

INFLUENCE OF COORDINATION COMPOUNDS OF MICROELEMENTS ON COTTON PRODUCTIVITY

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The article presents the data of field experience which show that the increase of the yield of raw cotton when using the coordination compounds of microelements of cobalt and copper on the optimal nutritional background – N250 P175 K125 increases by 4.5 and 5.8 c / ha, respectively, relative to the cotton crop, grown without microelements, and by 2.8 and 3.2 c / ha in the variants with the use of inorganic salts. Also, research has found that the use of coordination compounds of microelements has a positive effect on the course of physiological and biochemical processes and the yield of various cotton varieties. It is noted that the increase of the yield obtained from the introduction of coordination compounds of trace elements, an average in three years increase of yield was from 12.4 to 17.7%, compared with the control. Coordination compounds Co-31, Co-34 and Cu-12 significantly improve the technological properties of the fiber and increase the oil content of the nucleus' seeds. Thus, the greatest increase of cotton yield is observed in the variants with the coordination compound of cobalt – 5.8 q / ha; the share of the first harvest of raw cotton in the variant is 74.6%, i.e. by 12.3% more than in the control variant, and in the variant with the coordination compound of copper is 4.3 centners per hectare, compared to the control. The share of the first harvest in these conditions increases by 8.3-12.9% compared with the control options and 1.5-2 to 2 times more than in the variant with the addition of inorganic cobalt and copper salts to the cotton. The coordination compounds of microelements in combination with the optimal norms of mineral fertilizers improve the technological properties of the fiber and increase the oil content of seeds more than their inorganic compounds.

Keywords: microelements, growth, development, variety, cotton, fruit trees, copper, cobalt

An important factor of increasing of raw cotton's production, along with the introduction of advanced methods of cotton cultivation technology, the use of new high-yielding varieties is the rational and effective use of mineral and organic fertilizers [1].

As is known, trace elements are found in plants in small quantities. However, the lack, like the excess of many trace elements, causes adverse consequences for the growth and productivity of plants, which affects the provision of human and animal nutrition of a certain qualitative composition. In this regard, the problem of supplying plants with microelements is increasingly acquiring a general biological significance [1].

When studying the effect of two biological products RIZOKOM-1 and SERHOSIL on the content of trace elements such as zinc, copper and arsenic in cotton plants and saline soils, the researchers noted that the content of these elements was not within the normal range and toxic effects on plants were not detected. The use of these biologics contributed to the improvement under the action of the state of saline soils under cotton, which had a positive impact on the yield of raw cotton, an increase of 13.4 centners per hectare compared with traditional cotton sowing [2].

Studying, using the method of neutron-activation analysis, the content of 6 macro- and microelements in medicinal plant raw materials was determined. It was determined that the content of macronutrients in all pro-

posed plants is comparable. The content of trace elements allows to select more promising species [3].

Studies with the use of trace elements in the composition of mineral fertilizers for cotton show low efficiency of inorganic salts of trace elements in carbonate soils of cotton areas of the Republic of Uzbekistan. It is connected with the fact that inorganic salts of microelements in the soil are transformed into insoluble forms that are inaccessible to plants [4, 5].

In recent years, as is well known, much attention has been paid to intracomplex coordination compounds of microelements called complex or chelates.

Some researchers have considered the role of trace elements in plant life and highlighted theoretical and practical issues regarding the use of complex micronutrients on crops, rice, which provide increase yields, seed quality and grain. Metal complexonates, used as micronutrients, are effective form of microelements by regulating the production process of agricultural crops, both when treating seeds before sowing and when conducting non-root dressings of vegetative plants. Their inclusion in the rice fertilizer system allows to balance the mineral nutrition necessary for plant life, which provides increase of yield, seed quality and grain [6].

According to many researchers, complex microelement compounds accelerate growth, development, increase the yield of cotton and other crops more than their inorganic salts.

In addition, entering to the plant, coordination compounds of microelements exhibit great biological activity, remain in soil solution in a form accessible to plants for a long time, have high resistance to microbiological cleavage and are not deposited in an alkaline environment, which determines the high efficiency of their application under crops [7].

Purpose of the study

In recent years, the agrochemistry of plant nutrition with microelements and the practice of their application in agriculture have paid much attention to intracomplex compounds of microelements. The aim of the study is identifying ways to increase the yield of the cotton varieties, which we study, by using the coordination compounds of microelements. Especially, the effectiveness of the using of trace elements of copper and cobalt for cotton has not been studied enough [5, 6].

The limited information about the effectiveness of microelement coordination compounds in increasing cotton productivity determined the direction of our research.

Materials and research methods

The influence of coordination compounds of trace elements copper and cobalt on the growth and development of cotton varieties Namangan-34, S-6524, Bukhara-102 and Omad was investigated in field conditions. Field experiments were conducted in the experimental area of the Uzbek Research Institute of Cotton.

The dependence of cotton yield on the application of inorganic salts and coordination compounds of microelements on typical sierozem has been studied in field conditions. The initial content in the soil of the arable layer of field experiments of humus, gross nitrogen, phosphorus and potassium was 1.10; 0.09; 0.11 and 2.3%. The humus content and the gross amount of nutrients are reduced in the subsoil horizon of the soil. The initial content of nitrates in the soil is 20.4 – 21.2 mg / kg of soil. Available phosphorus in soil, soluble in ammonium carbonate, was 22.3–23.2 mg / kg in arable and 11.3–11.9 mg / kg in subarable horizons, exchange potassium, respectively, 190–201 and 130 –134 mg / kg of soil.

The content of conditionally digestible forms of microelements averaged: cobalt 0.12–0.14; copper 0.30–0.34 mg / kg and, therefore, the soil of the experimental plots belongs to the low-provided by these trace elements soils. Field experiments were located in 2 tiers, with eight-row strips, where 4 middle rows were used to account for growth and development, to conduct

agrochemical studies, and 2 extreme rows as defensive measures. The plot area is 67.2 m² (14.4 and 4.8 m). The repetition of the experiment is fourfold. The layout of plants 60x15-1 with a thickness of 105-110 thousand. Before sowing, cotton seeds were soaked with an aqueous solution of inorganic, as well as coordination compounds of microelements with subsequent addition to the budding phase of ammophos or superphosphate at a depth of 14-16 cm.

From a large number of coordination compounds of microelements by the two-three-year field tests, the following are most effective for the growth, development and yield of the cotton: Co-31 – cobalt trismethioninate – Co (C 15 H16 N3S3O9) with a cobalt content of 14%; Cu-12 – bis-glutaminatocuproat tetrahydrate [Cu (C5H7O4N) 2] · 4H2O with a copper content of 13.2% and Co-34 bis (glutamine cobalt) cobalt (II) Co [Cu (gluta-2H2)] · 4H2O with cobalt content of 11 %, copper 13%.

Research results and discussion

Researchers have found that the absorption of microelements of copper, molybdenum, and especially zinc by *Artemisia leucodes* Schrenk and *SOPHORA JAPONICA* L ...is increased at combined using of nitrogen, phosphorus, potassium and half-dead manure.

Thus, to obtain sustainable yields with high quality raw cotton, the use of trace elements is becoming increasingly important along with balanced nitrogen-potassium and phosphate nutrition. So, they play an important role in the metabolism of plants, their lack can lead to significant disturbances in growth and development, decreasing of yield and a deterioration of product quality.

The long-term results of scientific research and the practice of using trace elements in the composition of mineral fertilizers for cotton show the low effectiveness of inorganic salts of trace elements in the carbonate soils of cotton regions of Central Asia. This is due to the fact that with the introduction of inorganic salts of microelements in the soil are transformed into insoluble, inaccessible to plant forms [7].

We have established that the use of coordination compounds of trace elements of cobalt and copper by setting seeds at 0.3% in their solutions and the subsequent application of 6.0–8.0 kg / ha increases the productivity (biomass) of wormwood on average 3, 2-2.0 q / ha in two years.

The results of research have shown that the use of coordination compounds of trace elements have a positive effect on the course of physiological and biochemical processes and the yield of various cotton varieties.

Table 1
Removal and consumption of copper, cobalt (g/ha), nitrogen and phosphorus (kg/ha) at application of their inorganic and organic compositions

Option of experiment	Copper		Cobalt		Nitrogen		Phosphorus	
	Removal 1 ha	Consumption on 1t of raw cotton	Removal 1 ha	Consumption on 1t of raw cotton	Removal 1 ha	Consumption on 1t of raw cotton	Removal 1 ha	Consumption on 1t of raw cotton
Control (without microelements)	49,99 ± 2,74	13,96 ± 0,31	6,59 ± 0,38	1,84 ± 0,11	184,7 ± 0,17	51,16 ± 0,10	60,7 ± 2,4	16,80 ± 0,11
CoSO ₄ (inorganic compositions)	52,31 ± 3,12	13,52 ± 0,11	7,64 ± 0,41	1,97 ± 0,08	201,3 ± 0,14	51,22 ± 0,09	65,5 ± 2,2	16,67 ± 0,18
CuSO ₄ (inorganic compositions)	55,15 ± 2,86	14,40 ± 0,10	7,13 ± 0,39	1,86 ± 0,07	199,7 ± 0,11	51,34 ± 0,12	66,2 ± 2,7	17,02 ± 0,017
Co-31 (coordination compositions)	57,67 ± 2,36	13,70 ± 0,17	8,45 ± 0,10	2,01 ± 0,06	230,0 ± 1,86	54,89 ± 1,78	72,6 ± 0,08	17,33 ± 0,19
Co-34(coordination compositions)	62,77 ± 1,98	15,20 ± 0,47	8,56 ± 0,12	2,07 ± 0,05	238,7 ± 1,75	57,80 ± 0,32	72,2 ± 0,07	17,48 ± 0,72
Cu-12(coordination compositions)	62,84 ± 2,88	15,75 ± 0,11	7,52 ± 0,20	1,88 ± 0,18	232,0 ± 1,67	56,76 ± 0,29	69,990,09 ±	17,11 ± 0,09

It is noted that the difference in the yield increase, obtained by making the coordination compounds of microelements, depending on the varietal characteristics of cotton, is not significant. On average, over three years, the yield increase was between 12.4 and 17.7% compared to the control.

According to the research results, it was established that the content of copper and cobalt in the tissues of the cotton organs does not differ significantly when introducing inorganic salts and coordination compounds of these trace elements. With the introduction of cobalt alone, the copper content in the tissues of the plant organs in the variant with the introduction of copper. In terms of cobalt and copper content, when they are introduced in the form of inorganic salts, the options differ slightly, and when cotton is grown using coordination compounds, they are marked to a greater increase in the organs of cotton.

The removal of copper and cobalt by a single plant when these batteries are introduced in the form of coordination compounds exceeds the indicator in the variant with the use of their inorganic compounds (Table 1).

It confirms the opinion that the coordination compounds of microelements are less fixed in the soil than their inorganic salts again. The total removal of copper and cobalt by plants with the addition of their coordination compounds is 57.6 and 62.8 g / ha, respectively, while in the control (with the addition of inorganic salts) it is 52.3 – 55.1. Currently, it is established that copper, manganese, zinc, cobalt, boron and other trace elements increase the activity of many enzymes and enzyme systems, redox processes, are involved in photosynthesis, carbohydrate and protein metabolism and other biological processes. Enzymes can form with microelements various metal-organic and intracomplex compounds. The effect of individual microelements on growth processes, fruiting and the quality of agricultural products, including cotton, has been widely studied.

Studies have established that the height increase of the main stem of cotton varies considerably depending on the use of inorganic and coordination compounds of microelements. On variants (by 5.VI) of inorganic salts of cobalt and copper, the length of the stem increases by 1.8–2.3 cm, while their coordination compounds – by 2.5–6.0 cm relative to control plants (without trace elements). Coordination compounds of microelements (cobalt and copper) increase the growth of the main stem to a greater extent than their inorganic salts.

According to the research results, it was established that the content of copper and cobalt

in the tissues of the cotton organs does not differ significantly when the inorganic salts of the coordination compounds of these trace elements are introduced. When only cobalt is introduced, the copper content in the tissues of the plant organs is higher than in the organs of the control plants, but lower than that of the plants in the variant with the addition of copper. The content of cobalt and copper when they are introduced in the form of inorganic salts varies slightly, and when growing cotton using coordination compounds, there is a tendency for their large increase in the organs of cotton.

The introduction of trace elements in the composition of ammophos has a positive effect on the fruiting of cotton. Inorganic salts of cobalt and copper increase the formation of ovaries and 5.VIII by 0.6 – 0.8 and their coordination compounds by 1.3 – 1.8. The number of fully formed bolls is more formed in the variants using the coordination compounds of microelements – 13.2; 13.0 and 12.5 pieces per plant versus 10.6 pieces in the control. When using inorganic salts (option 2 and 3), the number of boxes was 11.4 and 11.2 pieces. Inorganic cobalt salts increase the yield of raw cotton by 3.2 centners per hectare on average over 3 years, and copper sulphate increases by 2.8 centners per hectare. At the same time, an increase in the yield of first-stage raw cotton in the variant with cobalt sulphate by 6.2 and copper sulphate is 5.8% higher compared to the control (without trace elements).

The greatest increase of cotton yields is observed in the variants with a cobalt coordination compound of -5.8 c / ha; the share of the first harvest of raw cotton in the variant is 74.6%, i.e. by 12.3% more than in the control variant, and in the variant with the coordination compound of copper is 4.3 centners per hectare compared to the control. The share of the first harvest in these conditions increases by 8.3-12.9% compared with the control options and 1.5-2 to 2 times more than in the variant with the addition of inorganic cobalt and copper salts to the cotton.

The use of inorganic salts of microelements for cotton increases the fiber length by 0.1-0.3 mm, the breaking load is 0.2-0.4 gf / tex, and the weight of 1000 seeds is 0.5-1.2 g relative to to control. At the same time, an increase in the oil content of the seed kernel is observed as compared with the variant without trace elements. Coordination compounds of microelements increase the fiber length by 0.4–0.6 mm, the relative breaking load by 0.6–0.9 g / tex and the weight of 1000 seeds by 1.2–2.7 g compared to the control (Table 2).

Table 2
Cotton yield at application of inorganic salts and coordination compositions of microelements on the optimal background of mineral nutrition (Field experiment 2009-2010 y.)

№	Option of experiment	Annual rate of fertilizer, kg/ha			Concentration of the solution for seed lock before sowing, %	Feed by microelements kg/ha	Raw cotton crop, c/ha		
		N	P	K			3 years average	Increase to control	The first harvest i average %
1	Control (without microelements)	250	175	125	-	-	36,1 ± 1,9	-	60,9 ± 2,7
2	CoSO ₄ (inorganic compositions)	250	175	125	0,03	2,0	39,3 ± 0,8	3,2 ± 0,2	67,1 ± 1,3
3	CuSO ₄ (inorganic compositions)	250	175	125	0,03	2,0	38,9 ± 0,7	2,8 ± 0,3	66,7 ± 1,4
4	Co-31 (coordination compositions)	250	175	125	0,03	0,8	41,9 ± 0,3	5,8 ± 0,6	74,6 ± 0,6
5	Co-34(coordination compositions)	250	175	125	0,02	0,6	41,3 ± 0,5	5,2 ± 0,4	73,8 ± 0,7
6	Cu-12(coordination compositions)	250	175	125	0,03	0,8	40,9 ± 0,4	4,8 ± 0,3	69,2 ± 1,6

Thus, coordination compounds of microelements in combination with optimal norms of mineral fertilizers improve the technological properties of the fiber and increase the oil content of seeds more than inorganic compounds.

Studies have established that growing cotton using inorganic salts, the content of gross nitrogen in leaves and stems increases to 0.1 and 0.4%, respectively, in leaflets and raw cotton, to 0.1 and 0.8%. There is a tendency for a larger increase in gross nitrogen when the coordination compounds of trace elements are introduced, especially cobalt. When using inorganic salts and coordination compounds of trace elements on the content of phosphorus in the organs of cotton there is a similar pattern.

As one would expect, the greatest removal of nitrogen and phosphorus occurs in raw cotton than other cotton organs, but also in their total removal.

The results of research also found that the content of cobalt and copper in plant organs when they are introduced in the form of inorganic salts is, respectively, from 3.1 to 7.2 and from 0.34 to 1.37, and coordination compounds from 3.4 to 3.3 and from 0.41 to 1.47 mg / kg of dry matter versus from 3.9 to 6.7 and from 0.25 to 1.28 mg / kg in the control. It confirms that the coordination compounds of trace elements are less fixed in the soil than their inorganic salts again. The total removal of copper and cobalt by the plant when the coordination compounds of these elements are introduced is 57.6-32.8 and 7.5-8.6 g per hectare, and when inorganic salts are introduced, 52.3- 56.1 and 7.1 - 7.6 g hectare, where as in the control 50.0 and 6.6 g.

Conclusions

In this way, the using of coordination compounds of microelements of cobalt and copper

compared with their inorganic salts by locking seeds and adding ammophos in the cotton budding phase enhances growth processes, fruiting, improving the technological properties of the fiber and increasing the yield of raw cotton. The increase of the yield of raw cotton with the use of coordination compounds of trace elements of cobalt and copper on an optimal nutritional background –N250 P175 K125 increases by 4.5 and 5.8 c / ha, respectively, relative to the yield of cotton grown without microelements, and by 2.8 and 3.2 centners / ha in the variants with the use of inorganic salts of these microelements.

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