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Effects of deep softener and chemical compounds on mechanical compositions in heavy, difficult-to-ameliorate soils

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Abstract: The article deals with deep loosening of heavy, difficult-to-ameliorate, gypsum, medium salinity soils in the conditions of Bukhara region, as well as high-quality saline washing and watering of saline soils using a chemical reclamation (Spersal) compound. Significant water savings were observed during the harvest, and the control of dry residue and chlorine ions was reduced in the remaining variants, in addition the results of the study to the effect of the Bukhara-102 variety of cotton on the amount of salts in the soil by irrigating are presented. In this case, the cotton is cultivated without deep loosening of the soil with the variant of direct cultivation of the soil with a deep softener, softening at a depth of 60 cm and 80 cm, and irrigation of the (Spersal) compound, drainage, the effect of soil salinity on fertility and water permeability was analyzed.

1. Introduction

In recent years, Uzbekistan, like all other sectors, pays special attention to the development of the water sector. Efficient use of land and water resources in the country, improvement of water resources management system, effective organization of irrigation and saline washing in agricultural lands during the growing and non-vegetation months, saving every cubic meter of water using resource-saving technologies are among today's issues [1-4].

It is estimated that the area of glaciers in Central Asia has shrunk by about 30 percent over the past 50 to 60 years as a result of global climate change. By 2050, water resources in the Syrdarya are expected to decrease by 5%, and in the Amudarya - by 15%. As a result, water demand in Uzbekistan will reach 7 billion cubic meters by 2030, and by 2050, this figure could double. The per capita water supply has almost halved (from 3.048 cbm to 1.589 cbm) over the past 15 years due to rapid population growth and low water use efficiency. As a result, the population's demand for quality water is expected to increase by 18-20% (from 2.3 billion cbm to 2.7-3.0 billion cbm) by 2030. This includes a number of measures, such as the rational use of water resources, the use of modern water-saving technologies and the construction and reconstruction of irrigation facilities [5-8].

Identifying problems in the field of water management (factors affecting water scarcity and water resources, including climate change, population growth, increasing demand for water), eradicating them in time and developing measures require considerable effort [9, 10].

According to the FAO-UNESCO, over the past half century, the world's population has grown from 3 billion to 7.8 billion. It is not difficult to understand the value of these lands in the eyes of mankind, as the oil content of arable lands has increased by only 10%.

Intensively used agricultural lands in the Republic of Uzbekistan, amount to 4.325 million hectares, which are the gold fund of the republic. They make up about 10% of the total land fund and provide 97% of gross agricultural output [11]. This will determine the production activity of the republic and serve as a key factor in increasing the economic potential of the country [12].

Today, about 45% of irrigated lands in the country are saline to varying degrees, of which about 18% are strong and more than 23% are moderately poor. Most of the lands with unsatisfactory reclamation status are in the Republic of Karakalpakstan, Khorezm, Bukhara, Jizzakh and Fergana regions [13-16].

2. Materials and methods

Gypsum soils are widespread in some regions of the Republic of Uzbekistan: Syrdarya, Jizzakh, Navoi, Bukhara, partly in Surkhandarya and Fergana regions. Typically, gypsum is accompanied by salinization of soils. In the past, for the construction of such lands against the background of deep loosening of the soil (up to 1 m) was used large doses of manure, lignin added and capital washing of lands, increasing the drainage of the area by temporary drainage. In some cases, crushed cotton stalks and chemicals (complex polymer fertilizers) were used. Many of the lands that have been built today are again out of track and in need of redevelopment. They require partial construction to maintain irrigation and drainage infrastructure. Rehabilitation of lands and their fertility requires a set of hydrotechnical and agro-technological measures. A retrospective analysis of many research data on deep loosening in uncultivated lands related to this issue has shown that it has been studied as an agro-technological method that improves soil air and water regimes [17, 18], and to increase salinity recovery of saline soils for reclamation purposes, before capital washing [19].

The above studies have proved that the agro-technological criterion of the need for deep loosening is optimal for soil compaction density and favorable development and yield of cotton, the bulk mass of the soil is 1.1-1.3 g/ccbm (maximum 1.35 g/ccbm). Soil densities above this limit have a negative effect on cotton [20]. According to research from Research Institute of Irrigation and Water Problems (NIIIWP) and NIHI Union (NIISSAWH) [21], deep loosening of soils can be done 3-4 times in 1 year.

In experiments conducted by Bespalov and Madiev [22] in light-colored deserts, it was found that the initial filtration of soil in the presence of gypsum interlayers at a depth of 40-60-80 cm does not exceed 0.01 m/day. Deep softening helped to remove the gypsum layers, and chlorine ion washing against the background of temporary drainage increased 2.2 times. When applying manure in the amount of 30 tons/ha - 2.8 times [23-25].

The Research Institute of Irrigation and Water Problems (NIIIWP) works in Mehnatabad district of Syrdarya region, deep loosening of soils increases the efficiency and reduces the time of operational washing by improving the water-physical properties of the soil and increasing salt recovery. Experiments with the solution, due to the solution and the improvement of water-physical properties of the soil, the average yield increase over three years increased by 3.5 s/ha [26].

In the Fergana Valley, the greatest desalination effect during operational washing was obtained in the softening variant for plus two-joint plowing and plus 60 t/ha for varietal [27]. Deep loosening of the soil (70-80 cm), followed by fertilization of 30 t/ha (for plowing) and application of electricity, during the period of capital washing of highly saline soils (plastered to a depth of 55-87 cm) in Jizzakh steppe. In the combined variant of these three measures, the greatest impact on soil salinity was achieved: salt recovery (for chlorine) increased by 1.6-1.7 times compared to control, yield growth was 16.4 s/ha . Yield of raw cotton when washed by certain additional measures: 7.2 s/ha due to the use of electricity, 3.6 s/ha due to deep softening, 5.0 s/ha due to manure application and complex polymer proved to increase by 2.7 s/s due to the introduction of gits (SPU). It was found that the level of leaching with the initial salinization with 0.13-0.16 % chlorine ion by soil weight should be 10-13 thousand cbm/ha, water supply in 4 stages 2500-3200 cbm/ha [28, 29].

The model of agro-technical and chemical reclamation impact assessment for difficult reclamation soils (based on background and experimental database) and quantitative changes in soil properties under the influence of agro-reclamation measures (proposed by the author and using empirical dependence) Studies have been conducted to increase cotton yields [30].

Object of research: Experiments conducted in 2020-2021 in the farm "Mavlon Sattor" Kagan district of Bukhara region in the conditions of difficult reclamation, moderately saline, heavy mechanical sand, gypsum soils. Experiments were carried out on the cultivation of Bukhara-102 variety.

The volume of soil in the 0-100 cm layer of the selected experimental area was 1.52 g/ccbm, the boundary field moisture content was 65.6%, and these soils belong to the type of heavy soils with mechanical composition. lib, the soil contains gypsum crystals, grains.

In the study field, the distance between ditches was 250 meters, the depth of ditches was 3.2-3.8 meters, and the flow of ditches was 0.38 cbm/day during the growing season. ha, and 0.22 cbm/day during the non-vegetation period. This change in water content is explained by the irrigation norms applied to the field when irrigating agricultural crops during the growing season.

The purpose of the study: In order to improve the reclamation of soils in heavy, compacted, gypsum soils of Kagan district of Bukhara region, to ensure a favorable humidity, air, salt and water regime for plant growth (Table 1) Deep loosening and chemical ameliorants were used in the field, saline washing and plowing up to 35-40 cm with the use of chemical ameliorant (Spersal) until the chlorine ion content reaches 0.001%, in variant 4 plowing to a depth of 80 cm and up to 35-40 cm, and in variant 5 to 80 cm deep plowing to 35-40 cm, saline washing with a chemical compound (Spersal) up to 0.01%, and chlorine ion content in the soil in the autumn-winter period after plowing 0 , Saline was washed to 01%, and in early spring Bukhara-102 variety of cotton was planted and observed.

Table 1. Experimental system

Variant	Mechanical composition of the soil	Plowing	Saline washing	Pre-irrigation soil moisture, %
1	Heavy sand, gypsum soils	Plowing the soil 35 cm (Control)	Saline leaching in the soil in autumn-winter until the chlorine ion reaches 0.01%	70-75-65 %
2	Heavy sand, gypsum soils	loosen to a depth of 60 cm before plowing	Saline leaching in the soil in autumn-winter until the chlorine ion reaches 0.01%	70-75-65 %
3	Heavy sand, gypsum soils	loosen to a depth of 60 cm before plowing	In autumn-winter, saline leaching with the addition of Spersal chemical compound until the chlorine ion in the soil reaches 0.01%	70-75-65 % irrigation, use of Spersal chemical compound in irrigation
4	Heavy sand, gypsum soils	loosen to a depth of 80 cm before plowing	Saline leaching in the soil in autumn-winter until the chlorine ion reaches 0.01%	70-75-65 %
5	Heavy sand, gypsum soils	loosen to a depth of 80 cm before plowing	In autumn-winter, saline leaching with the addition of Spersal chemical compound until the chlorine ion in the soil reaches 0.01%	70-75-65 % irrigation, use of Spersal chemical compound in irrigation

3. Results and discussion

After deep softening in the experimental field, from the second decade of December 2020 to the 2nd decade of February 2021, 3 saline washing operations were carried out. As shown, in the first variant, the first saline wash was 2560 cbm/ha, in the second and third saline was 2050-1875 cbm/ha, and the seasonal salinity was 6480 cbm/ha. In variant II, 2280 cbm/ha in the first saline wash was 1640-1295 cbm/ha in the second and third saline washes, while the seasonal salinity wash was 5210 cbm/ha in the first saline wash in the variant was 1980 cbm/ha in the second and in the third saline wash 1620-1235 cbm/ha, while the seasonal saline wash rate was 4835 cbm/ha, in the IV variant the first 2060 cbm/ha in the second and third saline washes 1680-1270 cbm/ha, the seasonal salinity norm was 5100 cbm/ha, and in the first saline wash in the V-variant 1895 cbm/ha in the second and third saline leaching was 1620-1230 cbm/ha, and the seasonal saline leaching rate was 4745 cbm/ha. This is 1470 cbm/ha less in variant II, -1645 cbm/ha in variant III, 1380 cbm/ha in variant IV and 1745 cbm/ha in variant V than in variant I (control) (Table 2).

Table 2. Saline leaching rate in the experimental field (cbm/ha)

Variants	I salt wash	II salt wash	III salt wash	Seasonal salt washing rate is cbm/ha
I (control)	2560	2050	1870	6480
II	2280	1640	1290	5210
III	1980	1620	1235	4835
IV	2060	1680	1270	5010
V	1895	1620	1230	4745

When analyzing the results of experiments on irrigation of Bukhara-102 variety of cotton in the experiments, as shown in Table 3, in the first irrigation 1450 cbm/ha in the second irrigation 1180 cbm/ha in the third 1090 cbm/ha in irrigation and 1090-1011 cbm/ha in the fourth and fifth irrigations, and the seasonal irrigation norm was 5821 cbm/ha. In variant II, seasonal irrigation is 1330 cbm/ha in the first irrigation, 1120 cbm/ha in the second irrigation, 985 cbm/ha in the third irrigation and 939-910 cbm/ha in the fourth and fifth irrigation. half was 5284 cbm/ha. In variant III, the first irrigation is 1240 cbm/ha, the second irrigation is 1090 cbm/ha, the third irrigation is 905 cbm/ha, and the fourth and fifth irrigations are 830-782 cbm/ha and half was 4847 cbm/ha. In variant IV, the first irrigation is 1280 cbm/ha, the second irrigation is 1120 cbm/ha, the third irrigation is 965 cbm/ha, and the second and fifth irrigations are 930-805 cbm/ha and half was 5100 cbm/ha and in the V-variant in the first irrigation 1180 cbm/ha in the second irrigation 1020 cbm/ha in the third irrigation 875 cbm/gani and in the fourth and fifth irrigations 830-789 cbm/ha seasonal irrigation norm 4694 cbm/ha cotton was irrigated 5 times during the season.

This means that 537 cbm/ha less was used in Variant II, 974 cbm/ha in variant III, 721 cbm/ha in variant IV and 1127 cbm/ha in variant V than in variant I (control).

Table 3. Irrigation rate in the experimental field

Variants	I-irrigation	II-irrigation	III-irrigation	IV-irrigation	V-irrigation	Seasonal Irrigation rate is cbm/ha
I (control)	1450	1180	1090	1090	1011	5821
II	1330	1120	985	939	910	5284
III	1240	1090	905	830	782	4847
IV	1280	1120	965	930	805	5100
V	1180	1020	875	830	789	4694

When performing chemical analyzes of the experimental area before and after saline washing, the amount of dry residueand chlorine ion in the drive and sub-drive layers (Table 4) was 0.010 in the drive layer, compared to variant I (control). % to 0.003% of the driving layer, and the amount of chlorine ion to the driving layer decreased by 0.001% to 0.003% of the driving layer, in Variant III the dry residue in the driving layer decreased by 0.045% to 0.041% of the driving layer, and the amount of chlorine ion In variant IV, the amount of dry residue in the drive layer decreased by 0.012% to 0.007% in the drive layer, and the chlorine ion content decreased by 0.002% in the drive layer to 0.003% in the drive layer, and V- variant, the amount of dry residue in the drive layer decreased by 0.050% to 0.047% in the drive layer, and the amount of chlorine ion in the drive layer decreased by 0.008% in the drive layer by 0.007% analysis showed.

Table 4. Chemical analysis of the test site before saline washing

Variants	Soil layer, cm	Before leaching		After leaching	
		dry residue %	CI %	dry residue %	CI %
		2020 year			
1	0-40	0.462	0.057	0.233	0.013
	0-100	0.441	0.049	0.214	0.011
2	0-40	0.462	0.057	0.223	0.012
	0-100	0.441	0.049	0.211	0.008
3	0-40	0.462	0.057	0.188	0.007
	0-100	0.441	0.049	0.173	0.006
4	0-40	0.462	0.057	0.221	0.011
	0-100	0.441	0.049	0.207	0.008
5	0-40	0.462	0.057	0.183	0.005
	0-100	0.441	0.049	0.167	0.006

We can see that the dry residue of the experimental area decreased by 0.058% in variant II, 0.076% in variant III, 0.063% in variant IV and 0.074% in variant V compared to the control variant (Figure 1).

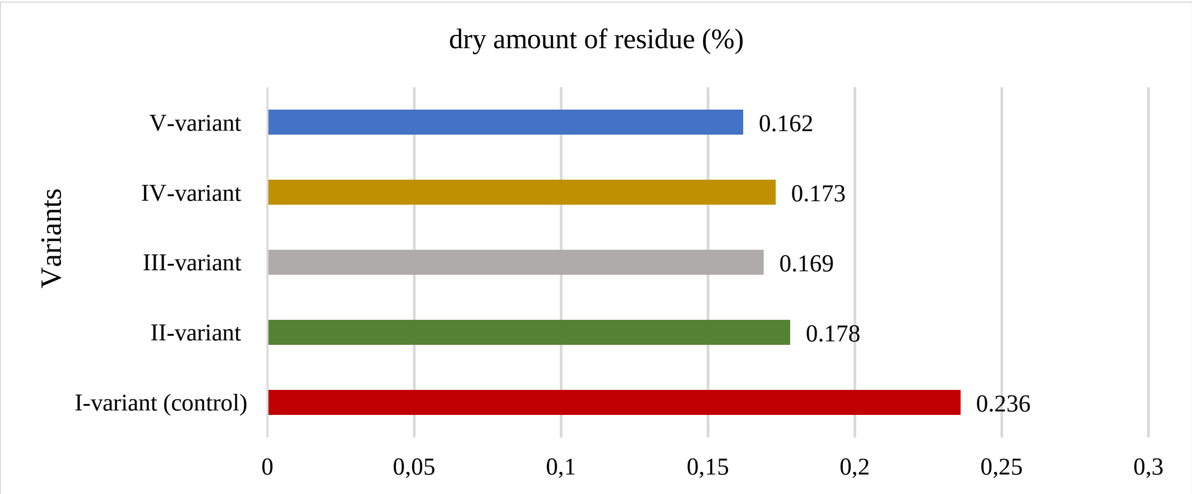

Figure 1. Variation of the amount of dry residue in the experimental area in the variants.

We can see that the total chlorine ion content of the experimental area decreased by 0.003% in variant II, 0.006% in variant III, 0.004% in variant IV and 0.008% in variant V compared to the control variant (Figure 2).

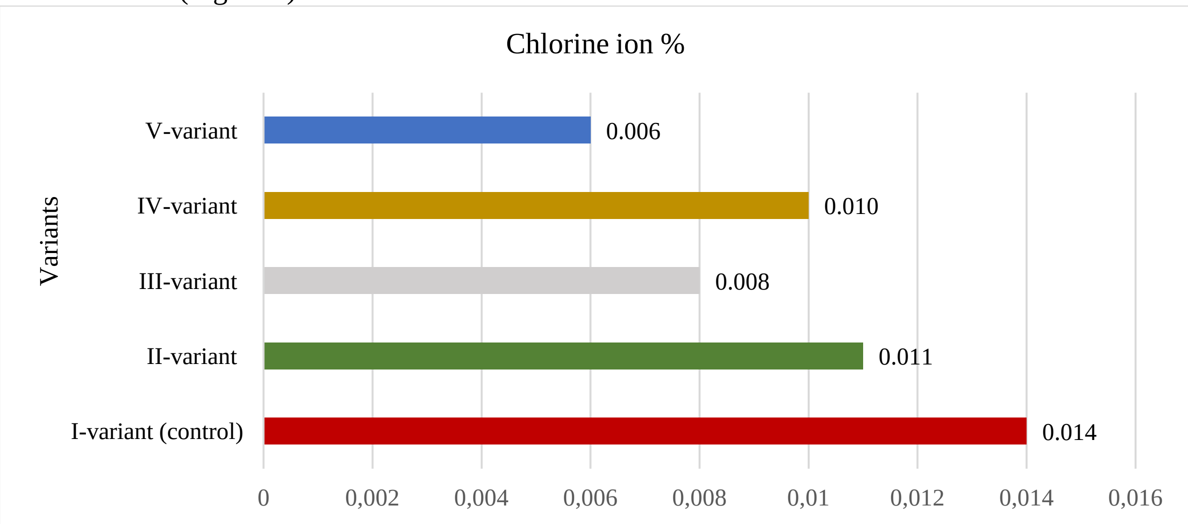

Figure 2. Changes in the amount of chlorine ions in the experimental field in the variants

When soil samples were taken from five points of the experimental area at a depth of 0 to 100 cm in the envelope method, the amount of dry residue at the beginning of the experiment was 0.478% at 0-20 cm, 0.402% at 20-40 cm, 0.466% at 40-60 cm and 0.472% at 60-80 cm. and in the last 80-100 cm it was 0.388%. When using the variants in the experimental field, the amount of dry residue is 0.018% in the 0-20 cm layer, 0.005% in the 20-40 cm layer, 0.021% in the 40-60 cm layer, and 0.008% in the 60-80 cm layer compared to the I-(control) variant and 0.008% in the 80-100 cm layer, 0.084% in the 0-20 cm layer in the III variant, 0.053% in the 20-40 cm layer, 0.076% in the 40-60 cm layer, 0.070% in the 60-80 cm layer and 80-100. 0.037% in the 0-20 cm layer, 0.070% in the 0-20 cm layer, 0.039% in the 20-40 cm layer, 0.069% in the 40-60 cm layer, 0.061% in the 60-80 cm layer and 0.040% in the 80-100 cm layer and in the V-variant we can see that it decreased by 0.080% in the 0-20 cm layer, 0.053% in the 20-40 cm layer, 0.077% in the 40-60 cm layer, 0.070% in the 60-80 cm layer and 0.047% in the 80-100 cm layer (Figures 3-5).

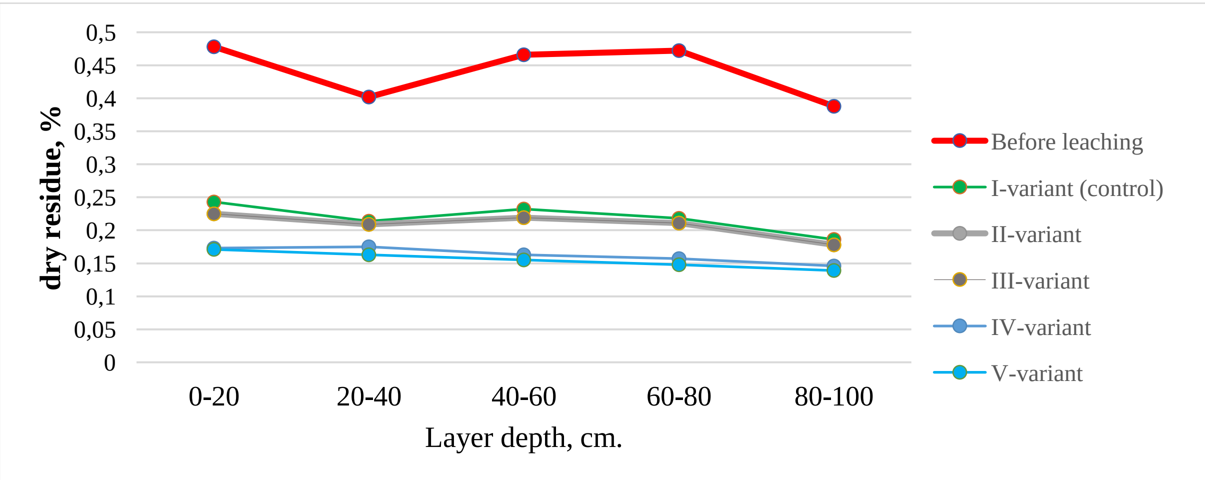

Figure 3. Change of dry residue before and after saline washing of the experimental field

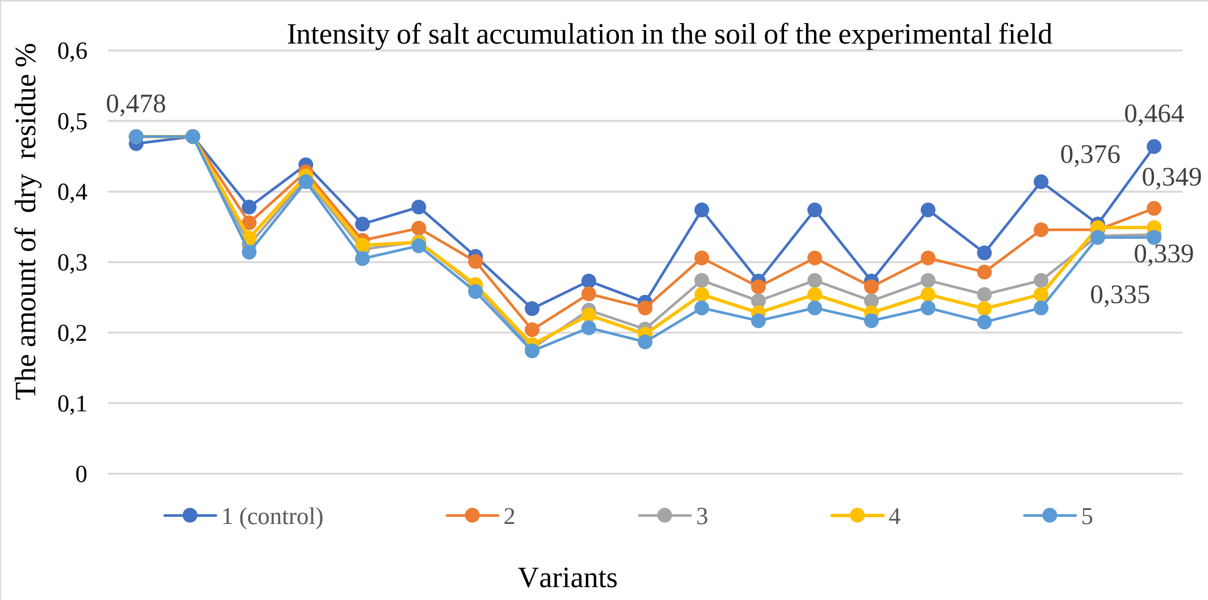

Figure 4. The intensity of salt accumulation in the soil of the experimental field

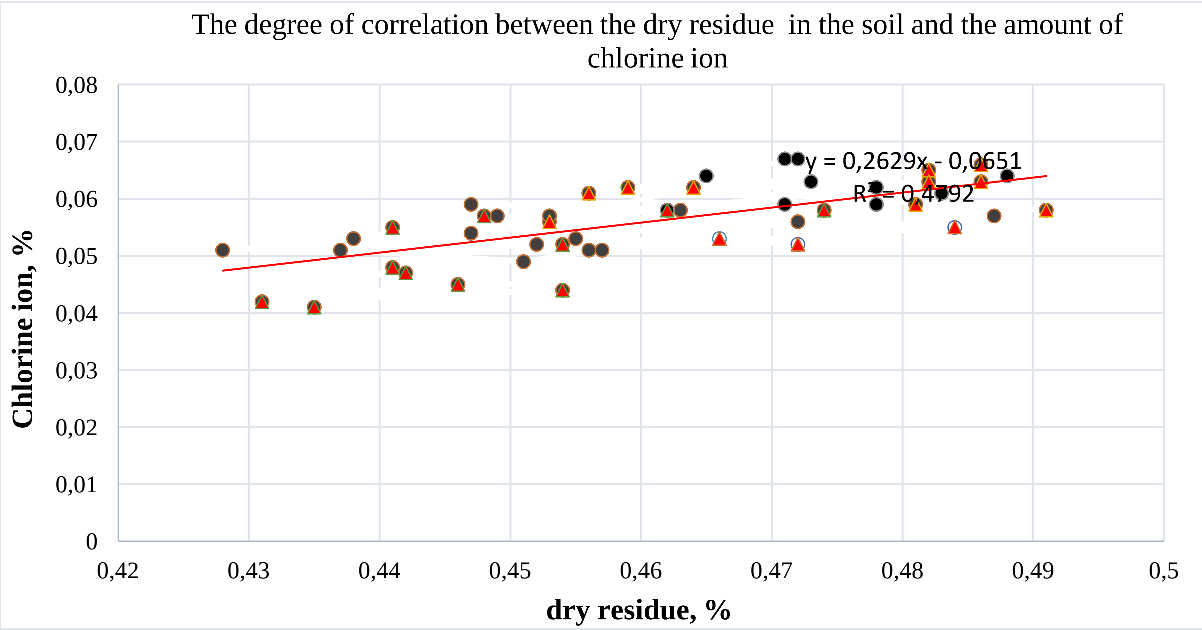

Figure 5. The degree of correlation between the dry residue in the soil and the amount of chlorine ion

When the yield of cotton was analyzed at the end of the growing season, in the first variant of observations, the seedling thickness of the plant was 82.000 bushels/ha and the yield was 2.95 t/ha. In Experiment II, the thickness of the seedlings was 88.000 bushel/ha, the yield was 3.34 t/ha. Also, in the third variant, the plant seedling thickness was 92 thousand t/ha, the yield was 3.92 t/ha, while in the fourth variant, the plant seedling thickness was 89 thousand t/ha, yield 3.47 t/ha, and in the V-variant the plant seedling thickness was 94 thousand bushels ha, yield was 4.24 t/ha. This is an increase of 0.39 t/ha in variant II, 0.97 t/ha in variant III, 0.52 t/ha in variant IV and 0.129 t/ha in variant V compared to control (Figure 6).

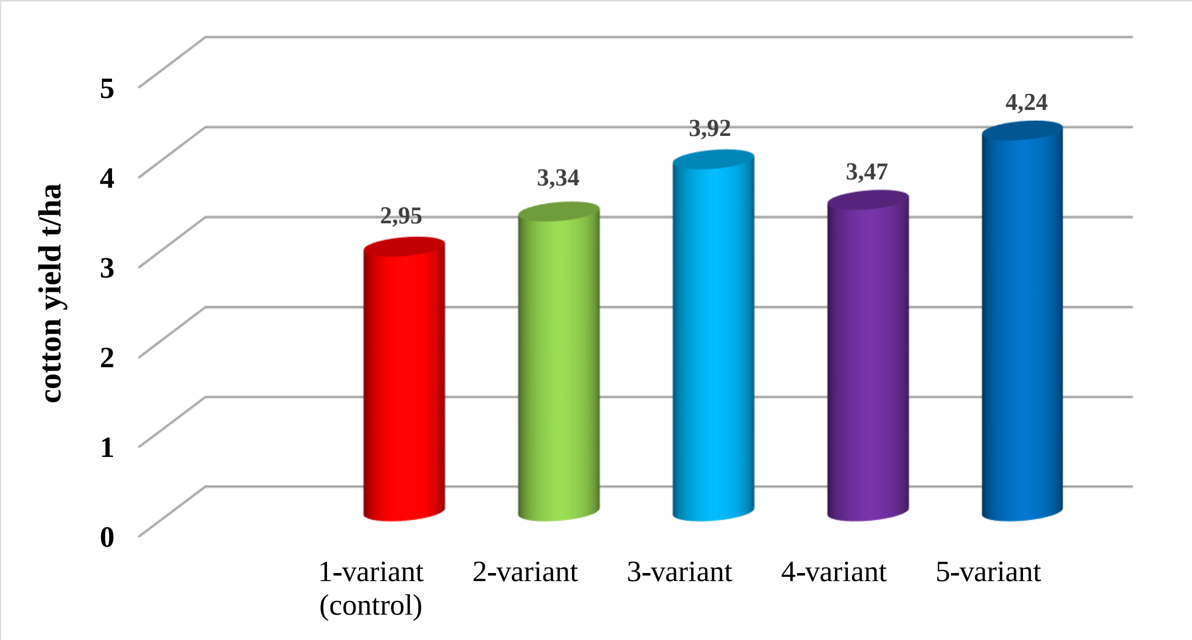

Figure 6. Cotton yield

4. Conclusions

From the results of experiments on soils with deep mechanical softening and chemical compound (Spersal) in soils with heavy mechanical sand (gypsum), it can be concluded that the amount of chlorine ion in the active layer is 0.003 in variant II compared to control. %, Variant III decreased by 0.006 %, variant IV by 0.004 % and variant V by 0.008 %, while the amount of dry matter decreased by 0.058% in variant II, 0.067 % in variant III, 0.063 % in variant IV and the V-variant was found to have decreased by 0.074 %.

Seasonal saline leaching norms differed from variant I (control) in variant II-1470 cbm/ha, in variant III-1645 cbm/ha, in variant IV-1380 cbm/ha and in variant V-1745 cbm/ha. The norm of irrigation of cotton is 537 cbm/ha in variant II, -974 cbm/ha in variant III, 721 cbm/ha in variant IV and 1127 cbm/ha variant in variant V compared to variant I (control) less water was used and improvement of soil water, air, salt regime was achieved.

Cotton yield was 0.39 t/ha in variant II, 0.97 t/ha in variant III, 0.52 t/ha in variant IV and 0.129 t/ha in variant V compared to control observed to increase At the same time, high-quality cotton was harvested and the reclamation of lands was improved.

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