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COMPARATIVE STUDIES OF POTATO FERTILITY AND SOIL ELECTRICAL CONDUCTIVITY AFTER PLANTS SEPARATE AND IN COMBINATION FERTILIZATION WITH ZEOLITE, ZEOKARBOFOS AND BIOHUMUS

Introduction

Currently there are many studies about fertilization of organic-mineral plants in the scientific literature. Crops fertilization enables to restore soil fertility, grow plants with necessary nutrients and get rich harvest with high quality. It also provides maximum economic productivity and low cost harvest price, which includes many components, the most important thing, and the cost price of used fertilizer. It is quite understandable that natural raw materials are of great concern to us [1]. In this regard zeolites rank high in our country.

Researches of zeolites usage in agriculture began in the second half of the last century. Soil conditions are getting better after soil fertilization with zeolites stimulating ion exchange, increasing the quantity of phosphorus and potassium exchanged in the soil, contributing nutrients preservation, and preventing their flushing from the soil layer around the root. Zeolites affect the cation exchange and absorbing complex, increase exchanging potassium content, and also exchanging capacity of Ca, K, Na and other ions. There are data showing that it is possible to increase zeolite agricultural value and vital function by applying organic waste and minerals to the soil with zeolites. Zeolites are heavy metal removing ameliorants from the soil. According to this grounding zeolites are important raw materials in agriculture and serious studies are under way in this direction in the world, including the Republic of Armenia [2-6].

According to scientific data, the quantity of mobile ions in soil changes after fertilizing with organic and mineral fertilizers. It also changes in seasons [7].

Theoretical arguments of results obtained by experimental research always are of perspective significance. It also refers to the soil free ions that affect the soil specific electrical conductivity, which is changed by soil fertilizing.

Water-soluble compounds in soil are important for normal growth of plants [8], their chemical composition and density (concentration) decide properties of soil

solution as an specific electrical conductance. The more soluble chemicals (active forms), the greater specific electrical conductivity of soil and its water solution. This indicator gives an additional information about soil pollution and salinity, which directly affect the soil fertility [8, 9].

Specific electrical conductivity is a function of a variety of factors and an important complex indicator of soil physical, mechanical and technical properties, structure and absorbing complex. It directly or indirectly affects soil fertility and crop yield, quantity, quality and efficiency of a variety of natural landscapes. However, these issues are relatively scarce in the scientific literature, which allows to assert that studies about soil specific electrical conductivity are topical and useful and will have a theoretical and practical significance, since there are many undiscovered problems and our goal was to study some of them. We have studied the soil specific electrical conductivity after plants fertilization with zeolites, zeokarbofos and biohumus, aiming at revealing the connection of specific electrical conductivity and fertilization. The studies with these bases are extremely urgent [10] that requires continuous and deep variety scientific research. It should be noted that few data are available in the literature. In this regard, we have tried to find out zeokarbofos, zeolite and biohumus separate and combined fertilization effect on the soil, soil pH, specific conductivity of soil, and water extract, on the quantity and marketability of potato yield.

The fertilizers used for studies are not expensive raw materials. There is no difficulty in organizing their production in the Republic of Armenia, since we have practically unlimited zeolite resources, as well as manure, straw and worms for biohumus production. Production of used fertilizers is based on the local raw materials. “Parart” Ltd in Tavush region of Armenia produces zeokarbofos fertilizer. The ingredients per percentage is the following: N-16 (without nitrates), P-16, Fe_2O_3-0.74, Al_2O_3-5.84, Ca-2.74, MgO-0.64, SO_3-0.05, Na, K, Ti oxides. This fertilizer contains around 20 microelements necessary for the plants. Natural zeolites are ground to produce zeolite raw material, then mixed with nitrogen and phosphorus mineral raw material to get zeokarbofos [3]. “Parart” Ltd in 2013 exported to Russia hundreds of tons of zeokarbofos, introduction of which goes very slowly in agriculture of Armenia.

Biohumus has a great usage in Armenia and today it is widely used for crop fertilization providing high-quality rich harvest. In Lori region we have done some work on development of methods and production of biohumus and use it for fertilization of crops (potato). We received noteworthy results, defined fertilization doses for biohumus, suggested to introduce it in agriculture, but farmers do not pay due attention to it.

1. Material and methods

Studies have been carried out on the black soil in Darpas rural community of Gugark region in Lori, in waterless conditions. Experiments have been carried out in six alternates and three times on experimental patches of 34 m^2. We have taken

raw material used for fertilization from Ayrum "Parart" Ltd, biohumus - from Jrvezh, where biohumus is produced.

Natural zeolites are part of the group of biological and ecological safety minerals. The main elements of those ingredients (in the ion form) are Na^+, K^+, Ca^{2+}, B^{2+}, Si^{2+}, Mg^{2+}.

In Lori region we have also studied fertilization problems of zeokarbofos, zeolite and biohumus - separate and in combination, on the "Impala" kind example, the results of which were published in [3]. Taking into account a number of advantages of German "Impala" kind, we repeat the experiment with that kind including the soil electrical conductivity problems. The specific electrical conductivity data have been presented by coauthors in conferences.

Fertilization was made by drill sowing fertilizing method. We directly filled fertilizers on the seed tubers in tuber planting, and then covered with soil. Plant fertilization norm by alternates is the following: biohumus - 10 g, zeolite and zeokarbofos - 6 g, each. Plant nutrition surface is 70 x 25 cm (80000 plants per hectare). Plants care and cultivation was done by potato cultivating technology accepted in the region - tillage, preparation of experimental patches, sowing and planting tubers, weed-tillage and twice earthing up. This work was done by hand.

To determine soil mixture's specific electrical conductivity 1 hectare of topsoil mass was defined. Average soil sample was separated from experimental patches and electrochemical studies were performed by alternates in laboratory conditions. 300 grams of pure soil and karbofos, zeolite, biohumus in appropriate quantity were added to soil sample. We were dried these samples in room conditions, out of direct sun rays until it became air-dried substance, then crumbled soil clods in faience mortar and sifted by sieve of 2 mm. We weighed 200 grams of soil mixture of sifted mass, filled into the tub made of dielectric material, smoothing the surface with palette knife. Distilled water was added to all samples to get 30-percentage moisture compared with soil. After five minutes, when the soil became wet, soil specific electrical conductivity was determined.

Determination of the soil specific resistance was done by four symmetrically aligned electrodes. Soil specific resistance was determined by the following formula:

$$\rho = K\frac{\Delta U}{I}$$

where:

ΔU - is the difference of potentials between the electrodes,

I - is the current value of supplying electrode chain,

K - is a factor calculated by the following equation:

$$K = 2\pi\frac{l_1 l_3 (l_1 + l_2)(l_2 + l_3)}{l_2\left[(l_1 + l_2)l_1 + l_3(l_2 + l_3)\right]}$$

where I_1, I_2, I_3 are the distances between electrodes [cm].

The opposite value of soil samples specific resistance is the index of specific electrical conductivity determined by the following formula:

$$\chi = \frac{1}{\rho}$$

Specific electrical conductivity of the soil sample was determined in water extracts in laboratory conditions.

2. Research results

Fertility of potato, specific electrical conductivity of soil samples and water extracts during our studies have been determined (Table 1).

TABLE 1

Alternates of potato fertilization, fertilizer doses, values of soil pH, conductivity of soil samples, water extract, and potato yield (2011-2012, Darpas village)

	Fertilization background	The norm of drill sowing fertilization [kg/ha]	Fertility [C/ha]	Tuber marketability [%]		Soil mixture		
				Marketable	Non--marketable	Electrical conductivity [mSm/cm]	Water extract	
							pH	Electrical conductivity [mSm/cm]
1	Zeokarbofos	480	415±3.2	93.8	6.2	0.85	7.57	1.67
2	Zeokarbofos + biohumus	480+800	450±2.7	96.6	3.4	1.16	7.25	2.57
3	Zeolite	480	398±2.1	93.2	6.8	0.41	7.92	0.43
4	Zeolite + bio-humus	480+800	410±3.2	94.4	5.6	0.33	8.06	0.27
5	Biohumus	800	390±2.6	91.2	8.8	0.38	7.94	0.37
6	Soil (test)	–	310±2.4	92.6	7.4	0.36	8.00	0.30

The tabulated data show that in all fertilization alternates obtained a high yield compared with the test soil, which is 80 for 140 C/ha. Tubers marketability also is high, except for one alternate. The highest yield was obtained from alternates, when plants fertilized with biohumus and zeokarbofos in combination (450 C/ha) and with zeokarbofos (415 C/ha). Tubers marketability is also high in these alternates. Interesting data have been obtained by indices of soil mixture specific electrical conductivity. The highest indices have been recorded in case of zeokarbofos plus biohumus (1.16), next were zeokarbofos alternates (0.85). It is lower in zeolite + biohumus alternate, which is even less than the 0.03-point from the test alternate. Hydrogen ion density variations are not large. This index for all alternates, except zeolite + biohumus one is lower than test alternate. The high result has been obtained

in zeokarbofos + biohumus (2.57) and zeokarbofos alternates by indices of soil mixture's extract solution. The index in case of fertilization of plants with zeolite and biohumus is 0.03% lower than test one.

It is clear from comparative analysis of the data that soil mixture specific electrical conductivity increases after soil fertilization with zeokarbofos and biohumus in combination and only with zeokarbofos. That is the result of increasing of nutritient free ions necessary for plant nutritiousness in soil, which penetrate into the plant providing a higher yield.

The study came to the following conclusions:

- Potato yield is 22-45 percent higher than the test alternate for all fertilization backgrounds. The harvest is the highest when plant fertilization is carried out with zeokarbofos and biohumus (450 C/ha).
- Specific electrical conductivity of soil mixture and water extract changed after applying zeokarbofos, zeolite and biohumus to the soil - separately and in combination. It is high in plant backgrounds fertilized with zeokarbofos and biohumus in combination and only in case of fertilization with zeokarbofos.
- There is a direct connection between potato fertility and soil specific electrical conductivity indices.

Proposals

- Potato drill sowing fertilization with zeokarbofos and biohumus in combination should be introduced into the agriculture of Lori region using 480 kg of karbofos and 800 kg of biohumus per hectare.
- It is necessary to take into account specific electrical conductivities of soil and its water extract for evaluation soil fertility.

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Abstract

We have studied the impact of potato drill sowing fertilization with zeokarbofos, zeolite and biohumus, both separately and in combination, on the soil conductivity and potato yield. It has been found out that fertility increases by 80÷140 g/ha compared with test one in all backgrounds. The highest yield has been received after applying zeokarbofos and biohumus to the soil in combination. Used fertilizers have increased soil specific electrical conductivity, which positively affects the plant fertility. We suggest to introduce the obtained results in agriculture and to take into account soil specific conductivity during soil fertility evaluation.

Изучение электропроводности почвы и урожайности картофеля, удобряя растения совместно и отдельно цеолитом, цеокарбофосом и биогумусом

Резюме

Статья посвящена изучению урожайности картофеля и электропроводности почвы, удобряя растения цеолитом, цеокарбофосом и биогумусом в отдельности и совместно. Исследования показали, что применение удобрений обеспечивает урожайность в пределах 80-140 ц/га относительно контроля. Самая высокая урожайность получается при сочетании цеокарбофоса и биогумуса (450 ц/га). Принимаемые удобрения положительно влияют на повышение электропроводностьи почвы, вследствии чего повышается урожайность растений. Изучение электропроводности почвы относится к числу малоизученных проблем. Проведенные опыты могут быть использованы в сельском хозяйстве.