THE INFLUENCE OF FERTILIZERS ON THE CHEMICAL COMPOSITION AND CONCENTRATION OF SOIL SOLUTION IN IRRIGATED SOILS

Ermatova Munojat[1], Sidikov Saidjon[2]

[1]Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology, Tashkent Branch
[2]National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan

Abstract. Seasonal changes in the chemical composition and concentration of the soil solution of irrigated automorphic soils in different agricultural zones were studied. It is established that the composition of soil solutions, concentrations and ratios of various compounds in it are subject to seasonal variation during the growing season. This is facilitated by the process of plant nutrition. At the beginning of the growing season, there is a high concentration of soil solution, and at the end of the growing season, a low concentration.

Introduction

At present, one of the most important directions of the country's development strategy is the modernization and intensive development of agriculture, the deepening of structural reforms, and dynamic development of agricultural production. Soil is the main resource in agricultural production. The properties of soil, especially the optimization of soil solution for plant nutrition, are the main guarantee of obtaining a high and quality yield.

Soil solution plays an extremely important role in the process of soil formation since all the processes of chemical and biological transformation of organic and mineral compounds occur with the direct participation of the liquid phase of soil. This function of soil solution can be generally called the transformation function. A soil solution containing cations (Ca^{2+}, Mg^{2+}, Na^{+}, H^{+}, NH_4^{+}, K^{+}) and anions (HCO_3^{-}, CL^{-}, NO_3^{-}, SO_4^{-2}, $H_2PO_4^{-}$) of various substances dissolves and transforms aluminosilicates and hydroxides due to complex formation, hydrolysis, ion exchange and other reactions. In a liquid, some substances are transformed into others.

Thus, the liquid phase is the main environment in which particular physicochemical reactions occur in soil, bringing up elementary soil-forming processes. Therefore, by its composition and properties, it inevitably reflects the most essential features of modern soil formation.

Soil solution affects the composition of the migration flows of substances in the soil and landscape, that is, plays a transporting role. The solutions affect the transport processes in the products of dissolution, leaching, exchange and hydrolysis that arise from the interaction of solid and liquid phases of soil. They are the basis that forms the composition of gravitational runoff of water from the soils of the catchment basin into streams and rivers. The informational role of soil solutions follows from their transformation and transporting functions. Soil solutions are a reflection of the processes occurring in soil under the conditions of specific biogeocenoses. Changes in soil under the influence of biological, chemical, and physicochemical processes are reflected in the composition of its liquid phase.

The fact that soil solution can be optimized for plant nutrition makes important the study of soil solution under the effect of natural and anthropogenic factors.

Currently, one of the main tasks of agriculture is to maintain the condition of soil solution for optimal plant nutrition. In this regard, the study of the composition and concentration of soil solution, its variations in different agricultural backgrounds and the creation, on this basis, of a favorable state for plant nutrition is an urgent task of agriculture. Object and subjects of research. The object of research is the experimental site of the Department of Soil Science of the National University of Uzbekistan named after Mirzo Ulugbek. The subjects of research are typical old-irrigated gray soils,

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

soil solution, anions, cations, cotton variety Namangan-77, agrotechnical measures, and mineral fertilizers.

Purpose, research objectives. The main purpose of the research is to study the composition and concentration of soil solution, its variations in different agricultural backgrounds. To achieve this goal, the following tasks were completed: conducting a field experiment on an old-irrigated typical gray soil, determining the composition and concentration of soil solution, studying the effect of the chemical composition and concentration of soil solution in various agricultural backgrounds, identifying seasonal changes in the chemical composition and concentration of soil solution depending on the agricultural backgrounds and the growing season of cotton plants.

In natural soils, the solid, gas phases and natural vegetation cover influence soil solution. Whereas in irrigated soils, the natural factors affecting soil solution also include agricultural aspects (tillage, application of fertilizers, irrigation, etc.).

When studying soil solution, the study should not be limited by the solid phase of soil. It should include scientific data on the liquid and gaseous phases of soils since all three phases are constantly interconnected. From the point of view of agrochemistry and plant nutrition, one should know, without exception, all properties of soil solution, such as concentration, chemical composition, osmotic pressure and their changes. The vital activity of plants and microorganisms is impossible without soil solution, which performs a protective and regulatory function and is a source of nutrition.

Scientific novelty of the topic. In the course of the research, the composition and concentration of soil solution were isolated and studied, for the first time, in the conditions of irrigated typical serozem. The influence of different agricultural backgrounds on the chemical composition and concentration of soil solution was determined, and their seasonal change during the growing season of cotton plants was revealed.

The theoretical and practical significance of the results obtained. The results obtained are of great theoretical and practical importance in understanding the exchange reactions in the soil-absorption complex between absorbed ions and ions in the composition of the solution; in determining the effect of fertilizers, irrigation and processing technology on this process; scientifically grounded application of fertilizers, and in the educational process in higher educational institutions [1,3,20].

Literature review on the research topic. Analysis of literature sources shows that the studies of soil solution at the proper level were conducted at the Dokuchaev Soil Institute (Russia) by A.A. Kizilova, P.I. Shavrigin and at the University of California (United States of America) by N.J. Barrow, T.N. Choo [5,15,18]. They obtained valuable data on soil solutions concerning their regions.

According to V.V.Smakin [14], individual states and processes of interaction between phases and components of soil systems can be described using the categories of equilibrium thermodynamics. In soil chemistry, there is still uncertainty in the interpretation of the term "soil solution", which is often understood as soil moisture content in different forms of soil composition and properties.

A.E.Vozbutskaya [2] considers the terms “liquid phase of soil” and “soil solution” to be analogs. The Explanatory Dictionary of Soil Science defines soil solution as “water found in soil and containing organic and mineral substances and gases in a dissolved state”. Water is the main factor providing the process of chemical weathering of minerals. One of the leading weathering mechanisms is the strongly pronounced tendency of ions in the composition of solid phases to pass into solution. In the process of dissolution of substances, the ions that form weak bonds with other ions predominantly remain in solution, the ions that form strong bonds form new solid phases, i.e. are re-precipitated.

The dictionary-reference "Chemical contamination of soils and their protection" adds to this statement "soil solution is a homogeneous liquid phase of a variable composition."

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

R.W.Pearson (quoted by Orlov) calls soil solution "a quasi-equilibrium solution of electrolytes that exists in soil under the condition of its incomplete saturation with moisture" [8]. A similar interpretation could be found in the dictionary "Biosphere: pollution, degradation, protection": "soil solution is a solution of chemicals in water, which is in quasi-equilibrium with the solid and gaseous phases of soil and partially or completely fills its pores".

D.S.Orlov [8] complements the concept of "soil solution", rightly defining it as a liquid part of soil in natural conditions. All these definitions reflect certain features of such a system as soil solution, but they cannot be considered strict. For example, it is not clear whether all forms of water in soil can be attributed to soil solution. In particular, do strongly bound (hygroscopic) and free gravitational water refer to soil solution? This question is not idle.

A number of foreign scientists have made a significant contribution to the development of isolation methods and especially to the study of the composition and dynamics of soil solutions [5,6,18]. In the soils of Uzbekistan, especially in irrigated areas, soil solution has not been studied; research has not been conducted within the framework of certain programs. Therefore, there is not enough information about the soil solution composition. The method of water extracts, while remaining the main one for the control of the salt state of soils, at the same time makes it possible by means of calculations to obtain data on the soil solution concentrations that characterize the true conditions of the plant growing in a certain type of soil. It is convenient to calculate the salt concentration from the data of water extracts relative to the soil moisture content corresponding to the least water capacity (LWC).

N.G.Minashina [7] proposed the following formula for calculating the soil solution concentration based on the analysis of water extracts:

$$C = S. 1000 / V,$$

where C is the concentration of the sum of salts in soil solution, g/l; S is the percent of toxic salts in dry soil according to the analysis of water extracts; V is the LWC in percent by weight minus hygroscopic water (salt dissolving volume).

S.Sidikov, M.Ermatova, Z.Abdushukurova, O.Ergasheva, N.Tashmetova studied the effect of plant residues on the amount and quality of humus, the degree of humification of individual organs of cotton, alfalfa and ephemera, their effect on the content and composition of organic matter in soil at a weak concentration of soil solution. According to the research results, the humus balance and the humification coefficient were calculated. When composting soil with cotton organs and alfalfa roots and ephemeral vegetation, the greatest increase in humus was obtained from the introduction of ephemeral roots, all cotton organs and alfalfa roots. The calculated humification coefficient typical for cotton leaves is 20%, for alfalfa roots - 15%, for ephemeral roots - 16%, for cotton roots - 12% [11,12;13,17].

As a result of the research, it was found that at a low concentration of soil solution, the plant develops poorly, it cannot absorb a sufficient amount of nutrients and, while a high concentration of the solution also negatively affects the plants. The optimal concentration is the most favorable environment for plant development, which helps accelerate the absorption of nutrients by the plants and ensure high crop yields.

Research methods. Studies on the isolation, determination of the composition, concentration of soil solutions and their dynamics were conducted on the basis of the methods generally accepted in agrochemistry.

Results and discussion. As a result of the studies conducted, data on the chemical composition and concentration of soil solution of irrigated automorphic soils were obtained; as well as a change in the chemical composition and concentration of soil solution, depending on the use of various fertilizer rates, and during the growing season of cotton plants.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Concentration of soil solution. The concentration of soil solution, depending on the types of soil, their geographic location varies widely, from several tens of mg/l to several g/l. In saline soils, they reach up to several hundred g/l. In the works of the authors A.A. Kizilova [4], N.G.Minashina [7], the situation was similar.

Data obtained by the authors show that the concentration of soil solution of a typical old-irrigated serozem ranges from 0.2 to 0.7 mg/l along the soil profile. Plants assimilate nutrients well from soil solution at a concentration of 0.2-1.0 mg/l. A further increase in concentration hinders the entry of nutrients into plants.

In the studied old-irrigated typical sierozem in soil solution of anions, the content of normal carbonates along the soil profile ranges from 0.022-0.027%, chlorine ions 0.002-0.003%, sulfate ions 0.003-0.008%. Of the cations, sodium ions are 0.002-0.005%, magnesium ions - 0.001-0.003%, calcium ions - 0.006-0.010% (Figure 1).

Soil solution reflects all the typical features of the biogeocenosis in its composition being in close contact with the solid phase of soil, interacting with atmospheric precipitation, living organisms and vegetation. Plants change the composition of the solution, extracting some elements from it (necessary for their life) and introducing other elements into it through intravital root secretions and with leaf mold. Carbon dioxide and various organic exudates are released into solutions due to root respiration and vital activity of the biota, and during the decomposition of organic matter. As a result of the research, it was found that at a low concentration of soil solution, the plant develops poorly, it cannot absorb a sufficient amount of nutrients and, while, a high concentration of the solution also negatively affects the plants.

The optimal concentration is the most favorable environment for plant development, which helps accelerate the absorption of nutrients by the plants and ensure high crop yields. Table 2 shows the average indices of the chemical composition of soil solution from the upper horizons of the old-irrigated typical serozem, obtained from four field experiments.

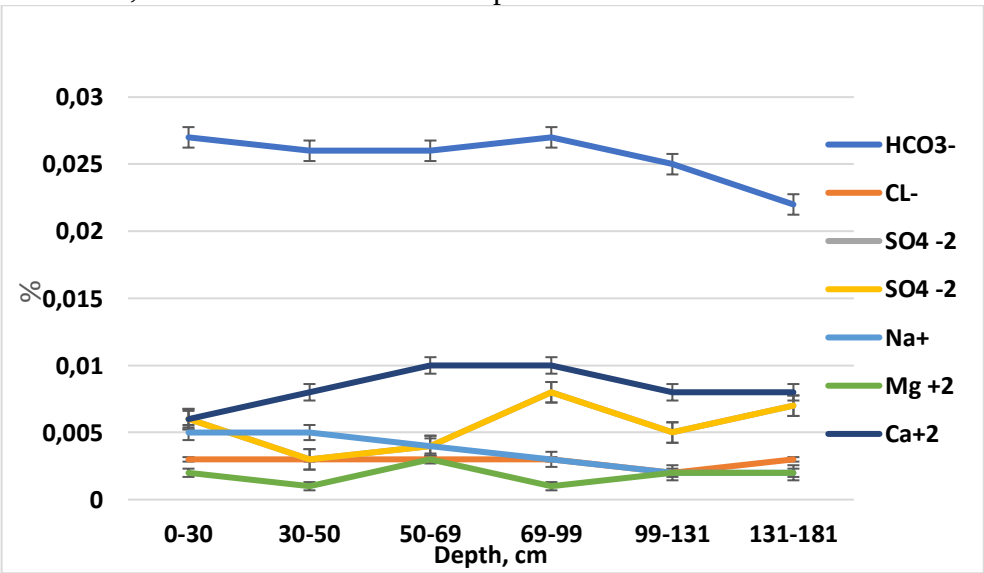

Figure 1. Concentration of soil solution in old-irrigated typical serozem, %

From the data given in Figure 2, it can be seen that there is a noticeable difference in the composition of soil solution between the variants of the experiments. The composition of soil solution in all variants contains comparatively more ions of calcium, magnesium and potassium.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

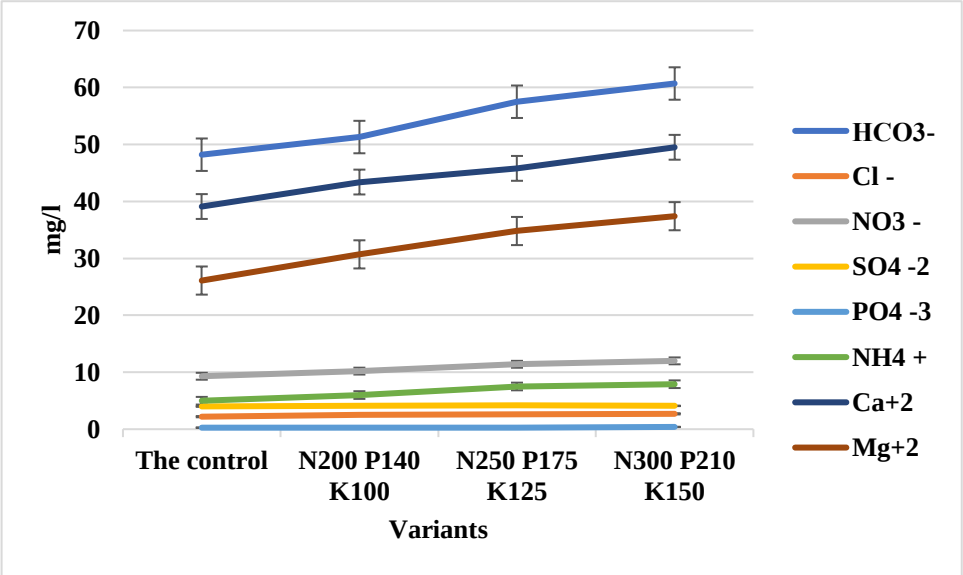

Figure 1. The chemical composition of soil solution in different agricultural backgrounds, mg/l

The lowest number of anions and cations was determined in the check variant of soil solution. The use of fertilizers led to an increase in the number of anions and cations in soil solution.

In the plow horizon of soils in the variant $N_{300}P_{210}K_{150}$, the content of HCO_3 was 60.7 mg/l, NO_3-12.0 mg/l, NH_4-7.9 mg/l, Ca-49.5 mg/l, Mg-37.4 mg/l, Na- 35.8 mg/l. Down the profile, their number decreased.

In the conditions of irrigated agriculture, as a result of an increase in biological activity, a high concentration of soil solution is observed. As a result of the development of virgin lands, the nitrification process intensifies, and soil solution is enriched with nitrates. Simultaneously with nitrates, an increase in the content of calcium, magnesium and potassium is observed.

The data obtained from the field experiment show that the composition of soil solutions, the concentration and ratio of various compounds in it are subject to seasonal variation during the growing season. This is facilitated by the process of plant nutrition. Noticeable changes occur in the composition of soil solution in the middle of the growing season (July, August). During this season, the content of nutrients in soil solution increases, and the sucking function of the cotton root system is enhanced. This is related to reaching the maximum point of the process of nitrification in soil, an increase in the activity of phosphatase and the content of carbon dioxide in the soil air. As a result, the content of nitrogen, ammonium and phosphorus in soil solution increases. At the same time, in the middle of summer there occur significant changes in the soil environment. As a result, the environment changes to an alkaline or weakly acidic side.

In later growing seasons, as a result of the direct influence of the plant, the amount of calcium ion in soil solution decreases and the amount of potassium ions increases. As a result, the ratio of potassium ions to calcium ions expands. The process of entry of nutrients into the root system depends on this ratio: the higher the ratio in the solution, the stronger the absorption capacity of the root, or vice versa.

Conclusion. Thus, in the studies, it was determined that the in the studied old-irrigated typical sierozem in soil solution the content of normal carbonates along the soil profile ranges from 0.022-0.027%, chlorine ions 0.002-0.003%, sulfate ions 0.003-0.008%. Of the cations, sodium ions are 0.002-0.005%, magnesium ions - 0.001-0.003%, calcium ions - 0.006-0.010%.

Composition and concentration of soil solution are subject to seasonal variation during the vegetation season. During the field experiment, for the first time under the conditions of irrigated

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

typical serozem, the composition and concentration of soil solution were identified and studied. At the beginning of the vegetation season, a high concentration of soil solution is observed, and at the end of the vegetation season, the concentration is low.

Noticeable changes occur in the composition of soil solution in the middle of the growing season (July, August). During this season, the content of nutrients in soil solution increases, and the sucking function of the cotton root system is enhanced. This is related to reaching the maximum point of the process of nitrification in soil, an increase in the activity of phosphatase and the content of carbon dioxide in the soil air. As a result, the content of nitrogen, ammonium and phosphorus in soil solution increases. At the same time, in the middle of summer there occur significant changes in the soil environment. As a result, the environment changes to an alkaline or weakly acidic side. The studies of soil solution under pressure from natural and anthropogenic factors show that soil solution can be optimized for plant nutrition.

The results obtained are of great theoretical and practical significance in determining the exchange reactions in the soil absorbing complex between the absorbed ions and ions in the composition of the solution; in determining the effects of fertilizers, irrigation, and processing technology on this process; scientifically based use of fertilizers, and in the educational process of higher educational institutions.

References

1. Bonito D. M. Trace Elements in Soil Pore Water: A Comparison of Sampling Methods. PhD thesis, University of Nottingham. 2005. -299 p.
2. Vozbutskaya A.E. *Soil chemistry*. Moscow: Higher School Publ., 1968, -428 p.
3. Essington M.E. Soil and water Chemistry. An integrative approach. CRC press. Boca Raton.London. NY. Washington. 2004. -534 p.
4. *Kizilova A.A.* Soil solutions of solonchaks of the Mugan-Salyan steppe and soil amelioration of Northern Mugan. In book: *Transactions of Soil Institute of the USSR Academy of Sciences, 1955, Vol. 43, -P. 141-255.*
5. *Komarova N.A.* The displacement of soil solutions by the method of fluid replacement and the use of the method in soil research. In book: *Transactions of Soil Institute of the USSR Academy of Sciences, 1956, Vol. 51, No. 5, -P. 5-97.*
6. *Malinina M.S., Motuzova G.V.* Methods for obtaining soil solutions during soil-chemical monitoring. In: physical and chemical methods of soil research. Moscow: Moscow State University Publ., 1991, -P. 101-129.
7. Minashina N.G. Dependence of the content and composition of salts in the soil solution on the moisture content of gypsum-bearing soil// Soil Science, No. 7, 2005. -P.15-23.
8. Orlov D.S. *Soil chemistry*. Moscow: Moscow State University Publ., 1985, 376 p.
9. Rode A.A. Soil moisture. Ed. AN USSR, 1952. 356 p.
10. Guidelines for conducting chemical and agrophysical analyzes of soils during land monitoring. Tashkent, 2004. 260 p.
11. Sidikov S., Ermatova M. Changes in the chemical composition and concentration of the soil solution of irrigated automorphic soils depending on the agro background and the period of the year. EESJ (East European Scientific Journal) 7 (47), 2019 part 3.
12. Sidikov S., Ermatova M., Tashmetova N. Optimization of the chemical composition and concentration of soil solution of soils of desert zone for nutrition of plants. Scopus-Pal Arch's Journal of Archaeology of Egypt/ Egyptology, 2020. -P. 14247-14265.
13. Sidikov S., Ermatova M., Abdushukurova Z. Method For Optimization Of Composition And Concentration Of Soil Solution Of Irrigated Soils For Nutrition Of Plants. Solid State Technology (Volume: 63 Issue: 4 Publication Year: 2020). -P. 5162-5179.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

14. Snakin V.V. Analysis of the composition of the aqueous phase of soils. M.: Nauka, 1989, 118 p.

15. *Shavrygin P.I.* The ratio between soil solutions and water extracts in saline soils. Soil Science, *1947, No3, -P. 172-177.*

16. Trofimov S.Ya., Karavanova E.I. *Soil Liquid Phase: A Study Guide for Some Chapters in Soil Chemistry*. Moscow: University Book Publ., 2009, -111 p.

17. Sidikov S., Ergasheva O., Ermatova M., Valieva A. Innovative technologies to increase the fertility of irrigated soils and crop yield. E3S Web of Conferences 386, 01012 (2023) GISCA 2022 and GI 2022. https://doi.org/10.1051/e3sconf/202338601012

18. www Ziyonet uz.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 13 Issue: 11 in November-2024
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2024 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/