying chemical meliorants at the rate of 10 tons per hectare is shown. It is recommended to accept the dose of both ameliorants at 10 t/ha when washing meliorative measures are implemented for the lands of Agdash region since the difference between the efficiency of amelioratives applied at the rate of 10 and 20 tons/ha is insignificant,

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