

Influence of coordination compounds of microelements on cotton productivity in Uzbekistan

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Abstract. The article presents the data of field experience which show that the increase in the yield of raw cotton when using the coordination compounds of trace elements of cobalt and copper on the optimal nutritional background $-N_{250} P_{175} K_{125}$ increases by 4.5 and 5.8 quintals (q)/ha, respectively, relative to the cotton crop, grown without trace elements, and by 2.8 and 3.2 q/ha in the variants with the use of inorganic salts. Also, the results of research have established that the use of coordination compounds of trace elements 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 in yield obtained from the introduction of coordination compounds of trace elements, an average of three years of yield increase 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 seeds of the nucleus. Thus, the greatest increase in cotton yield is observed in the variants with the coordination compound of cobalt -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 c/ha per hectare compared to the control.

1 Introduction

An important factor in increasing the production of raw cotton along with the introduction of progressive methods of cotton cultivation technology, the use of new high-yielding varieties is the rational and effective use of mineral and organic fertilizers [1-4]. As known, trace elements are found in plants in small amounts. However, the deficiency, as well as the excess of many microelements, causes unfavorable consequences for the growth and productivity of plants, which affects the provision of humans and animals with adequate nutrition of a certain qualitative composition. In this regard, the problem of supplying plants with microelements is increasingly acquiring general biological significance [1, 5-7].

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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 within the normal range and no toxic effect on plants was found. The use of these biological products contributed to the improvement under the influence of the state of saline soils under cotton, which had a positive effect on the yield of raw cotton, the increase was 13.4 q/ha compared to the traditional sowing of cotton [2, 3].

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 the proposed plants is comparable. The content of trace elements makes it possible to identify more promising species [3, 6].

At the same time, it is necessary to pay attention to the regulation of the use of microelements, since in high concentrations in soils and plants, they can harm human health through consumed products [4, 10-12].

Studies with the use of microelements in the composition of mineral fertilizers for cotton show the low efficiency of inorganic salts of microelements in the carbonate soils of cotton regions of Uzbekistan. This is due to the fact that inorganic salts of microelements in the soil turn into insoluble forms that are inaccessible to plants [7-9].

In recent years, as is known, much attention has been paid to intracomplex coordination compounds of microelements called complex or chelates. Some researchers considered the role of microelements in the life of plants and highlighted theoretical and practical issues related to the use of complex micronutrient fertilizers on crops, rice, providing an increase in yield, quality of seeds and grain. Metal complexonates used as micronutrients are an effective form of microelements as a means of regulating the production process of agricultural crops, both when treating seeds before sowing and when carrying out foliar feeding of vegetative plants. Their inclusion in the system of rice fertilization allows balancing the mineral nutrition necessary for the life of plants, providing an increase in yield, quality of seeds and grain [5, 6, 10].

According to several researchers, complex compounds of microelements accelerate growth, development; increase the yield of cotton and other agricultural crops to a greater extent than their inorganic salts. In addition, when entering the plant, the coordination compounds of microelements exhibit great biological activity, remain for a long time in the soil solution in a form accessible to plants, have a high resistance to microbiological degradation and do not precipitate in an alkaline environment, which determines the high efficiency of their use for agricultural crops [7, 11, 14].

In recent years, in the agrochemistry of plant nutrition with microelements and the practice of their use in agriculture, much attention has been paid to intracomplex compounds of microelements. The aim of the study is to identify ways to increase the yield of the studied varieties of cotton through the use of coordination compounds of microelements. Especially the effectiveness of the use of trace elements of copper and cobalt for cotton has been insufficiently studied [1, 6, 7, 13]. This limited information on the effectiveness of coordination compounds of trace elements in increasing the productivity of cotton determined the direction of our research.

2 Materials and methods

The influence of coordination compounds of trace elements of copper and cobalt on the growth and development of cotton varieties Namangan-34, C-6524, Bukhara-102 and Omad was studied. Field experiments were carried out at the experimental site of the Uzbek Cotton Research Institute.

In the field, the dependence of the yield of cotton on the introduction of inorganic salts and coordination compounds of microelements on a typical sierozem was studied. The initial content of humus, total nitrogen, phosphorus and potassium in the soil of the arable layer of field experiments was 1.10, respectively; 0.09; 0.11 and 2.3%. The humus content and the gross amount of nutrients decrease in the subsoil horizon. The initial content of nitrates in the soil is 20.4 - 21.2 mg/kg of soil. The available phosphorus in the soil, soluble in ammonium carbonate, was 22.3-23.2 mg/kg in the arable and 11.3-11.9 mg/kg in the subsoil, exchangeable potassium, respectively, 190-201 and 130-134 mg/kg of soil.

The content of conditionally assimilable forms of microelements was on average: cobalt 0.12-0.14; copper 0.30-0.34 mg/kg and, therefore, the soil of the experimental plots refers to the poorly supplied with these microelements. Field experiments were arranged 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 were used as protection. Plot area 67.2 m² (14.4 and 4.8 m). The experiment was repeated four times. The layout of plants is 60x15-1 at a density of 105-110,000. Before sowing, cotton seeds were soaked with an aqueous solution of inorganic and coordination compounds of microelements, followed by adding ammophos or superphosphate to the budding phase to a depth of 14-16 cm.

From a large number of coordination compounds of microelements by two-three-year field trials, the following ones were selected that are most effective on the growth, development and productivity of cotton: as Co-31 - cobalt trismethioninate - Co (C₁₅H₁₆N₃S₃O₉) with a cobalt content of 14%; Cu-12 - bis-glutamatedcuproate tetrahydrate [Cu(C₅H₇O₄N)₂] · 4H₂O with a copper content of 13.2% and Co-34 bis (glutamatedcuproate) cobalt (II) Co[Cu(glut-2H₂)] · 4H₂O with a cobalt content 11%, and copper 13%.

3 Results and discussion

Researchers have established that the combined use of nitrogen, phosphorus, potassium and half-matured manure, the absorption of *Artemisia leucodes* Schrenk and *Sophora japonica* L of trace elements of copper, molybdenum and especially zinc increases markedly [8].

Researchers have found that studies of the effect of Organomix liquid chelated fertilizer on productivity, product quality and resistance to diseases (in particular, to iron deficiency chlorosis) confirm the positive effect of its use on grapes.

In these experiments, two dosages of the drug were used (0.8 l/ha and 1.0 l per ha). We consider it advisable to use another dosage (1.2-1.5 l/ha) in order to finally determine the consumption rate, and find out how justified the indicated dosages of the drug are, at which there is (or is not observed) a further increase in both the yield and dose increment [9].

Thus, in order to obtain sustainable yields with high quality raw cotton, the use of microelements, along with a balanced nitrogen-potassium and phosphorus nutrition, is becoming increasingly important. Since they play an important role in the processes of plant metabolism, their lack can lead to significant disturbances in growth and development, a decrease in productivity and a deterioration in product quality.

Long-term results of scientific research and the practice of using microelements in the composition of mineral fertilizers for cotton show the low efficiency of inorganic salts of microelements in the calcareous soils of the cotton regions of Central Asia. This is due to the fact that when inorganic salts of microelements are introduced in the soil, they turn into insoluble forms that are inaccessible to plants [10].

We have established that the use of coordination compounds of trace elements cobalt and copper by soaking seeds of 0.3% in their solutions and subsequent application at the rate of 6.0-8.0 kg/ha increases the productivity (biomass) of cotton on average for two years 3.2 -2.0 q/ha.

The results of the research have established 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 varieties of cotton.

It is noted that the difference in the increase in the yield obtained with the introduction of 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 has been established that the content of copper and cobalt in the tissues of the organs of cotton does not differ significantly when inorganic salts of the coordination compounds of these microelements are added. With the addition of cobalt alone, the copper content in the tissues of plant organs is higher than in the organs of control plants, but lower than in plants with the addition of copper. The variants differ insignificantly in the content of cobalt and copper when they are introduced in the form of inorganic salts, and when growing cotton with the use of coordination compounds, a tendency to a large increase in them in the organs of cotton is noted.

The removal of copper and cobalt by one plant with the introduction of these nutrients in the form of coordination compounds exceeds the indicator in the variant with the use of their inorganic compounds (Table 1).

Table 1. Removal and consumption of copper, cobalt (g/ha), nitrogen and phosphorus (kg/ha) by cotton when adding their inorganic and organic compounds.

Options	Copper		Cobalt		Nitrogen		Phosphorus	
	Removal of 1 ha	Consumption per 1 ton of raw cotton	Removal of 1 ha	Consumption per 1 ton of raw cotton	Removal of 1 ha	Consumption per 1 ton of raw cotton	Removal of 1 ha	Consumption per 1 ton of raw cotton
Control (without trace elements)	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 compounds)	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 compounds)	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 compounds)	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 compounds)	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 compounds)	62.84± 2.88	15.75± 0.11	7.52± 0.20	1.88± 0.18	232.0± 1.67	56.76± 0.29	69.99± 0.09	17.11± 0.09

This once again confirms the opinion that the coordination compounds of microelements are less fixed in the soil than their inorganic salts. The total removal of copper and cobalt by plants with the introduction of their coordination compounds is,

respectively, 57.6 and 62.8 g/ha, while in the control (with the introduction of inorganic salts) - 52.3 - 55.1.

It has now been established that copper, manganese, zinc, cobalt, boron and other trace elements increase the activity of many enzymes and enzymatic systems, redox processes, participate in photosynthesis, carbohydrate and protein metabolism and other biological processes. Enzymes can form various organometallic and intracomplex compounds with microelements. The influence of individual microelements on growth processes, fruiting and the quality of agricultural crops, including cotton, has been widely studied.

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

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 by 0.6 - 0.8 and their coordination compounds by 1.3 - 1.8. The number of fully formed bolls is more formed in variants with the use of coordination compounds of microelements under cotton -13.2; 13.0 and 12.5 pieces per plant versus 10.6 pieces in the control. When using inorganic salts (options 2 and 3), the number of boxes was 11.4 and 11.2 pieces. Inorganic cobalt salts on average for 3 years increase the yield of raw cotton by 3.2 q/ha, and copper sulfate - by 2.8 q/ha. At the same time, the increase in the yield of raw cotton of the first harvest in the variant with cobalt sulphate was 6.2% and copper sulphate by 5.8% more compared to the control (without microelements).

The greatest increase in the yield of cotton is observed in variants with a 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. 12.3% more than in the control variant, and in the variant with the coordination compound of copper it is 4.3 q/ha 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 times more than in the option with the introduction of inorganic salts of cobalt and copper under cotton.

The use of inorganic salts of microelements for cotton increases the fiber length by 0.1 - 0.3 mm, relative to the breaking load by 0.2-0.4 gf/tex, as well as the weight of 1000 seeds by 0.5 - 1.2 g in relation to control. At the same time, an increase in the oil content of the seed kernel is observed in comparison with the option 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 gf/tex and the weight of 1000 seeds by 1.2 - 2.7 g in comparison with the control (Table 2).

Table 2. Cotton yield with the introduction of inorganic salts and coordination compounds of microelements against an optimal background of mineral nutrition

#	Options	Annual fertilizer rate, kg/ha			Concentration of the solution for pre-sowing seed lock, %	Top dressing with microelements, kg/ha	Yield of raw cotton, q/ha		
		N	P	K			Average over 3 years	Increase control	Average yield of the first harvest, %
1	Control (without trace elements)	250	175	125	-	-	36.1 ± 1.9	-	60.9 ± 2.7
2	CoSO ₄ (inorganic compounds)	250	175	125	0.03	2.0	39.3 ± 0.8	3.2 ± 0.2	67.1 ± 1.3
3	CuSO ₄ (inorganic compounds)	250	175	125	0.03	2.0	38.9 ± 0.7	2.8 ± 0.3	66.7 ± 1.4
4	Co-31 (coordination compounds)	250	175	125	0.03	0.8	41.9 ± 0.3	5.8 ± 0.6	74.6 ± 0.6
5	Co-34 (coordination compounds)	250	175	125	0.02	0.6	41.3 ± 0.5	5.2 ± 0.4	73.8 ± 0.7
6	Cu-12 (coordination compounds)	250	175	125	0.03	0.8	40.9 ± 0.4	4.8 ± 0.3	69.2 ± 1.6

Thus, the coordination compounds of microelements in combination with the optimal rates of mineral fertilizers improve the technological properties of the fiber and increase the oil content of seeds to a greater extent than inorganic compounds.

Studies have established that when growing cotton with the use of inorganic salts, the content of gross nitrogen in the leaves and stems, respectively, increases to 0.1 and 0.4% in the valves and raw cotton - to 0.1 and 0.8%. There is a tendency for a greater increase in total nitrogen with the introduction of coordination compounds of trace elements, especially cobalt. When using inorganic salts and coordination compounds of microelements in terms of the phosphorus content in the organs of cotton, a similar pattern is observed.

As expected, the largest removal of nitrogen and phosphorus occurs in raw cotton than other organs of cotton, but also their total removal.

The research results also found that the content of cobalt and copper in plant organs when 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 dry matter versus from 3.9 to 6.7 and from 0.25 to 1.28 mg/kg in the control. This once again confirms that the coordination compounds of microelements are less fixed in the soil than their inorganic salts. The total removal of copper and cobalt by the plant upon the introduction of coordination compounds of these elements is, respectively, 57.6-32.8 and 7.5 - 8.6 g per hectare, and upon the introduction of inorganic salts 52.3 - 56.1 and 7.1 - 7.6 g hectares, while in the control 50.0 and 6.6 g.

4 Conclusions

Thus, the use of coordination compounds of microelements of cobalt and copper in comparison with their inorganic salts by soaking seeds and adding ammophos in the budding phase of cotton helps to enhance growth processes, fruiting, improve the technological properties of fiber and increase the yield of raw cotton. The increase in the yield of raw cotton when using coordination compounds of trace elements cobalt and copper on an optimal nutritional background - $N_{250}P_{175}K_{125}$ increases by 4.5 and 5.8 q/ha, respectively, in relation to the yield of cotton grown without trace elements, and by 2.8 and 3.2 q/ha in variants with the use of inorganic salts of these microelements. The acknowledgements should be typed in 9-point Times, without title.

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