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NEW APPROACHES TO CONDUCTING AGROCHEMICAL RESEARCH UNDER CONDITIONS OF GLOBAL CLIMATE CHANGE

Kuziev J. M.
Institute of Soil Science and Agrochemical Research,
Tashkent, Uzbekistan
E-mail: mmjahongir81@gmail.com

Abstract
The article provides information about the reasons for changes in the agrochemical properties of irrigated soils in the republic. As part of scientific projects, agricultural technologies have been created to develop the ratio of NPK mineral fertilizers for cotton under conditions of global climate change. It has been established that in these conditions for the cultivation of agricultural plants, the ratios of mineral fertilizers used do not satisfy their needs, which necessitates the need for in-depth scientific research to solve this problem.

Keywords: Soils, fertility, agrochemical research, ratios, NPK, mineral fertilizers, innovation, agricultural technologies, climate change.

Introduction

The issue of land, rational use of land resources, increasing soil fertility and productivity of cultivated agricultural crops remains one of the fundamental issues of the state's agricultural policy and the solution to the country's food security depends on it.

The development of agriculture and the increase in its productivity are inextricably linked with the intensification of the industry, one of the most important conditions of which is the use of various fertilizers, without which economically viable agricultural production is impossible.

It is known that the loss of fertility of irrigated lands sharply reduces the yield of cultivated agricultural crops and this is associated with a widespread decrease in the content of humus and forms of nutrients available to plants in the soil.

Currently, the lack of nutrients is not fully compensated for by applying mineral fertilizers due to their high cost and therefore it is not always possible to apply the recommended rates of mineral fertilizers. The current situation requires large-scale scientific research to improve the fertility of the republic's soils and protect them from depletion.

Soil depletion is a natural phenomenon when cultivating any agricultural crops, since plants absorb the nutrients they need from the fertile soil layer, and the more productive the variety, the greater their need for nutrients.

Restoration of soil fertility occurs naturally, but its rate is quite low and, in order to prevent it from becoming unsuitable for farming, various agricultural technologies are used that are acceptable for a specific type of soil and cultivated crop. But the most important and main thing is the rational use of mineral, organic and organomineral fertilizers.

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Annual application of fertilizers significantly reduces the negative impact on soil fertility against the background of a progressive decrease in the content of organic matter, which is the most important indicator of the level of fertility and serves as a reserve of nutrients necessary for plants and has a positive effect on soils and the yield of cultivated crops.

Effective use of all means of preserving and increasing soil fertility, protecting the environment and intensifying production is possible only if each farm has a scientifically based farming system. Numerous studies have established that more than 95% of agricultural crops are grown on different types of soil and receive different yields. There are many factors that contribute to increasing crop yields, but the main one is the use of various fertilizers - mineral, organic, organomineral and others in various scientifically based rates and terms.

Research conducted with the participation of FAO in more than 40 countries around the world, in various soil and climatic conditions using mineral and organic fertilizers. Their positive effect on soil fertility and crop yields has been established, and it has also been proven that the use of mineral and organic fertilizers in optimal rates and timing allows for a several-fold increase in plant yields. The results obtained have been widely reported [1, 2, 5].

For example, American scientists believe that to increase plant yields, the share of mineral fertilizers is 40-45%, herbicides - 12-15%, the share of optimal climatic conditions is 9-10%, hybrid seeds - 7-10%, irrigation - 13-15%. According to calculations by German scientists, half of the resulting plant yield (out of the total) is compensated for by the use of fertilizers, French scientists believe that fertilizers are used to obtain 50-70% of the yield, and in Russia slightly less - 50-60% of the resulting yield [3].

Agriculture is the predominant sector of the country's economy, and an important part of agricultural production is the chemicalization system, which has a huge impact on soil fertility, growth, development and crop yields. Violation of this system, based on soil and climatic conditions, leads to starvation of plants and threatens human lives.

Failure to comply with optimal standards and timing of application of mineral, organic and other fertilizers, as well as violation of irrigation regimes, limits the possibility of obtaining high and high-quality yields of cultivated crops, which are the real breadwinners of humanity.

In nature, unfortunately, there are rare cases when plants have a sufficient amount of moisture and nutrients, which does not allow obtaining the expected crop yield and maintaining sustainable soil fertility, and this necessitates the development of scientifically based, optimal norms and ratios for the application of mineral fertilizers, taking into account the soil and climatic conditions of each territory, soil environment and types of cultivated crops [1, 6].

The Resolution of the President of the Republic of Uzbekistan dated March 14, 2019 No. 4239 "On measures to develop agricultural cooperation in the fruit and vegetable industry" and the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan dated June 18, 2019 No. 510 "On measures to improve the system of agrochemical analysis of soils in agriculture, increasing the fertility of sown lands" for the first time determined the implementation of annual agrochemical studies on irrigated agricultural lands occupying an area of at least 20% of the territory, at the expense of the state budget and, on this basis, indicated the importance of developing agrochemical cartograms of the content of humus, mobile forms of nutrients - nitrogen, phosphorus, potassium, taking into account the types of cultivated crops, which will improve the system of differentiated use of mineral fertilizers and establish annual rates and timing of their application, taking into

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account the need for them of agricultural crops.

In recent years, degradation processes such as a decrease in humus content, nutritional elements, desertification, salinization, irrigation and wind erosion, overgrazing, etc. have been observed in the irrigated soils of the Republic.

It was found that the humus content in irrigated soils decreased by 10-15 percent, which led to a loss of 450 thousand hectares of irrigated arable land in equivalent terms. More than 90% of irrigated soils belong to the group below the average provision for humus content (average - 1.0-1.5%), 70% of soils - for the content of mobile phosphorus (31-50 mg/kg) and about 80% of soils - for the content of exchangeable potassium (201-300 mg/kg).

In recent years, the institute's scientists have conducted agrochemical studies of soils on an area of 750.8 thousand hectares in the Bukhara, Jizzakh and Syrdarya regions. Based on field, office and cartographic work, agrochemical cartograms were compiled for the content of humus, mobile forms of nitrogen, phosphorus and potassium in soils at a scale of 1:10,000 and, based on the data obtained, annual optimal rates and timing of application of mineral fertilizers for the cultivation of agricultural crops in certain soil and climatic conditions were established, and a fertilizer application system was developed that allows preserving and increasing soil fertility, which will ensure stable and high-quality harvests.

Research was conducted to compile agrochemical cartograms of the content of humus and mobile forms of nitrogen, phosphorus, and potassium in irrigated soils of the Khorezm, Jizzakh, and Kashkadarya regions over an area of 944.6 thousand hectares.

A mobile laboratory, the Soil Clinic, has been created at the Institute and its territorial divisions, providing cotton-textile clusters of the republic and other land users of all types of ownership with soil services directly in the fields based on business contracts.

During the period 2021-2023, through the mobile laboratory "Soil Clinic" created at the institute, soil services were provided to more than 100 clusters and farms.

In the Soil Clinic laboratory, the express method with a barcode determines ammonium and nitrate forms of nitrogen, phosphates, exchangeable potassium, salinity, density and temperature of the soil, its pH, which makes it possible to determine the depth of plowing, establish the norms and timing of irrigation during the growing season of plants, determine soil moisture, as well as the direction and speed of the wind (in soils subject to deflation).

The results obtained make it possible to apply mineral fertilizers in a differentiated manner depending on the plants' needs.

Another area of the mobile laboratory is the performance of emergency analyses and measurements to create optimal conditions for the growth and development of cultivated crops.

Greenhouse farming activities occur mainly during periods of heat and light deficiency, and therefore the mobile laboratory has the ability to simultaneously determine the provision of plants with nutrients, the necessary lighting, temperature, atmospheric oxygen and carbon dioxide, as well as the photosynthetic activity of radiation using a quantum meter.

The Department of Agrochemistry conducts scientific research on the project: "Development of a technology for a geophase smart system for applying fertilizers in irrigated agriculture based on precise factors", as well as "Creation of an innovative agricultural technology for developing NPK ratios of mineral fertilizers for cotton under conditions of global climate change".

The studies conducted under the first project made it possible to establish that the studied irrigated

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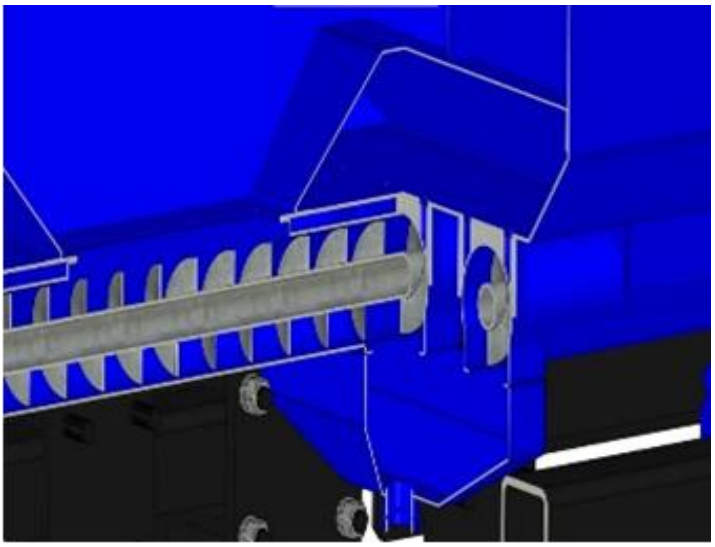
typical and light serozems, ierozem-meadow soils (pilot plots), on which mineral and organic fertilizers and various agricultural techniques were used for a long time, are distinguished by a thickened agro-irrigation horizon and the leaching of carbonates into the underlying layers, as well as a number of other distinctive features, compared to such soils not used in agriculture.

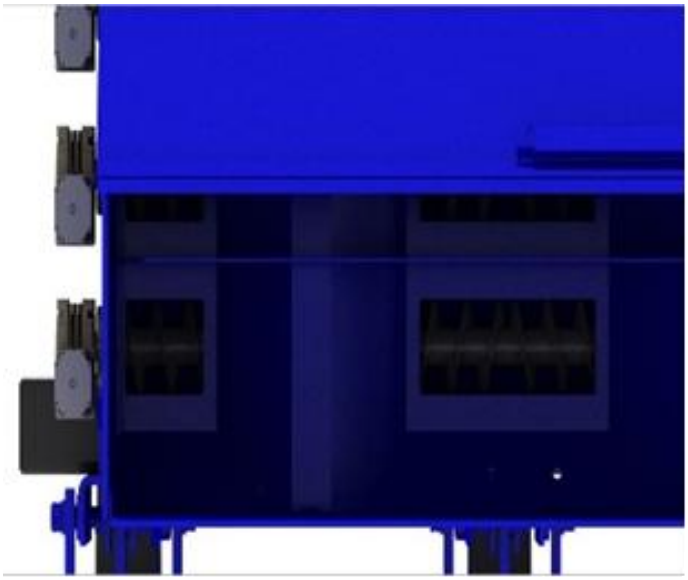


Irrigated typical serozems and serozem-meadow soils are mainly medium loamy, partly heavy loamy. Newly irrigated light serozems are mainly light loamy and sandy in mechanical composition. The humus content in these soils fluctuates within 0.168-1.257%, the amount of total nitrogen is 0.027-0.084%, total phosphorus - 0.098-0.217%, total potassium within 0.44-1.11%.

It was found that in the arable soil horizons of some pilot plots the content of both gross and mobile forms of nitrogen, phosphorus and potassium is quite high and gradually decreases in the underlying horizons. The nitrogen to carbon ratio in medium loamy and light loamy soils by mechanical composition decreases down the soil profile, and in heavy soils by mechanical composition no specific pattern was noted.

The ratio of nitrogen to carbon in medium loamy and light loamy soils decreases down the soil profile, and in heavy soils no specific pattern is observed.

In order to introduce chemicalization as the main link in agricultural production in the system of "precision farming", the degree of provision of the selected contours with nutrients and the need for them by plants have been established, elementary areas in pilot areas have been determined taking into account soil and climatic conditions and the coordinates of each sample taken using GIS software, agrochemical cartograms of the content of mobile forms of nutrients have been compiled, annual rates of application of mineral fertilizers have been developed based on determining the amount of nutrients used by plants to obtain 1 centner of harvest.



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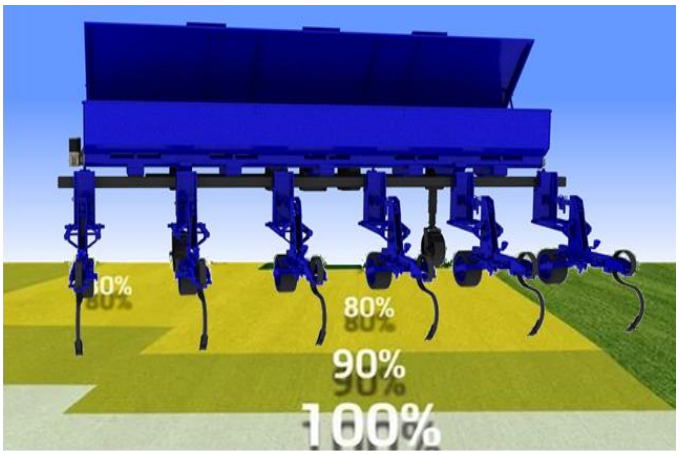

Using a precisely coordinated farming system, a drawing of a unit for an automatic individual geophase-smart system for applying mineral fertilizers was developed, a 3D model of this unit was created, which was patented by the Intellectual Property Agency under the Ministry of Justice of the Republic of Uzbekistan.

Conducting scientific research on the development of innovative agricultural technology for the NPK ratio in fertilizing cotton in various soil and climatic conditions of Uzbekistan in the context of global climate change has made it possible to establish the following:

- using automatic small agrometeorological stations, in conditions of automorphic and hydromorphic soils in real time, the thermohygrothermal coefficient of air dryness was calculated, the relationship between moisture reserves and the thermohygrothermal coefficient during the growing season of agricultural plants was established and, on this basis, the need of plants for nutrients was established;

- OXUS-2 weather stations have been installed at the selected pilot sites and this is due to the fact that in recent years, climate change, the creation of new species and varieties of plants, the consumption of nutrients required to form 1 ton of crops, their timing and ratios have significantly differed in comparison with data from 40-50 years ago.

Due to global climate change, the ratios of mineral fertilizers (NPK) used for agricultural plants, in particular cotton, do not meet the needs of cultivated crops, which necessitates their scientifically based revision.

Comparison of climate data obtained over the past 40 years for the studied regions of the Republic showed that the air temperature has increased over the past decade relative to the basic climate indicators: in the Kurgantepa district of the Andijan region by +0.70C, the Syrdarya district of the Syrdarya region - by +1.6 0C, the Dustlik district of the Jizzakh region - by +1.0 0C, the Karshi district of the Kashkadarya region by +0.9 0C, the Khiva district of the Khorezm region by +1.3 0C. The amount of precipitation (relative to 1961-1990; 2009-2022) decreased by 1.1 mm in the Kurgantepa district, by 29.2 mm in the Karshi district, by 31.0 mm in the Khiva district, by 3.3 mm in the Dustlik district, and by 22.1 mm in the Syrdarya district. In the Kurgantepa and Dustlik districts, the average amount of precipitation did not change, while in the Syrdarya, Karshi and Khiva districts, the average amount of annual precipitation decreased significantly. In the areas where the field experiments were conducted, no precipitation was observed in the summer months. The research results showed that the humus content in the arable horizon of the soils of the experiment was 1.23%, the amount of total nitrogen, phosphorus and potassium was 0.097%, 0.157% and 1.15%, respectively. The soils are very depleted in nitrate nitrogen, mobile phosphorus and exchangeable potassium and can be classified as very low in these elements. The carbon to nitrogen ratio (C:N) increases from the upper arable horizon to the subarable horizon and then decreases to the rock (7.4-8.0-5.7).

A tendency towards a gradual decrease in the content of humus, gross and mobile forms of

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nitrogen, phosphorus and potassium in the underlying soil horizons is noted. As a result of global climate change, spring, during the study period, came earlier: at an air temperature relative to the base period at 0 ^{0}C by – 0-3 days, at + 5 ^{0}C – by 9-17 days, at + 15 ^{0}C – 8-33 days, at + 15 ^{0}C by 2-5 days, and autumn in Dustlik and Karshi districts came 10-15 days earlier.

It has been established that mobile nitrogen at a soil temperature of + 2 ^{0}C passes from the amide form (NH2) to the ammonium form (NH4) within 4 days, at a soil temperature of + 20 ^{0}C within 1 day, at a soil temperature of + 5 ^{0}C the ammonium form (NH4) passes into the nitrate form (NO3) within 6 weeks, at + 8 ^{0}C - within 4 weeks, at + 10 ^{0}C - within 2 weeks, at + 20 ^{0}C - passes into the nitrate form (NO3) within 1 week. This pattern is typical for phosphorus and potassium and is related to the fact that during the growing season, cotton absorbs nutrients depending on the period of its development: for example, during the period of 2-3 true leaves, nitrogen, phosphorus and potassium are absorbed in the ratio of 1:0.8:1, and from the budding period to full ripening, the ratio is 1:0.5:1.

For economic diagnostics, certain indicators were selected based on agrotechnical and technological characteristics that greatly affect the cotton yield:

- indicators of the economic efficiency of mineral fertilizers and the degree of their provision during the growing season of cotton;
- indicators of the economic efficiency of water use and the degree of its provision for irrigation of cotton during the growing season;
- the degree of provision with agricultural machinery and the economic efficiency of its use, allowing for timely and high-quality implementation of agrotechnical measures;
- the degree of provision of cotton growing with labor, their economical use, allowing timely implementation of agrotechnical measures, control over their implementation and, based on the obtained economic indicators, their diagnostics.

At present, agrochemical studies conducted at the Institute have allowed us to draw a conclusion about the possibility of monitoring these studies. Based on the agrochemical indicators of irrigated soils, it is necessary to compile digital maps and accept them as a "standard" of the current state. This, in turn, will allow observing the dynamics of changes in the agrochemical state of soils, urgently analyzing the results obtained, making appropriate conclusions and recommendations to production.

The presented new system differs from the previous one by the ability to save time on research.

The introduction of the "Precision Farming" system into the agriculture of the Republic allows for uniformly providing the field contours with nutrients, increasing the yield of cultivated crops, improving their quality, preventing environmental pollution with various residues of mineral fertilizers, which allows land users to reduce costs by 20-30 percent.

The obtained research results made it possible to establish that on automorphic and hydromorphic soils of the Republic, differentiated application of mineral fertilizers is recommended depending on the period of cotton vegetation: during the period of 2-3 true leaves, the ratio of nitrogen, phosphorus and potassium should be 1: 0.8: 1; in the budding phase 1: 0.5: 1.

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