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Innovative soil leaching technology: A case study from Bukhara region of Uzbekistan

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Abstract. The paper presents the results of field experiments on improving leaching technology in salty fields of Bukhara oasis through Biosolvent chemical compound (BChC). Scientific researches were carried in irrigated fields of scientific-research center of Tashkent Institute of Irrigation and Agricultural Mechanization Engineers Bukhara Branch which is located in Bukhara region, Kagan district, during 2017-2019 years. Leaching saline soils through Biosolvent reduces salt content in the active soil layer from 0.417 % to 0.204, while desalinization ratio will be 1.84. With this innovative technology leaching norm was 30% less compared to the control.

1. Introduction

Salts in the composition of the soil, especially soluble, have a serious impact on the development of crops, it can dramatically reduce their yield [1,2]. The salts are white, chemically neutral, and include chlorides, sulfates, carbonates and sometimes nitrates of calcium, magnesium, sodium and potassium [3]. Salinity is a soil and water quality concern, especially in arid and semiarid areas where water demand is increasing day by day for irrigation and agriculture. Arid and semiarid areas are the regions where there are insufficient rain to leach salts and excess sodium ions out of the lithosphere. Most of saline soils contain calcites and calcium salts of extremely low solubility [4].

In the view of several scientists, salt-affected soils may inhibit seed germination, retard plant growth, and cause irrigation difficulties. Salty soils cannot be reclaimed by chemical amendments, conditioners or fertilizers. Salty soils are often reclaimed by leaching salts from the plant root zone [3].

There are numerous sources of soil salinity. In the view of some authors, Soil salinity is a measure of the minerals and salts that can be dissolved in water. Salt-affected soils occupy, on a global basis, 952.2 million ha of land. These soils constitute nearly 7% of the total land area or nearly 33% of the potential agricultural land area of the world [5].

Several scientists made researches on determining the level of soil leaching, and suggested a number of formulas to determine the level of soil leaching [6]. In research salinity was determined by the formula by V.Volobuyev and the method of soil leaching was carried out on this basis.

Before soil leaching, the soil should be cleaned from the cotton stalks, land leveling, drainage, flat slope must be provided. In the field, the soil leaching is carried out by polling. In the 1980's in Mirzachul, the soil salinity was leached by shallow and deep furrows [7].



Another researcher developed recommendations on how to apply sampling measures to soil degradation and to perform saline cleaning. The recommendations are reflected in the table below [8].

Table 1. Compatibility of Pollen Sizes to field inclination

Fields slope	Pollen size, m	Pollen square, ha
less than 0,002	50x50	0,250
0,002-0,004	50x33	0,165
0,004-0,006	50x25	0,125
0,006-0,01	50x17	0,085

The researchers studied that cotton yield is dependent on land salinity [9]. Mineralized water can also be used for soil leaching. Salinity leaching process may be done by mineral water as well. A number of researches have been conducted in "Soil research and salinity leaching" laboratory of the Central Asian Research Institute of Irrigation. Research showed that soil leaching can be provided when mineralization in studies of weak salinity is 3.0-6.0 g/l; average salinity - 5.0-7.5 g/l; in the case of heavy salinity it is possible to provide 7.2-10.0 g/l and saline soaking up to 15.0-16.0 g/l in very strong saline [8].

The lush soils areas of Uzbekistan have natural and secondary features of salinity. According to the several researchers' ideas there are three main sources of land salinity in the Republic:

- Salt content of irrigation water;
- The initial amount of salts present in the soil;
- Saturation of pressured groundwater and aeration zone with mineralized water [9].

From the background of scientists, it is clear that, salt regime implies the history of salt composition and migration in value ecosystem soils. It consists in unwashed salts, particularly by impulverization, dissolving of salts that are in crystalline state, and vice versa in precipitation of salts from solutions, consumption of salts from solutions by plants and partially by soil organisms, their return with abatement, cyclic vertical migrations of salts, carry-over of salts into illuvial horizons during soil formation, carry-over of salts from the system with surface and ground waters, as well as by expulverization. Salt regime can be broken by environmental pollution [10].

Salt regime implies the history of salt composition and migration of salts in soils and water bodies. It is one of the most important environmental factors. It can be broken by erosion of banks, salinity and over wetting of soils, pollution of environment, etc. [11].

Salt regime of soil implies change in the inter-irrigation, annual or many-year cycle of salt content and its qualitative composition in soil. Salt regime of soil is as a rule heavily dependent on irrigation and natural water regime; it (water-salt regime) is usually studied simultaneously [12].

It enhances the solubility of salts in the soil based on the BChC. Salts are removed from the agro-irrigation horizons, improving the water-physical properties of the soil, which in turn promotes the growth of the seed, reduces the risk of stroke. It can be used in any irrigation method: flood irrigation, ridge irrigation, drip irrigation, micro spray irrigation and sprinkler irrigation. The drug can be leached with saline, damp cloth or used at any time of year. In short, the obtained polymer is effective and harmless to the plant, and also improves soil structure [13].

2. Materials and methods

The research was carried out on the irrigated fields of the educational-scientific center of the Bukhara branch of Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, located in the Khodzha Yakshaba rural citizens' residence, Kagan district, Bukhara region during the 2017-2019 years. The educational-research center specializes in cotton, grain and gardening, and collector-hub branches are built in the center. There is a 4.7 km open-air drainage within the training center and the irrigation branch has engineering capability. For irrigation purposes, water is supplied to the fields by horns and bullets, and is irrigated by spruce. The soil of the farm is weak and moderately saline.

Field experiments were conducted to study the growth and development of Bukhara-6 varieties of cotton in conditions of grass-alluvial soils, the largest area of irrigated lands of the region (87.7%) and deep water depth of 1.5-2.0 m.

Scientific-research works were carried out in the following systems for salinization:

Soil leaching were carried out in the area of VI-hydromodul district of Kagan district of Bukhara region by methodology of Irrigation and Water Problems Scientific Research Institute and Cotton Research Institute of Uzbekistan

The experiments were 3 options and 3 repetitions of divisions - 0, 0625 hectares. In the first variant of the researches, soil leaching based on recommended salt solution according to V.R. Volobuev's recommendation. In the second option of experiments soil leaching was carried out through biosolvent chemical compound at the Institute of Bioorganic Chemistry named after academician O. S. Sodikov of the Academy of Sciences of the Republic of Uzbekistan and determined that the salinity was less than 30%. In last variant number 3, traditional methods of salinization were performed in the farm, and the results of the experiments were compared.

The experiments in this field are carried out in 3 variants, 1 fertilizer norm, 1 grade and the width of the fracture row is 90 cm.

Table 2. Experimental scheme for soil leaching

Variants, number	Technology of soil leaching	Amount of soil leaching
1	soil leaching based on recommended salt solution	determination of saline detection by V.R.Volobuev formula
2	soil leaching technology by using BChC method	30% less water used than determination of saline detection by V.R.Volobuev formula
3 (control)	traditional method	the principle of soil leaching used in practice

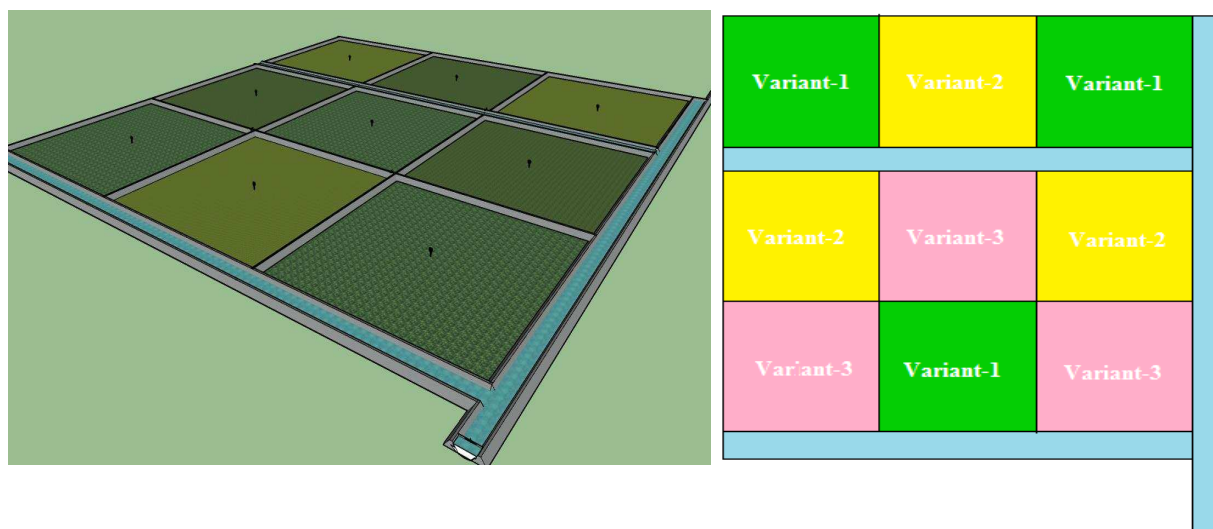


Figure 1. Soil leaching scheme [1,2].

Agrophysical studies:

The determination of the morphological structure of the soil's genetic layers (on soil slices during the commencement of research)

The determination of mechanical composition of soils. It was discovered at the beginning of the research on the method of N. A. Kachinsky.

The weight of the soil was determined by a steel cylinder with a height of 10 cm in the soil layers from 10 cm to 100 cm at the beginning and at the end of the vegetation period.

The water permeability of the soil was determined by the Nesterov method for 6 hours at the beginning and at the end of the vegetation period, for internal and external cylindrical rings.

The limited soil density of the soil (LSDS) was determined by the Rozov method in the beginning of the research, by filling a layer of 2x2 m² with 20-30 cm of water thickness.

The determination of the dynamics of the level of the groundwater.

To do this, two observation wells were installed. Monitoring activities were conducted during the academic year on the 10, 20, 30 days of each month.

The determination of mineralization levels of the groundwater.

The samples were taken from all observation wells on the 10th day of month and dry residue was detected.

Agrochemical Research:

Humus, grape nitrogen, phosphorus and potassium in the soil were found at 0-30, 30-50 cm layers at the beginning of the study.

The active nitrogen (nitrate and ammonia), phosphorus and potassium in the soil have been found at the beginning of the vegetation on the 0-30, 30-50 cm layers in all options of 2 and 3 repetitions. This is the amount of humus in the soil determined by I. V. Tyurin's method, general nitrogen, phosphorus by L. P. Gritsenko's method and the method of M. M. Maltseva, mobile phosphorus by means of B. M. Machigin's method, the potassium metabolite is converted to P. V. Protasov's method.

3. Results and Discussion

The soil leaching was carried out in this field to continue experiments after the stacking of the stems. In order to conduct experiments on saline soil, the soil temperature, salinity and salinity level, dry residue were measured by using UMP-1 soil measurement device with 7 points in field conditions, soil samples on 0-100 cm layer, and analysis for soil leaching area selected. For the purpose of determining soil leaching standards in the field of experiments, the above indicators were determined in laboratory and field conditions. The purpose of this research is to achieve high efficiency through the introduction of modern technologies to improve saline care in farms operating in saline soils by reducing soil leaching norms and terms.

3.1. Soil leaching with the BChC

Leaching rate means the quantity of water to be supplied to the field for removal of excess water-soluble salts that are harmful for cultivated plants from soil. Leaching rate is determined experimentally or calculated by using relevant formulas [12].

In order to perform saline cleaning in the field of experiments, the amount of saline detection was determined by the end of the vegetation, depending on the chlorine-ion content of the soil and the mechanical composition of the soil. During the study of the method of salinization the saline detection parameters for each option were determined, depending on the amount of salts contained in soil, soil salinity and mechanical composition of the soil and the specific natural and climatic characteristics of the area. Calculation of the rate of salinity is based on the water-physical properties of the soil and the amount of salts in the soil for a one-meter soil layer calculated according to V. R. Volobuev's formula:

$$N = 10000 \cdot \lg \left[\frac{S_i}{S_{adm}} \right]^\alpha, \quad \text{cbm} / \text{ha} \quad (1)$$

where α is the free salt yield factor, S_i , S_{adm} – amount of salts in the soil before leaching and allowed amount, in% of weight.

As a result of soil analyzes, the level of salinity of soils is considered to be saline, the type of chloride-sulfate salinity [6]. In the field scientific researches on soil leaching was twice carried out in January. The highest level of soil leaching in the test field was recorded in the experimental option of traditional field-controlled control; seasonal saline dumping option was 4620 m³/ha, with soil leaching

carried out twice during the season. In option 2, which performs soil leaching using Biosolvent chemical compound which is produced by the scientists of the Institute of Bioorganic Chemistry named after academician O. S. Sodikov of the Academy of Sciences of the Republic of Uzbekistan, according to their recommendation, is calculated at a rate of 8-10 liters per 1 ha, for each option is sprinkled, which is 30% less water was consumed than the saline detection rate calculated by the V. R. Volobuev formula and the salinity was 2906 m³/ha, with soil leaching done only 1 time. Option 1 is calculated using the formula of V. R. Volobuev, taking into account the salt content of the chlorine salts in the soil. In this option the seasonal leaching rate was 4151 m³/ha during the entire season, soil leached twice.

Table 3. Amount of soil leaching in experimental field.
(average amount during the period of researches)

Variants	Indicators	Irrigations, m ³ /ha		Seasonal soil leaching amount, cbm/ha
		1-soil leaching	2-soil leaching	
1-variant	Period of soil leaching	11. 01	30.01	4151
	Interval of soil leaching, day		19	
	Amount of soil leaching, cbm/ha	2134	2017	
2-variant	Period of soil leaching	11.01		2906
	Interval of soil leaching, day			
	Amount of soil leaching, cbm/ha	2910		
3-variant	Period of soil leaching	11.01	31.01	4620
	Interval of soil leaching, day		20	
	Amount of soil leaching, cbm/ha	2539	2081	

The dynamics of salts in the soil before and after washing are given in the table 6.

During the researches, soil leaching activities lasted from the first decade of January to the last ten days of January and the period between soil leaching was 19 days. Table 3 shows that the highest water consumption was consumed in the traditional way, used for soil leaching in agricultural conditions, with a biosolvent concentration ratio of up to 30% determined by the chemical compound, and 1714 cbm/ha have been consumed compared to option 2. During the experiments, the least amount of water consumed for saline was option 2, the seasonal salinity was 2906 cbm/ha, or by 37% compared to option 3, and by 30% in option 1, the efficiency of soil leaching has increased.



Figure 2. Process of sowing BChC by variants, and soil leaching

3.2. Influence of the BChC on the salts present in the experimental field

As it is noted above, the soils of the test field are irrigated, grassy alluvial soils. Due to the fact that the mineralization of the waste water is 1.0-3.0 g/l and depth is at a depth of 1.5-2.0 m, the salinity of the soils at the end of the vegetation period will increase.

That is why in the area of the farm every year in the winter and spring, salinization is carried out. At the time of cultivation, the soil is formed on the rootstock of the plant and the optimum salt level for the production of cotton seeds. In the field of experiments, the soil samples were collected prior to and after saline soils, and the soil samples were taken from each variant and the amount of Cl and dry residues in the soil was determined (in% of soil dry weight). Table 4 shows that, in the first option, the amount of Cl in the carrier layer (0-30 cm) before the leaching process was 0.027 %, the dry residue in the soil was 0.406 %. The amount of chlorine in the 0-100 cm layer of soil corresponds to Cl - 0.025 % and dry matter residues equal to 0.376 %. The classification of salts in soils is approximated to the category of average saline soils.

At the end of the soil leaching it was determined that all the salts in the soil were diminished, but in the control version only their quantity was higher than the other options. If we analyze the amount of Chlorine (Cl) in the soil, during the research, the chemical composition of biosolvent is sown in the soil, saline leached in the first option, the chlorine content in the soil (0-30 cm) layer decreased from 0.025 % to 0.008 %, if the amount of chlorine decreased to 0.018 % relative to the result of the soil leaching (30-50 cm) it was found that the amount of chlorine in the soil decreased from 0.025 % to 0.008 % after the soil leaching in the 0-100 cm layer. The amount of dry residue decreased by 0.194 % to 0.212 % after the saline washing process, compared with the saline wash season. During the observations, the amount of dry residue in the 0-100 cm layer was equal initially 0.376 %, down to 0.172 % at the end of the seasonal leaching and amounted to 0.204%. In the second option, which soil was leached through Biosolvent Chemical Compound, the soil salinity was 3.15 in chlorine ion and 1.79 by dry residue. This indicates that it was 0.39-0.18 more than 1st variant, and 0.78-0.21 more than variant 3.

Table 4. Impact of soil leaching on soil salinity
(average amount during the period of researches)

Soil layer, cm	Before leaching		After leaching		Desalinization ratio	
	chlorine	dry residue	chlorine	dry residue	chlorine	dry residue
1-variant						
0-30	0,027	0,406	0,010	0,240	2,79	1,69
30-50	0,026	0,351	0,009	0,215	3,00	1,63
50-100	0,025	0,305	0,011	0,221	2,31	1,38
0-50	0,027	0,378	0,009	0,228	3,00	1,66
0-100	0,025	0,376	0,009	0,225	2,68	1,67
2-variant						
0-30	0,027	0,406	0,008	0,212	3,24	1,92
30-50	0,026	0,351	0,008	0,189	3,25	1,85
50-100	0,025	0,305	0,009	0,203	2,74	1,50
0-50	0,027	0,378	0,008	0,205	3,38	1,85
0-100	0,025	0,376	0,008	0,204	3,13	1,84
3-variant						
0-30	0,027	0,406	0,012	0,247	2,31	1,65
30-50	0,026	0,351	0,010	0,214	2,52	1,64
50-100	0,025	0,305	0,012	0,229	2,11	1,33
0-50	0,027	0,378	0,011	0,231	2,53	1,64
0-100	0,025	0,376	0,011	0,230	2,38	1,64

Note: The seasonal salinity collecting coefficient was calculated by 0-100 cm according to soil layer.



Figure 3. Process of conducting soil analysis through UMP-1 measurement device

In summary, after soil leaching, the amount of salts in the field of experimental field varied in comparison with the state of the experiment. These changes can be attributed to the fact that the amount of salts in the soil can be determined by the scientifically-based salt-based formulas recommended by scientists. In the case of soil leaching through BChC, the chemical compound has a positive impact on the salinity of the soil in the process of melting and achieving high efficiency, while less than 30% of the saline detection rate has been achieved.

4. Conclusion

On meadow-alluvial, on the mechanical composition of medium loamy, medium-saline soils of the Bukhara region, leaching irrigation using the chemical compound Biosolvent at the rate of 8.0 l/ha ensures high efficiency of washing water. When using the chemical preparation Biosolvent, despite a decrease in the required norm of washing rate by 30%, the best conditions for washing out water-soluble salts are achieved and the desalination coefficient in the 0-100 cm layer will be 1.84 (dry residue) and 3.13 (chlorine ion).

References

- [1] Khamidov M Kh, Khamraev K Sh, Muinov U B, Khasanov M V, Shukrullayev J B and Jumayev F S 2019 *Agrarian science* **3** 55–58 DOI: 10.32634/0869-8155-2019-323-3-55-58
- [2] Khamidov M Kh, Khamraev K Sh, Muinov U B and Khasanov M V 2018 *The Way of Science. International Scientific Journal* **I 12 (58)** 45-48
- [3] Bauder T A, Davis J G, and Waskom R M *Colorado State University Extension* **7/03**
- [4] Sameen R. Imadi and Parvaiz Ahmad 2016 *Plant Metal Interaction*
- [5] Artiola J F and Crimmins M A 2019 *Environmental and Pollution Science*
- [6] Khamidov M Kh, Shukurlaev Kh I and Mamataliev A B 2009 *Agricultural hydrotechnique melioration* (Tashkent: General directorate of publishing and stock company)
- [7] *Recommendations for washing saline soils (project)* 2005 (Central Asian Irrigation Scientific Research Institute (SANIIRI))
- [8] *Recommendations for washing saline soil* 2010 (Central Asian Irrigation Scientific Research Institute (SANIIRI))
- [9] Central Asian Interstate Water Management Coordinating Commission Science and Information Center 2017 *Uzbekistan's Irrigated Farming: Is There Water Reservation for Sustainable Development?*
- [10] Bykov B A 1983 *Ecological glossary* (Alma-Ata: Publishing House “Nauka”)
- [11] Dedyu I I 1989 *Ecological Encyclopedic Vocabulary* (Kishinev: Chief Editorial Board of the Moldavian Soviet Encyclopaedia)

- [12] Ed. Rode A A 1975 *Soil science thesaurus*(Moscow: Publishing House “Nauka”)
- [13] *Recommendations on cotton husbandry agro-technologies* 2017 (Tashkent)