



Қазақстан Республикасы Тәуелсіздігінің 30 жылдығы шеңберінде
Тұрақты даму бойынша ЮНЕСКО кафедрасының 10 жылдығына арналған

«XXI ҒАСЫРДЫҢ ЖАҢАНДЫҚ СЫН-ҚАТЕРЛЕРІ ЖӘНЕ ҚОРШАҒАН ОРТА»

атты халықаралық ғылыми-тәжірибелік конференцияның
ЖИНАҒЫ

Алматы, Қазақстан, 2-3 желтоқсан 2021 жыл

СБОРНИК

Международной научно-практической конференции

«ГЛОБАЛЬНЫЕ ВЫЗОВЫ XXI ВЕКА И ОКРУЖАЮЩАЯ СРЕДА»,

посвященной 10-летию кафедры ЮНЕСКО по устойчивому развитию
в рамках 30-летия Независимости Республики Казахстан
Алматы, Казахстан, 2-3 декабря 2021 года

COLLECTION

International Scientific and Practical Conference

«GLOBAL CHALLENGES OF THE 21ST CENTURY AND THE ENVIRONMENT»

dedicated to the 10th anniversary of the UNESCO Chair for
Sustainable Development within the framework of the
30th anniversary of independence of the Republic of Kazakhstan
Almaty, Kazakhstan, 2-3 of December 2021

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STUDY OF THE EFFECT OF CADMIUM AND ZINC IONS ON THE ACCUMULATION OF DRY BIOMASS BY VARIOUS VARIETIES OF SPRING WHEAT

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Abstract. The aim of the study is to investigate the effect of cadmium and zinc ions on the accumulation of dry biomass by spring wheat plants. The experiments were performed on 14-day-old seedlings of various genotypes of spring wheat grown on a nutrient mixture containing 0.1 mM CaCO₄, Cd ions at a concentration of 40 mg/l (in the form of CdSO₄ x 8H₂O salt) and Zn ions at a concentration of 400 mg/l (in the form of ZnSO₄ salt). According to the accumulation of dry biomass of roots and aboveground organs, the spring wheat varieties Lyazzat and Omsk-18 were the most resistant to the action of cadmium ions. According to the accumulation of dry biomass of roots, the spring wheat variety Lyazzat was the most resistant to the action of zinc ions. According to the accumulation of dry biomass of aboveground organs, spring wheat varieties Lyazzat and Samal were the most resistant to the adverse effects of zinc ions.

Keywords: wheat, cadmium ions, zinc ions, dry biomass, resistance.

Introduction. Environmental pollution, especially by chemicals, is one of the most powerful factors in the destruction of biosphere components. Currently, a huge amount of pollutants enters the biosphere. Heavy metals occupy a significant place among them. It is believed that among the chemical elements, heavy metals are the most toxic [1].

The creation and use in production of technogenically resistant varieties of agricultural crops sets the initial task of studying the gene pool of cultivated and wild-growing plants and identifying donors that accumulate the minimum amount of pollutants in the commercial part of the crop [2]. Evaluation of the breeding material and the direction of research on the principles of using traits that allow accumulating a minimum amount of ecotoxicants will make it possible to shorten the time of breeding work [3, 4]. In connection with the task of studying the gene pool of cultivated plants in conditions of technogenic pollution, the subject of the study was the screening of spring wheat varieties for metal resistance in order to identify forms promising for cultivation in the East Kazakhstan region, as well as breeding donors accumulating a minimum amount of pollutants.

Research methods. The objects of research are various varieties of spring wheat from the collection of the East Kazakhstan Research Institute of Agriculture (EK RIA): Lyazzat, Glubochanka, Nargiz, Omsk-18, Samal.

Growing plants. The experiments were performed on 14-day-old seedlings of various genotypes of spring wheat grown on a nutrient mixture containing 0.1mM CaCO₄ and Cd ions at a concentration of 40 mg/l (in the form of CdSO₄ x 8H₂O salt) or Zn ions at a concentration of 400 mg/l (in the form of ZnSO₄ salt). The plants were grown for 14 days in water culture under daylight and room temperature conditions. In the control variant, the plants were grown without the addition of cadmium and zinc ions.

Determination of dry biomass of plants. To determine the dry biomass, the plants were placed in an oven and dried at t=105⁰C to a constant weight, cooled to room temperature, and weighed on analytical scales.

Research results. Study of the effect of cadmium and zinc ions on the accumulation of dry biomass by spring wheat plants. Studies of the effect of cadmium and zinc ions on the accumulation of dry biomass of wheat seedlings in laboratory conditions have shown that cadmium ions suppress biosynthetic processes (Figure 1).

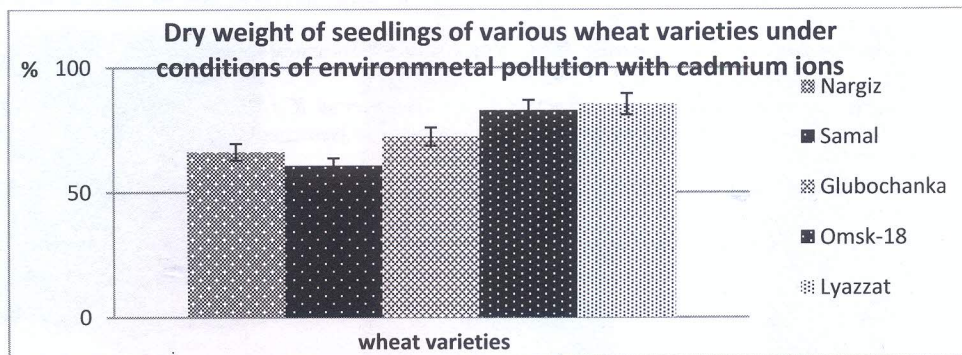


Figure 1. The effect of the presence of cadmium ions in the growing medium on the accumulation of dry matter by seedlings of various wheat varieties

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In the study of wheat varieties from the collection of the EK RIA, it was shown that according to the accumulation of dry biomass by aboveground organs of various varieties of spring wheat with a high concentration of cadmium ions, genotypes can be arranged as follows: Lyazzat > Omsk-18 > Glubochanka > Nargiz > Samal (Figure 1). The highest accumulation of dry matter by spring wheat seedlings under the action of cadmium ions was found in the Lyazzat and Omsk-18 varieties, the average level of accumulation was in the seedlings of the Glubochanka and Nargiz varieties, the lowest in the Samal variety (Figure 1).

When studying the effect of cadmium ions on the accumulation of dry biomass of plant roots of various varieties of spring wheat from the collection of the EK RIA, it was shown that according to this feature, genotypes can be arranged as follows: Lyazzat > Omsk-18 > Nargiz > Samal > Glubochanka (Figure 2).

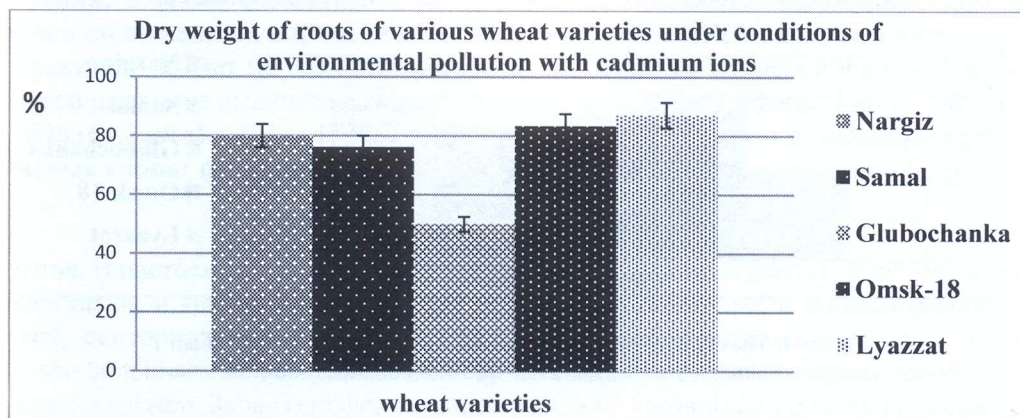


Figure 2. The effect of the presence of cadmium ions in the growing medium on the accumulation of dry matter by the roots of various wheat varieties

The most resistant to the action of cadmium ions were the varieties of spring wheat Lyazzat and Omsk-18. In Lyazzat and Omsk-18 varieties, the accumulation of dry root biomass is inhibited to a lesser extent than in other varieties at a high concentration of cadmium ions in the growing medium. The average level of accumulation of dry root biomass in spring wheat varieties Nargiz and Samal. The most sensitive to the adverse effect of cadmium ions on the accumulation of dry root biomass was the spring wheat variety Glubochanka (Figure 2).

According to the accumulation of dry biomass of roots, the most resistant to the action of cadmium ions were the varieties Lyazzat and Omsk-18, the most sensitive to the adverse effect of cadmium ions was the variety of spring wheat Glubochanka. According to the accumulation of dry biomass by aboveground organs, the most resistant to cadmium ions were the spring wheat varieties Lyazzat and Omsk-18, the least resistant variety is Samal.

Studies of the effect of zinc ions on the accumulation of dry biomass of wheat seedlings in laboratory conditions have shown that zinc ions inhibit biosynthetic processes (Figure 3).

When studying the effect of zinc ions on the accumulation of dry biomass of aboveground organs of wheat varieties from the collection of EK RIA, it was shown that, according to the accumulation of dry biomass by aboveground organs at a high concentration of zinc ions, genotypes can be arranged as follows: Lyazzat > Samal > Omsk-18 > Nargiz > Glubochanka (Figure 3).

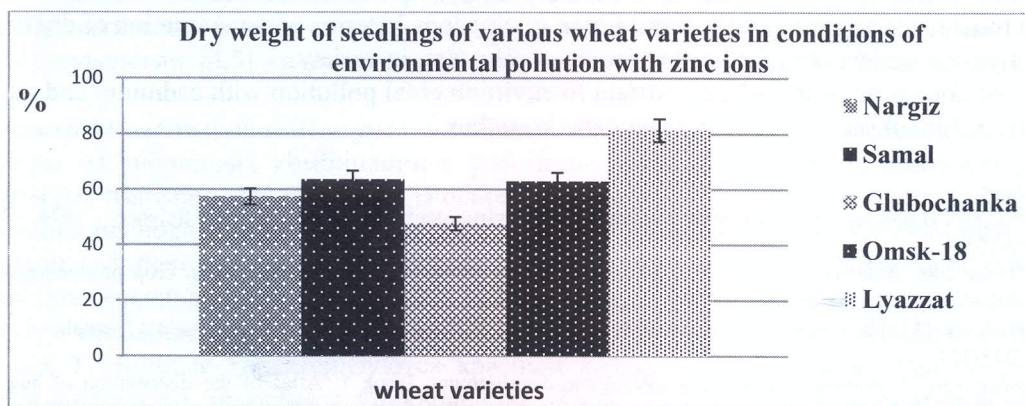


Figure 3. The effect of the presence of zinc ions in the growing medium on the accumulation of dry matter by seedlings of various wheat varieties

The aboveground organs of spring wheat varieties Lyazzat and Samal were the most resistant to the action of zinc ions. In varieties Lyazzat and Samal, the accumulation of dry biomass by aboveground plant organs is inhibited to a lesser extent than in other varieties with a high concentration of zinc ions in the growing medium. The average level of accumulation of dry biomass of seedlings in the varieties of spring wheat Omsk-18 and Nargiz. The most sensitive to the adverse effect of zinc ions on the accumulation of dry biomass of aboveground organs was the spring wheat variety Glubochanka.

When studying the effect of zinc ions on the accumulation of dry biomass of roots of wheat varieties from the collection of EK RIA, it was shown that, according to this indicator, with a high concentration of zinc ions, genotypes can be arranged as follows: Lyazzat > Samal > Glubochanka > Omsk-18 > Nargiz (Figure 4).

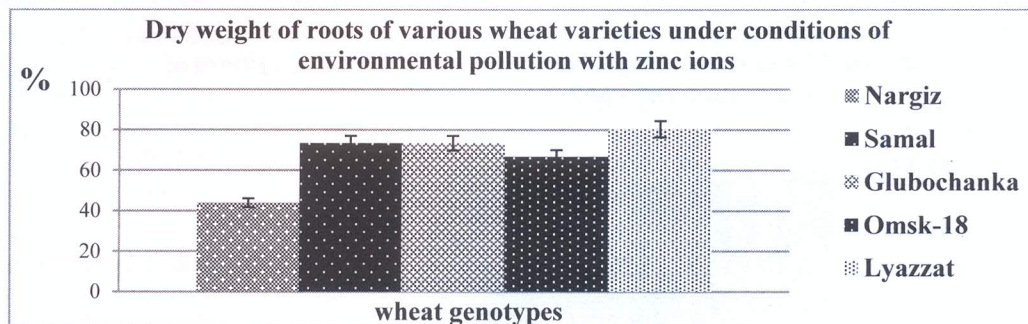


Figure 4. The effect of the presence of zinc ions in the growing medium on the accumulation of dry matter by the roots of various wheat varieties

The root system most resistant to the action of zinc ions in terms of the accumulation of dry biomass was found in the Lyazzat variety. In the Lyazzat variety, the accumulation of dry biomass is inhibited to a lesser extent than in other genotypes with a high concentration of zinc ions in the growing medium. The average level of accumulation of dry biomass of roots under conditions of contamination of the growing environment with zinc ions is observed in the varieties Samal, Glubochanka and Omsk-18. The plant roots of the Nargiz variety were the most sensitive to the adverse effects of zinc ions.

Thus, according to the accumulation of dry biomass of roots, the spring wheat variety Lyazzat turned out to be the most resistant to the action of zinc ions; the roots of the spring wheat variety Nargiz turned out to be the most sensitive to the adverse effect of zinc ions. According to the accumulation of dry biomass of aboveground organs, the most resistant to the adverse effect of zinc ions were the spring wheat varieties Lyazzat and Samal, the least resistant variety is Glubochanka.

Conclusion. Based on the results of the study, the following conclusions were made:

1. The greatest accumulation of dry matter by seedlings and roots of spring wheat under the adverse effect of cadmium ions was found in the varieties Lyazzat and Omsk-18.

2. According to the accumulation of dry biomass by seedlings, the Samal variety turned out to be the least resistant to the action of cadmium ions; according to the accumulation of dry biomass by roots, the Glubochanka variety turned out to be the most sensitive to the action of cadmium ions.

3. The varieties of spring wheat Lyazzat and Samal were the most resistant to the adverse effect of zinc ions on the accumulation of dry biomass by seedlings, and the variety Glubochanka was the least resistant.

4. The most resistant root system to the action of zinc ions in terms of accumulation of dry biomass was found in the Lyazzat variety, and the least resistant – in the Nargiz variety.

Identified donors of spring wheat resistant to environmental pollution with cadmium and zinc ions can be recommended for subsequent breeding and genetic studies.

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