Reduction of Herbicidal Toxicoses on Plants Using Berkana and Izabion Organomineral Fertilizers

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Abstract. Today herbicidal treatments become an obligatory component of agrotechnical activities required for plant cultivation. At the same time, being biologically active compounds, herbicides may negatively influence on plants during crop rotation. In this study the experimental data confirmed the negative effect of a metribuzin-based herbicide applied on potato towards the next crops (cucumber and lentil). Treatment of these crops with amino acid-based bioorganic fertilizers (Berkana and Izabion) in a seedling stage reduced the manifestations of the negative aftereffect of the herbicidal stress on the tested plants.

1. Introduction
Modern agriculture requires almost obligatory use of herbicides during cultivation of various crops. At the same time, such preparations possess certain biological activities and may negatively influence on plants at the next crop rotation stages [1,2]. Aftereffect of herbicidal toxicoses is a negative effect of herbicide residues and metabolites, still existing in the soil since the preceding year, on the next planted crops.

Planning the sowing of crops, one should take into account the residual effect of herbicides used in the previous season. The rate of degradation of active herbicidal components in the soil depends on many factors, such as the dosage of the applied preparation, season conditions (temperature and soil humidity), soil type, microbiota, etc. [3]. For example, under arid conditions, application of herbicides based on sulphonylurea, imidazolines, dicamba, picloram, clopyralide, metribuzin, etc. increases the risk of the next-year presence of their residues in the soil and the further damage of planted potato or other crops [4]. Thus, if one has some doubts concerning the degradation of applied herbicides in the soil, he should analyze the soil for presence of herbicide residues or make a soil biotesting using indicator (test) plants [5,6].

For the herbicides from the group 2 (ALS inhibitors), such as sulphonylurea and imidazolinones, the test plants are sugar beet, mustard and rape [7]. In the case of herbicides referred to the group 4 (synthetic auxins including 2.4D, benzoic acid (dicamba), and pyridine acid (clopyralide, picloram)), the test plants include beans and linen [8]. For the herbicides from the group 5 (metribuzin), the test plants are cucumber, oats, sugar beet, and lentil [8].

The purpose of this study was the determination of a toxicity level of a metribuzin-based herbicide used for treatment of potato fields in relation to the subsequent crops (cucumber and lentil) as well as the determination of the efficiency of bioorganic Berkana and Izabion fertilizers applied during plant vegetation on the reduction of manifestations of the herbicidal toxicosis.
2. Materials and methods
The studies were carried out in 2019 under controlled conditions (greenhouse) including hydrothermal regime. Field soil samples were collected on April 06, 2019 from two plots. The first one represented the control plot (no treatments with herbicides), whereas the second plot was used for potato growing in 2018 and was treated with the Zenkor herbicide (a.i. metribuzin, 700 g/kg).
Cucumber (cv. Edinstvo) and lentil (cv. Petrovskaya 6) were used as test crops. Plants were sown into small 0.6-L pots having 80 cm in diameter and filled with the collected samples of the sod-podzol soil. The sowing date was May 14, 2019. The growing conditions included the day/night temperature 25/20ºC and the soil moistening up to 60% of the total moisture capacity. Seven days after the shoot appearance (3–4 leaves in lentil plants and cotyledonous leaves in cucumber plants), the following preparations were applied on plants:
(a) Berkana, an organic fertilizer intended for a rapid recovery of plants after exposure to stress caused by the soil/air overwetting and chemical or physical burns caused by application of pesticides or plant hormones. The active ingredients of this fertilizer included L–amino acids, polypeptides, natural polysaccharides, and biologically active enzymes;
(b) Izabion, a biological fertilizer stimulating plant growth. Active ingredients included amino acids and peptides (62.5%).

The dosages of fertilizers used in this study were 1.5 L/ha (Izabion) and 50 mL/ha (Berkana).

A comparative phytotoxicity of the soil samples caused by the aftereffect of the herbicide, as well as the efficiency of Berkana and Izabion fertilizers were evaluated 28 days after sowing of the tested crops by the difference in the height and weight of the aboveground parts of test plants.

3. Results
The data obtained on cucumber plants are shown in Table 1 and Figs. 1, 2. In the case of the metribuzin application on the preceding crop (sample 2), we observed a significant reduction in both height (16.3%) and weight (38.4%) of cucumber plants compared to the control (sample 1). At the same time, samples 3 and 4 (application of Izabion or Berkana fertilizers, respectively, at the shoot appearance stage) did not demonstrate significant difference from the control concerning the plant height; weight reduction was rather insignificant (Table 1, Figs. 1, 2).

| No. | Soil sample                           | Average test plant weight, g | % of weight reduction comparing to the control | Average test plant height, cm | % of height reduction comparing to the control |
|-----|--------------------------------------|------------------------------|-----------------------------------------------|-----------------------------|-----------------------------------------------|
| 1   | Control (no treatment)               | 4.66                         | -                                             | 12.3                        | -                                             |
| 2   | Sample 1 (herbicide treatment)       | 2.87                         | -38.4                                         | 10.3                        | -16.3                                         |
| 3   | Sample 2 (herbicide treatment + Izabion) | 4.50                  | -3.4                                          | 12.3                        | 0                                             |
| 4   | Sample 3 (herbicide treatment + Berkana) | 4.58                   | -1.7                                          | 12.4                        | +0.8                                          |
|     | LSD0.05                               | 1.33                         |                                                | 1.4                         |                                                |
Figure 1. Effect of a cucumber plant treatment with bioorganic fertilizers on the manifestations of a herbicidal toxicosis. K, control (no herbicide treatments), 1–3, variants grown on the soil with herbicide residues (1, no fertilizer application; 2, treatment with Izabion; 3, treatment with Berkana). The picture was made two days after the treatment with the studied preparations.

Figure 2. Effect of a cucumber plant treatment with bioorganic fertilizers on the manifestations of a herbicidal toxicosis. K, control (no herbicide treatments), 1–3, variants grown on the soil with herbicide residues (1, no fertilizer application; 2, treatment with Izabion; 3, treatment with Berkana). The picture was made 28 days after the treatment with the studied preparations.

The data obtained on lentil plants are shown in Table 2 and Figs. 3, 4. Evaluation of the plant weight in different experimental variants demonstrated a negative aftereffect of metribuzin (variant 2) on the growth and development of this crop. Visual examination showed deformation (rolling) of leaves and top shoots. Comparing to the control (variant 1), the average weight of the above-ground part of plants decreased by 18.1%, and the average plant height decreased by 27.4% (Table 2). Variants treated with the tested fertilizers demonstrated increase in the number of new shoots, i.e., their layering capacity (Figs. 3, 4).
Figure 3. Effect of a lentil plant treatment with bioorganic fertilizers on the manifestations of a herbicidal toxicosis. K, control (no herbicide treatments), 1–3, variants grown on the soil with herbicide residues (1, no fertilizer application; 2, treatment with Izabion; 3, treatment with Berkana). The picture was made two days after the treatment with the studied preparations.

Figure 4. Effect of a lentil plant treatment with bioorganic fertilizers on the manifestations of a herbicidal toxicosis. K, control (no herbicide treatments), 1–3, variants grown on the soil with herbicide residues (1, no fertilizer application; 2, treatment with Izabion; 3, treatment with Berkana). The picture was made 28 days after the treatment with the studied preparations.
Table 2. Comparative toxicity of soil samples in relation to lentil plants

| No. | Soil sample                      | Average test plant weight, g | % of weight reduction comparing to the control | Average test plant height, cm | % of height reduction comparing to the control |
|-----|----------------------------------|------------------------------|-----------------------------------------------|------------------------------|-----------------------------------------------|
| 1   | Control (no treatment)           | 0.99                         | –                                             | 14.9                         | –                                             |
| 2   | Sample 1 (herbicide treatment)   | 0.81                         | –18.1                                        | 10.8                         | –27.4                                        |
| 3   | Sample 2 (herbicide treatment + Izabion) | 0.88                      | –11.1                                        | 12.7                         | –14.9                                        |
| 4   | Sample 3 (herbicide treatment + Berkana) | 0.89                      | –10.1                                        | 13.1                         | –12.2                                        |
|     | LSD$_{0.05}$                     | 0.23                         | 2.8                                           |                              |                                               |

4. Conclusions
The performed study data confirmed the negative aftereffect of a metribuzin-based herbicide applied on potato towards some other crops used in the crop rotation, such as cucumber and lentil. Treatment of these crops with amino acid-based bioorganic fertilizers (Berkana and Izabion) makes it possible to reduce the manifestations of such aftereffect of herbicides.

5. References
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