Nutritional Regime, Trace Element Composition and Microbiological Nutritional Value of Soils Under Various Crops Under the Influence of Electrical Treatment

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Abstract: This article presents the results of scientific research conducted in the Aral Sea region to study the aftereffect of electrical treatment of a complex biological system consisting of «seed, soil, plant» using the example of cultivation of cotton, sunflower, millet, corn, and sesame. The electrical effect on the "seed, soil, plant" system has a positive effect on the content of digestible forms of nitrogen, phosphorus, potassium and trace elements in the soil, had a positive effect on the microflora of the rhizosphere of cotton, increasing the content of useful and reducing quantitative microorganisms in the soil, which improves the phytosanitary condition of the soil by reducing microscopic mold fungi and increasing the number of actinomycetes. It has been experimentally proven that differentiated irrigation regimes in combination with electrical technologies increase the yield of agricultural crops and save irrigation water.

1 INTRODUCTION

The problem of increasing the productive capacity of irrigated lands and crop productivity has always been in the focus of scientists' attention. Currently, this problem is of particular relevance due to the fact that in the 21st century, soil degradation, deterioration of their useful properties, intensive decomposition of natural humus reserves and, in general, a decrease in soil fertility is noted on the irrigated lands of Central Asia.

The search for new environmentally friendly, economical and effective plant growth stimulants is one of the important problems of crop production, including cotton growing, etc. Most of the plant growth stimulants widely used in the world are chemicals that ultimately harm the environment and humans.

In addition, the well-known agrotechnical methods of cultivating crops have also exhausted their capabilities to a certain extent and their further improvement over the years does not, in fact, give any tangible results.

The improvement of technical means, intensive use of chemicals, increased doses of mineral fertilizers, etc. become not only economically unjustified, but also harmful, taking into account the environmental situation.

The deteriorating environmental situation due to environmental pollution, moisture deficiency, salinization of the soil environment and other adverse environmental factors, along with a decrease in soil

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fertility, lead to significant crop losses and deterioration in the quality of agricultural products.

Meanwhile, the intensification of crop production and the need to increase the productivity and quality of agricultural products remain an urgent problem of the day.

2 MATERIALS AND METHODS

A solution to this problem based on the improvement of well-known agricultural technologies is not expected in the future.

Therefore, it is vital to create a fundamentally new alternative highly efficient, environmentally friendly, industrial technology for cultivating crops.

In Uzbekistan, the Head Design Bureau for Cotton-growing Machines has been conducting scientific research since 1995 on the creation of a new environmentally friendly agricultural technology for growing crops, which consists in the integrated use of electricity in the technological process of cultivated crops (Mukhammadiev, 1992, Khuyae et al., 2000).

Moreover, depending on the operation of the technological process of cultivation, the type and variety of seeds, as well as on the degree of their infestation with pathogenic fungi, bacteria and pests. Electricity is used in various forms (pulsed, electrothermal, radiation, etc.) and also in combination, which makes it possible to completely abandon the use of pesticides in the cultivation of crops.

The essence of environmentally friendly agroelectrotechnology consists in the combined and stage-by-stage electrical effects on the «seed, soil, plant» system.

3 RESULTS AND DISCUSSION

Environmentally friendly electrotechnological techniques have been developed to prepare agricultural seeds for sowing, to stimulate and protect them from diseases and pests. A number of technical means for the implementation of agroelectrotechnological techniques in agricultural production have been manufactured and tested in production conditions in almost all the republics of Central Asia, the People's Republic of China and the Arab Republic of Egypt (Figure 1).

Figure 1: Agroelectrotechnological methods of agricultural production

In the conducted studies on the mechanisms of electrical stimulation of seeds and plants during the growing season, it was found that electrical stimulation of seeds and plants (for example, cotton, potatoes, tomatoes, cereals) enhances nucleic and protein metabolism, the intensity of photosynthesis, the activity of enzymes, proteins at the cell level, etc. (Mukhammadiev et al., 2002, Sodikova and Turapov, 2004). Electrical action does not disrupt pollen formation, does not reduce its viability and fertilization process, has a positive effect on the microflora of the rhizosphere, increasing the content of beneficial and reducing the number of harmful microorganisms in the soil, improving the phytosanitary condition of the soil by reducing microscopic mold fungi and increasing the number of actenomycetes (Mukhammadiev, 2003).

It has been experimentally proven that electrostimulation of soil, seeds and plants using ultraviolet rays (hereinafter referred to as electrotreatment) contributes to a significant (Mukhammadiev et al., 2001).

In this article, we will highlight the results of these studies in more detail.

The effect of electrical treatment on the nutrient regime of the studied soils has shown that under various crops and under the influence of electrical treatment, noticeable changes occur both in the soil and in plant nutrition (Khusanov et al., 2002).

A slight increase in the assimilable potassium in the arable horizon was found under the influence of electrical treatment. A slight decrease in the content of digestible phosphorus under the influence of electrical treatment was also recorded under millet culture.

The data obtained show that the content of N-NO3 under the rhizosphere of cotton, regardless of the time of year, is always higher in the variants with electrical treatment compared with the control. For example, at the beginning of the growing season, the content of mobile nitrogen in the control variant ranges from 71.4 to 95.2 mg/kg and in the electrotreated variant from 108.0 to 148.0 mg/kg. The P2O3 content under the same crop and under the influence of electrical treatment always increases in control variants – from 40.0 to 60.0 mg/kg of soil, and in variants with electrical treatment from 50.0 to 70.0 mg/kg of soil. As for the content of mobile potassium, it can be said that the impact of electrical technology on the soil and on the seeds of cotton crops has shown the best results.

The content of mobile potassium in the humus horizon ranged from 219.0 to 398.8 mg/kg, in low horizons – from 94.0 to 350.8 mg/kg of soil. Under sunflower culture, regardless of the season, there is an increase in the content of N-NO3 and K2O under the influence of electrical treatment compared with the control. The amount of mobile nitrogen under the influence of electrical treatment ranged from 119.0 to 166.0 mg/kg, and without electrical treatment from 38.1 to 123.8 mg/kg of soil. The exception is phosphorus (P2O5). Its content in the version with electrical treatment is from 20.0 to 70.0 mg/kg, and in the version without electrical treatment – from 20.0 to 180.0 mg/kg of soil.

During the study, it was found that even in bad weather, more favorable conditions are created under the influence of electrical treatment in various cultures. Compared with the control variant, the processed variants improve the nutrition of various crops. In order to definitively clarify the reasons for the decrease or increase in the NPK content, it is necessary to conduct a more detailed comprehensive study of the processes occurring in the "seed-soil-plant" system under the influence of electrical treatment.

The effect of electrical treatment on the trace element composition of the studied soils.

Trace elements are an integral part of living matter and are necessary for the normal functioning of plants, animals and humans.

It has been established that the distribution of trace elements in the soil, their migration, and mobility depend on a number of factors: soil pH, gross humus content, mechanical composition, humidity, content of 〖CO〗2 carbonates, composition of absorbed bases, and degree of salinity (Khusanov et al., 2002).

Copper. The main sources of copper in biogeocenoses are bedrock. In the studied soils, the available copper content mainly ranges in low numbers – from 0.30 to 0.50 mg/kg, but sometimes ranges from 0.70 to 1.27 mg/kg (Table 2).

Zinc. The availability of zinc to plants is mainly determined by the pH of the soil solution. The results of determining the content of available forms of zinc indicate a suspended content in the upper humus horizons and a gradual decrease in the depth of the profile. However, it should be noted that when studying the composition of trace elements, we studied only the arable and sub-arable horizons of the soil profile. In the studied soils, the content of available zinc in all variants of the experiment ranges from 3.30 to 5.30 mg/kg.

Manganese. It is known that manganese promotes the synthesis of carbohydrates, affects the colloidal chemical properties of plasma, the content of bound water, increases the intensity of photosynthesis, is a catalyst for the activity of enzymes, vitamins, and plays an important role in the processes of protein synthesis in the body. The content of available manganese in the studied soils is insufficient. In the upper horizons, in all variants under different crops, in the first phase -29.0 to 31.0 mg/kg, and in the second phase (budding) ranges between 24.4 and 31.3 mg/kg.

In connection with the above, the use of manganese micro fertilizers on the studied soils is promising. Thus, the soils formed on alluvial deposits differ somewhat in the content of mobile Zn, Mn, Cu from meadow soils of a gray-earth oasis, depending on the climate of humus content and degree of cultivation. The microelement composition, the nature of their distribution along the soil profile under the influence of electrical treatment changes markedly.

The work of microorganisms is able to continuously raise the potential fertility of the soil. Human activity can transform the potential wealth of the soil into actual fertility and realize it in the form of a high yield. The biochemical processes occurring in the soil are crucial in creating soil fertility. These processes are carried out under the influence of a variety of numerous enzymes produced by soil microorganisms, microfauna and higher plants. The result of their pathological activity is both the transformation of complex organic substances into a mineral form accessible to plants, and the synthesis of new high-molecular compounds, also necessary for normal plant growth and development.

Data on the total number of microorganisms are presented in Table 3, for the main physiological groups of microorganisms in tables 4, 5. We studied the dynamics of the development of soil microflora under the influence of electrical treatment and without electrical treatment under various crops. Electrotreatment has different effects on the microbiological activity of soils under different crops. Thus, electrical treatment had a positive effect and increased the total number of microorganisms in the rhizosphere of cotton at all stages of the growing season.

Table 1: The effect of electrical treatment on the total number of soil microorganisms 1000/1g of soil.

№	Experience options	Depth, cm	The phase of the growing season		
			June	July	August
1	Cotton-control	0-30	53475	40290	43425
2	With electrical processing	0-30	114925	80143	73515
3	Sunflower control	0-30	64065	60990	27225
4	With electrical processing	0-30	40320	40743	79890
5	Sesame control	0-30	33675	72885	33039
6	With electrical processing	0-30	71055	34101	26685
7	Millet control	0-30	72735	35145	44910
8	With electrical processing	0-30	36795	94713	49950
9	Corn control	0-30	12825	15750	24210
10	With electrical processing	0-30	19185	105060	35355

Table 2: The effect of electrical treatment on the amount of soil ammonifying bacteria 1000/1g of soil.

№	Experience options	Depth, cm	The phase of the growing season		
			June	July	August
1	Cotton-control	0-30	51000	39000	42000
2	With electrical processing	0-30	112500	79500	72000
3	Sunflower control	0-30	63000	60000	25500
4	With electrical processing	0-30	39000	39000	78000
5	Sesame control	0-30	31500	72000	31500
6	With electrical processing	0-30	69000	33000	24000
7	Millet control	0-30	72000	34500	43500
8	With electrical processing	0-30	33000	93000	48000
9	Corn control	0-30	12000	15000	22500
10	With electrical processing	0-30	18000	99000	33000

Table 3: The effect of electrical treatment on the number of soil oligonitrophils 1000/1g of soil.

	Experience options	Depth, cm	The phase of the growing season		
			June	July	August
1	Cotton-control	0-30	2460	1185	1275
2	With electrical processing	0-30	2895	1200	1350
3	Sunflower control	0-30	1050	900	1650
4	With electrical processing	0-30	1290	1680	1740
5	Sesame control	0-30	2160	810	1470
6	With electrical processing	0-30	2025	1080	2550
7	Millet control	0-30	720	600	1320
8	With electrical processing	0-30	3780	1695	1800
9	Corn control	0-30	810	675	1530
10	With electrical processing	0-30	1155	6000	2145

Electrical treatment did not have a significant effect on the total number of microorganisms at the beginning of the growing season for sunflower and millet. And in the middle of the growing season, under sesame culture, electrical treatment did not affect the total number of microorganisms, the best options were corn with and without electrical treatment. From the data obtained, it was revealed that electrical technology had a beneficial effect on the dynamics of microorganisms.

Table 4 presents data on the effect of electrical treatment on the amount of ammonifying bacteria in the soil under the rhizosphere of different crops. From the presented data, it can be seen that cotton and corn turned out to be the best options in terms of the number of bacteria: at the beginning of the growing season under the rhizosphere of cotton-51000 thousand /1 g of soil in the control variant, 114925 thousand/1 g of soil with electrical treatment. However, it should be noted that at the beginning of the growing season, in the phase of 3-4 real leaves and in the budding phase, electrical treatment had a somewhat weak effect on the number of ammonifiers in the direction of their decrease in the rhizosphere of sunflower, millet and sesame. For example, 64065 thousand / 1 g of sunflower soil in the control version 40320 thousand / 1 g of soil in the version with electrical treatment.

The content of micromycetes increases in experimental variants under all studied crops throughout the vegetation of plants. Electrical processing had a significant positive effect on increasing the number of fungi in the rhizosphere of cotton, sunflower, millet and corn. For example, under the rhizosphere of cotton in the control variant, 75 thousand / 1 g of soil, and in the variant with electrical treatment-80 thousand/ 1 g of soil, under sunflower-45 thousand/ 1 g of soil –control, 60 thousand/1 g of soil – with treatment, 30 thousand/1 g of soil in the millet variant – in control, 45 thousand /1g of soil with treatment. In the control variant and with electrical treatment, the number of them is equal under the corn crop – 30 thousand / 1g of soil.

Table 4: The effect of electrical treatment on the number of micromycetes (fungi) of soils of the RCC Research Institute, 2005, 1000/1g of soil

№	Experience options	Depth, cm	The phase of the growing season		
			June	July	August
1	Cotton-control	0-30	15	75	120
2	With electrical processing	0-30	45	80	135
3	Sunflower control	0-30	15	45	45
4	With electrical processing	0-30	30	60	105
5	Sesame control	0-30	15	15	60
6	With electrical processing	0-30	30	6	75
7	Millet control	0-30	15	30	75
8	With electrical processing	0-30	15	45	120
9	Corn control	0-30	15	30	135
10	With electrical processing	0-30	30	30	150

Electrical treatment had a different effect on the development of alligonitrophils. In the rhizosphere of cotton, sunflower, millet and corn during their growing season. The number of olligonitrophils increased under the influence of electrical treatment in the sesame rhizosphere, a decrease in the number of olligonitrophils was observed at the beginning of the growing season and an increase in the middle and end of the growing season (Table 4).

Thus, the study of the quantitative distribution of microorganisms in the studied soils showed the dependence of the number of different physiological groups within the same soil type on the content of organic matter (humus), the degree of salinity and vegetation. Changes in soil conditions significantly affect the ordinary composition of microorganisms, but do not affect the presence of a particular physiological group.

In this regard, the dynamics of soil microflora with different degrees of water availability under various agricultural crops (cotton, sunflower, millet, corn and sesame) has been studied.

Table 2,3,4 shows the results characterizing the microbiological activity of soils under different crops with different degrees of water availability.

During the research, the influence of the anthropogenic factor of electrical treatment and various degrees of water availability on stimulation, suppression or indifference to soil and plant microorganisms was studied.

Electrotreatment has different effects on the microbiological activity of soils under different crops with different degrees of water availability.

The conducted research allows us to conclude that, in general, electrotreatment of soil, seeds and vegetative organs of agricultural crops grown in saline soils with varying degrees of water availability has a positive effect on microbiological activity, on the rhizosphere of various crops, even with moisture deficiency (Khusanov et al., n.d).

4 CONCLUSIONS

The use of differentiated irrigation regimes in combination with electrical technology contributed to an increase in crop yields by 1.5-2.0 kg/ha and saving irrigation water by 10-15%.

It was found that the effect of electrical treatment of seeds and vegetative organs of plants provided an increase in the yield of the tested crops. For example, under the influence of electrical treatment, the yield of cotton increased by 3-12%; sunflower by 4-14%; corn by 6-15%; sesame by 10%, millet by 3-12%. The optimal result for all agricultural crops was obtained with a 50-60% degree of water availability.

It was revealed that the electrical effect on the "seed, soil, plant" system has a positive effect on the content of assimilable forms of nitrogen, phosphorus, potassium and trace elements in the soil, which contributes to the creation of a favorable plant nutrition regime.

The electrical effect had a positive effect on the microflora of the rhizosphere of cotton, increasing the content of beneficial and reducing the number of harmful microorganisms in the soil, improved the phytosanitary condition of the soil by reducing microscopic mold fungi and increasing the number of actinomycetes.

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