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# The Role Of Diatomite In Obtaining Eco Safe Products Of Spring Wheat In Case Of Soil Contamination With Copper.

**A Kh Kulikova*, AV Dozorov, ON Tsapovskaya, and A Yu Naumov**

FSBEI HE Ulyanovsk SAU named after P.A. Stolypin, 432017, Ulyanovsk, Novyi Venets Boulevard, 1.

**ABSTRACT**

The paper presents results of model experiments in field conditions with artificial soil contamination with copper at the level of maximum allowable concentrations (MAC) of the 2, 4 and 10 MACs. It has been established that contamination even in the amount of 2 MACs of Cu is accompanied by a yield loss of spring wheat up to 8%. At a higher level of contamination (up to 10 MACs of Cu) yield losses can reach almost one third (in our experiments - 29%). Diatomite, as a detoxicant, contributed not only to production of environmentally friendly products, but also to a yield increase of spring wheat grain due to its beneficial effect on soil properties and improvement of soil growth conditions for plants.

**Keywords:** contamination with copper, diatomite as a detoxicant, spring wheat, yield.

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***Corresponding author***

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## INTRODUCTION

The behavior issues of heavy metals, including copper, in the soil-plant system and their detoxification are widely considered by Russian and foreign researchers [1, 2, 3, 4, 5].

Copper is an essential trace element that participates in a number of physiological and biochemical processes of plants. However, due to current state of the biosphere and enormous influx of elements from man-made sources, it can also be considered as a pollutant. Excessive content in the soil of available copper compounds may have a phytotoxic effect, manifested in a change of basic physiological processes of plants, including disorder in absorption mechanisms of biophilic elements [6, 7].

In this regard, the identification of levels of toxic copper concentrations for agricultural crops, their influence on yield formation and obtaining eco safe products is the most important task. It is equally important to develop agrotechnical methods for heavy metal detoxification when cultivating crops on soils with a high content of heavy metals, or local contamination within the agricultural limits.

The aim of the study was spring wheat cultivation on artificially copper-contaminated soil and study of the possibility of diatomite usage as a detoxicant. The choice of diatomite, which belongs to the group of high-silicon rocks with high adsorption, ion-exchange and catalytic properties, was determined by the fact that it is able to retain nutrients of root layer in case of introduction of water in the arable layer, as well as to absorb heavy metals, which contributes to reducing their flux into plants [8, 9].

## OBJECTS AND METHODS OF RESEARCH

The effect of different concentrations of copper and diatomite as a detoxicant on growth, development and formation of yield of spring wheat was studied in a microfield experiment on the experimental field of Ulyanovsk State Agrarian University. The scheme of the experiment consisted of 8 variants: the 1st - control, the 2nd - 2 MACs of copper (Cu), the 3rd - 4 MACs of Cu, the 4th - 10 MACs of Cu, the 5th - diatomite at the dose of 5t / ha, 6th - 2 MACs of Cu + diatomite, 7th - 4 MACs of Cu + diatomite, 8th - 10 MACs of Cu + diatomite. Copper of appropriate doses (at the level of 2, 4, and 10 MACs) was introduced into the soil as $CuSO_4$ sulfate in its pure form (variants 2, 3, and 4) as well as in combination with diatomite at the dose of 5t / ha (6th, 7th and 8th variants).

The soil of the experimental field is typical medium loamy black soil, slightly humic, with humus content of 4.7%, mobile (available) phosphorus of 196 mg / kg (high content according to Chirikov), potassium of 206 mg / kg (very high supply), soil solution is close to neutral ($Ph_{KCl}$ 6.3-6.7).

The area of a record plot is $1m^2$, repetition is fourfold, the plot location is randomized. All work on application of copper sulfate and diatomite was performed manually. Harvesting was also carried out manually. The yield was calculated for 100% purity and 14% humidity (State Standard 27548-97).

## RESULTS AND THEIR DISCUSSION

One of the limiting factors of formation of crop yields is undoubtedly the creation of suitable conditions for growth and development not only from the point of view of nutrition, moisture supply, etc., but also from the point of view of presence or lack of negative factors, heavy metals being one of them. The table shows yield parametres of spring wheat according to the variants of the experiment.

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**Table: Productivity of spring wheat depending on the level of copper contamination and the use of diatomite as a detoxicant**

| № | Variant | Yield, t/ha | Deviation from the control | |
|---|---|---|---|---|
| | | | t/ha,+– | %, +– |
| 1 | Control | 2,01 | – | – |
| 2 | 2 MACs of Cu | 1,86 | –0,15 | –8 |
| 3 | 4 MACs of Cu | 1,52 | –0,49 | –24 |
| 4 | 10 MACs of Cu | 1,43 | –0,58 | –29 |
| 5 | Diatomite, 5 t/ha | 2,24 | +0,23 | +11 |
| 6 | 2 MACs of Cu + diatomite | 2,17 | +0,16 | +8 |
| 7 | 4 MACs of Cu + diatomite | 2,08 | +0,07 | +4 |
| 8 | 10 MACs of Cu + diatomite | 1,79 | –0,22 | –11 |
| LSD $_{05}$ | | 0,07 | | |

When analyzing the data in the table, first of all, attention is drawn to a significant increase in the yield of spring wheat grain when diatomite is introduced into the soil (by 0.23 t / ha, or by 11%).

Studies conducted in Ulyanovsk State Agrarian University, as well as in a number of other works, have proved [9, 10] that high-silicon rocks such as diatomites, zeolites, bentonite clays, and bergmeal have a multiple positive effect on the soil-plant system:

- have structuring and loosening effect on the soil during cultivation of any crops;
- have a favorable effect on the activity of soil organisms (soil biogenicity may increase by 20–30%);
- contribute to the increase of water-retaining capacity and improvement of the soil nutrient regime (including silicon);
- possess protective properties in any stressful situations caused by both biogenic and abiogenic factors;
- contribute to production of environmentally friendly products.

The soil contamination with copper up to the level of 10 MACs was accompanied by a sharp decrease of spring wheat yield: at the level of 2 MACs, the loss of grain was 0.15 t / ha (8%), 4 MACs - 0.49 t / ha (24%), 10 MACs - 0 , 58 t / ha (29%).

Apparently, the influence of copper on formation of crop yields is regulated by complex biochemical mechanisms due to copper presence in copper-containing proteins and enzymes, and participation in redox-reducing processes. High concentrations of the metal led to the development of metallotoxicosis, growth inhibition of roots and shoots, up to complete plant death [11].

The use of diatomite as a detoxicant at a dose of 5 tons / ha with soil contamination up to 4 MACs completely blocked its negative impact on formation of spring wheat yield, due to its high absorption capacity and ion-exchange capacity. The possibility of active use of high-silicon rocks for production of eco safe products of agricultural crops was pointed out by Yu. G. Distanov and T. P. Konyukhova [12], V. V. Matychenkov [8], A.Kh. Kulikova [9].

In our experiments, the yield of spring wheat grain increased by 0.16 (2 MACs of Cu) and 0.07 t / ha (4 MACs of Cu) due to introduction of diatomite. However, at a sufficiently high contamination of 10 MACs, it was not possible to completely block the toxic effect of copper on yield formation and it decreased by 0.22 t / ha.

Thus, copper contamination, even in the amount of 2 MACs of Cu, was accompanied by a loss of harvest of spring wheat up to 8%. Yield losses can reach almost one third (in our experiments – 29%) with a higher level of contamination (up to 10 MACs of Cu). Diatomite, as a detoxicant, contributes not only to an increase in the spring wheat yield, but also to production of eco safe products (Figure).

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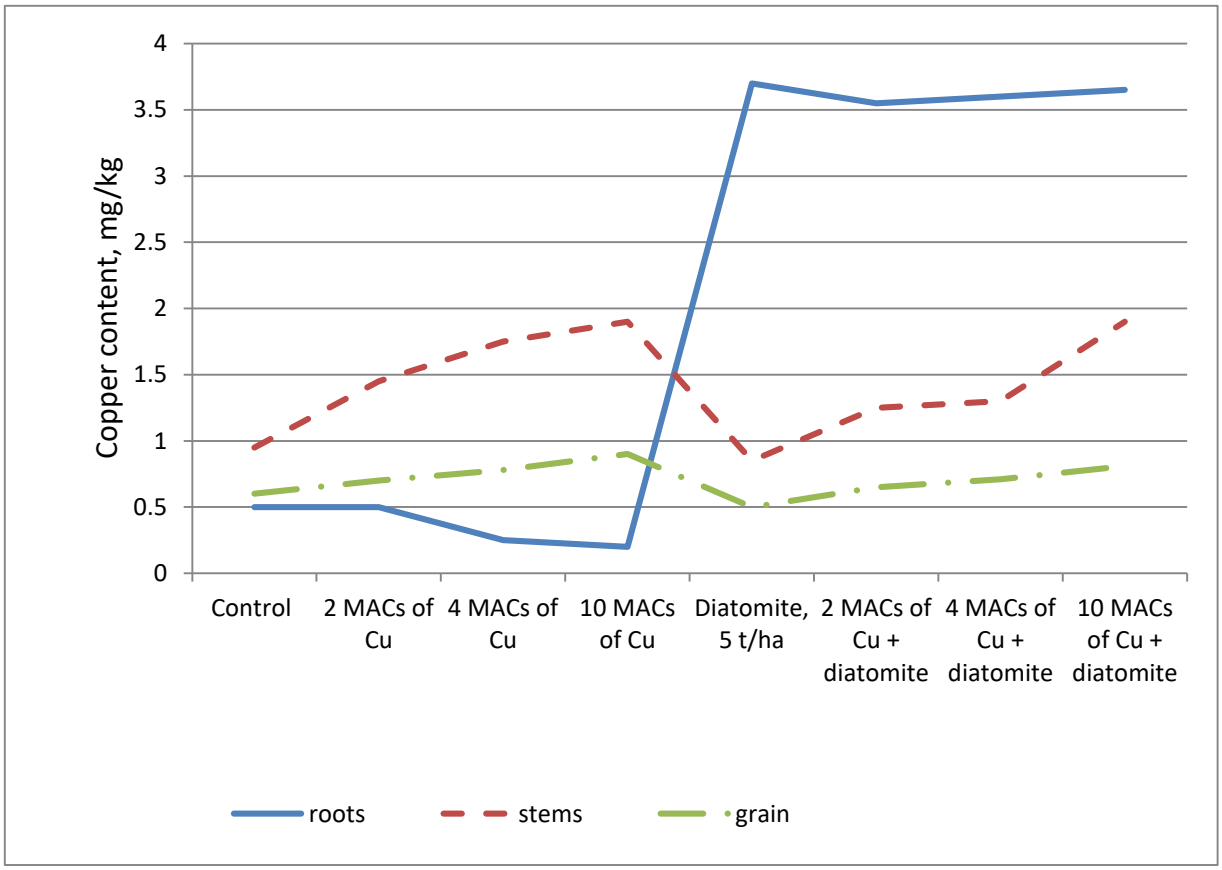


**Figure - Copper content in spring wheat grain**

Research results indicate that in case of cultivation of spring wheat on contaminated soil, copper is mostly concentrated in stems, especially with an increase of contamination. So, in case of contamination in the amount of 10 MACs, the copper content in roots was 0.20 mg / kg, in stems – 1.90, and in grain - 0.90 mg / kg. However, when diatomite was introduced into the soil, the movement of copper to the plant organs was sharply blocked (cooper accumulation in wheat roots was 6.7 times more than in the control). The introduction of diatomite into the contaminated soil also contributed to its retention in roots and a noticeable decrease of copper supply to the main organs: its content in spring wheat grain decreased by 8-10% in comparison to the control.

## CONCLUSION

1. Contamination of leached black soil with copper from 2 to 10 MACs was accompanied by a loss of harvest of spring wheat by 8-29%.
2. Diatomite, as a detoxicant, contributed not only to an increase in the yield of spring wheat grain (by 0.23 t / ha, or 11%), but also to production of environmentally safe products: the accumulation of copper in grain decreased by 8-10%.

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