

## The features of the influence of heavy metal compounds on germinated barley *Hordeum vulgare* L. in the presence of ammonium and nitrate nitrogen

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### Abstract

The article analyzes the cumulative effect and toxic influence of pollutants on germinated barley *Hordeum vulgare* L. in the model experiment at different concentrations by the example of heavy metal ions Cd<sup>2+</sup>, Cu<sup>2+</sup>, Pb<sup>2+</sup> and Zn<sup>2+</sup> in the presence of ammonium and nitrate nitrogen in the form of single and multicomponent systems. The experiment enables to make a multivariate analysis of the effect of heavy metal compounds on germinated barley *Hordeum vulgare* L. in the presence of nitrate nitrogen and to draw a conclusion about the presence or absence of a summation or potentiating effect of various combinations of pollutants under study. Based on the multifactorial analysis of the influence of pollutants on barley caryopses in the presence of nitrogen-bearing compounds, inhibition and stimulation series are ascertained for single, double, triple and quadruple systems of pollutants being studied.

It has been established, that the strongest toxicants of components being analyzed for roots of barley *Hordeum vulgare* L. are copper compounds, both in the separate presence and together with zinc, ammonium and nitrate nitrogen, then for shoots they are cadmium compounds. This research has also indicated that the compounds of ammonium nitrogen heighten the inhibiting effect of copper, zinc, lead and cadmium on root system and shoot development. But the pollutants under study should be more toxic in the presence of ammonium ions, compared to the nitrite ion. The antagonistic effect of heavy metal on the impact of the root system and barley shoots *Hordeum vulgare* L. is more significant than the synergetic one and it would intensify by increasing the concentration of pollutants. The multivariate analysis of the effect of copper, lead, zinc, cadmium and ammonium nitrogen on the root system and barley shoots *Hordeum vulgare* L. in single and multicomponent systems has made it possible to determine the series of inhibition and stimulation of pollutants under examination. For the root system of barley the combined presence of copper and zinc at the concentration of 100 µm is the most toxic (the root length makes up 3.6 cm, in comparison with the separate influence of zinc with 9.1 cm, and copper – with 4.7 cm). Then copper and cadmium ions in the combined presence have the most inhibiting effect on shoots (the coleoptile length is 2.9 cm, compared to the separate influence of copper with 4.3 cm, and cadmium – with 3.8 cm).

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