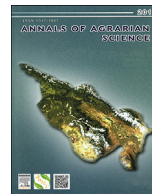




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Development direction of the soil-formation processes for reclaimed soda solonetz-solonchak soils of the Ararat valley during their cultivation

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ABSTRACT

The data of the article show that the long-term cultivation of reclaimed sodium solonetz-solonchak soils entails to further improvement of their properties and in many parameters of chemical compositions of soil solution and soil-absorbing complex they come closer to irrigated meadow-brown soils in the period of 15–20 years of agricultural development. The analysis of the experimental research by the method of non-linear regression shows, that for the enhancement of some yield determining parameters to the level of irrigated meadow-brown soils, a time period of 30–40 years of soil-formation processes is needed and longer time is necessary for humidification. The forecast of soil-formation processes for the long-term period, allows to reveal the intensity and orientation of development of the specified processes and to develop the scientifically-justified actions for their further improvement.

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Introduction

The soils salinization and alkalization is a great disaster for the agriculture of many countries all over the world. According to FAO data the world area occupied by the salted soils has reached up to 350 million hectares by 2000 [1] that makes 50% of the irrigated soils of the globe. These processes are intensively developed in the Ararat valley as well. Because of the mountainous relief Armenia is considered as a country with insufficient arable land. The share of agricultural arable lands makes only 46% from the entire area. And only in a valley of the river Araks due to its favorable environment on big massifs plentiful crops of fruits, grapes, vegetable, watermelon, melon and pumpkin, grain and commercial crops are raised. However among irrigated meadow-brown soils the significant areas in a valley occupy the fruitless soda solonetz-saline soils. The salinization and alkalization of the soils of Ararat valley occurs under a number of hydro-geological circumstances. In the valley, where the evaporation considerably exceeds the atmospheric precipitations in conditions of ground waters mineralization and its high level the capillary enhancement and evaporation of those waters occur which results in soil salinization and

alkalinization.

Amelioration of solonetz-solonchak soils is of great economic and national importance for the Republic of Armenia. The area of salinized and alkalized soils currently make about 35–40 thousand hectare, while it was all in all 30 thousand hectare in the 60th of the previous century.

Since the 60s of previous century chemical amelioration technologies for the sodium solonetz-solonchak soils have been investigated, developed and recommended by the employees of the scientific center of soil science, agro-chemistry and amelioration after H. Petrosyan (the former scientific research institute of soil science and agro-chemistry) and sulfuric acid and ferric sulfate appearing as production wastes have been used as chemical ameliorants, which were imported into the republic from other countries due to which the strong sulfuric acid with 80–82% was experimented instead of 1% one.

It is worth to mention that strong salinization-alkalinization is peculiar to the clay and heavy clay and sandy soils with heavy mechanical composition, as the soils of Ararat valley are colmatage soils, consequently the saline-alkaline areas have a spotted salinization image.

For the development of ameliorative events a differentiated approach is needed: first the soil extraction is implemented, the soil chemical composition in one meter layer according to the taken samples (0–25, 25–50, 50–75 and 75–100 cm layers) is identified,

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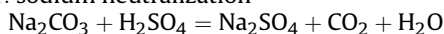
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and then its mechanical composition is identified by means of which the standards of the required chemical ameliorants and leaching water is determined. A plan is designed, after which a drainage net is constructed, the depth of which depends on the soil mechanical composition, depth of ground waters and the area curvature. According to the calculations the drainage system in Ararat valley is held at the depth of 3,0–3,5 m.

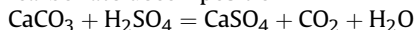
The amelioration of the solonetz-solonchak soils is based on the neutralization of alkaline reaction of the soil solution, substitution of the exchangeable sodium with calcium, after which the removal of the emerged neutral salts and at the same time exclusion of the secondary salinization threat is carried out through the drainage system installed at the 3,0–3,5 m depth in advance. The main task of the amelioration of saline-alkaline soils is to remove the water-soluble salts from the one meter soil layer, where roots exist, reducing them to 0,1–0,2%, and then to extrude the absorbed Na from the soil absorbing complex by means of ameliorant reducing it up to 5%. In such conditions the soil physical, chemical and physical-chemical, water-physical properties improve and in case of relevant agro-technology implementation, proper fertilization and irrigation the crop yield capacity is rather high and qualified. During the ameliorative activities the normal sodium is neutralized in the soil, sulfuric acid sodium (N82804) arises, which is removed with the help of leaching water through drainage system.

The following exchange reactions take place in the soil:

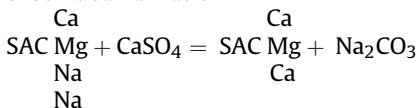
1. sodium neutralization



2. carbonate decomposition



3. soil dealkalization



As a result of extrusion of sodium sulfuric acid calcium from the soil absorbing complex through salt the soil physical and water-physical properties improve (dispersity, swelling capacity), silt fraction coagulation takes place, the soil air-water regime improves, the porosity and water permeability increase (before amelioration, filtration is practically missing and after it the filtration reaches 0,10–0,20 m/day depending on the soil mechanical composition and amelioration degree).

In the recommended technology the issues of mainly productive significance are settled, which are related to the investigation of the soil main properties, estimation of the norms of chemical ameliorants and leaching water, use of the necessary technical facilities, accurate soil cultivation and besides, the most important thing is to pay attention to the environmental issues during the ameliorants application.

Due to elaboration and introduction of some reclaiming measures (1960–1990) in the Ararat valley, including the collector-drainage networks construction (more than 1500 kms), the chemical reclaiming and washing of salted soils (more than 5 thousand hectares) the constant monitoring over a level of ground waters bedding have enabled the improvement of reclaiming conditions in this region and the provision of high productivity of agricultural crops [2,3]. For the further development of agriculture in the Ararat valley the special consideration is assigned for studying of soils formation processes on the reclaimed soda solonetz-saline soils at their agricultural implementation. The study of intensity and orientation of soils formation processes enables to develop the scientifically-based reclaiming measures directed to their further properties improvement.

Objectives and methods

For forecasting of the soils formation processes development the data of multi-year monitoring of 5 different cuttings located on various sites of reclaimed soda solonetz-saline soils were used. For the estimation of soils formation processes variation the data of irrigated meadow-brown soils of Ararat valley were used as a standard. The studies have been conducted in conditions of the most important irrigated regions of agricultural use, namely in Ararat valley of the Republic of Armenia. Field experiments have been held in the ameliorated sodium solonetz-solonchaks soils used 15–20 years for agricultural purposes, as well as in their adjacent irrigated meadow-brown soils.

The following investigations have been carried out in the laboratory conditions:

The analyses of soil water according to Ye. V. Arinuskina [4], by common methods, humus investigation according to I. V. Tyurin, M. M. Kononova [5], pH- by electro potentiometric method, the absorbed sodium and potassium have been examined by acetic acid ammonium according to H.T. Ananyan and K. G. Ghukasyan [6], the exchangeable calcium and magnesium by the method of Ivanov through the modification of A. N. Baghrmian, S. A. Abrahamyan. A. Sh. Galstyan [7], the nitrogen has been studied by Kjeldahl's method, phosphorus-by Machigin's method, potassium-by Maslova method, the bacteria quantity has been identified according to the method of A. K. Panosyan [8] and the invertase enzyme activity according to that of A. Sh. Galstyan [9].

Results and analysis

The change of qualitative characteristics of soils were conducted by the measurement of cation (Ca^{2+} , Mg^{2+} , Na^+) and anion (HCO_3^- , Cl , SO_4^{2-}) components and also humus content and some microbiological parameters.

Analyzing the data results in Fig. 1, we come to the conclusion, that content of HCO_3^- in the reclaimed solonetz-saline soil after 5 years of agricultural development makes 0.69–1.80 mg-eqv./100 g. A gradual decrease of the total alkalinity content is observed during their further cultivation and on the twentieth year of development makes 0.60–0.80 mg-eqv./100 g. The content of HCO_3^- in the irrigated meadow-brown soils makes 0.95 mg-eqv./100 g. Thus within 15–20 years of development, the content of HCO_3^- in reclaimed soda solonetz-saline soil is reduced up to a level of irrigated meadow-brown soil. The content of Cl ion after 5 years of development varies within the limits of 0.34–0.37 mg-eqv./100 g. Within 15–20 years of development their content changes insignificantly, making 0.22–0.36 mg-eqv./100 g, that is a little bit lower, than in the irrigated meadow-brown soils (0.38 mg-eqv./100 g). The content of SO_4 ions after 5 years of development makes 0.24–0.43 mg-eqv./100 g. Within 15–20 years of cultivation the tendency of some increase in their content (0.35–0.48 mg-eqv./100 g) is observed, that, obviously, is connected to fertilization by the sulfate containing fertilizers, nevertheless remaining below a level of irrigated meadow-brown soils (0.94 mg-eqv./100 g).

The content of water soluble Na after 5-year development varies within the limits of 0.75–2.67 mg-eqv./100 g (Fig. 2). As a result of the further agricultural development their content is gradually reduced and in the twentieth year makes 0.55–0.82 mg-eqv./100 g, that is lower than the content of Na ions in irrigated meadow-brown soils (1.02 mg-eqv./100 g). The content of Ca and Mg ions at the end of 5-year development varies within the limits of 0.10–0.34 and 0.06–0.15 mg-eqv./100 g, respectively. During further development the tendency of their content's increasing is observed and in the twentieth year of their cultivation makes 0.32–0.35 and 0.26–0.36 mg-eqv./100 g. It testifies to the

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