BIO Web of Conferences **40**, 01010 (2021) https://doi.org/10.1051/bioconf/20214001010
*ILS 2021*

# Effect of increasing doses of Pb and Cd salts for growth and development of sprouts of seed peas (*Pisum sativum*) and soft wheat (*Triticum aestivum*)

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**Abstract.** The aim of the study was to study the effect of increasing doses of Cd and Pb salts on the morphometric parameters of pea and wheat seedlings. The problem of protecting the biosphere from chemical pollution, which is caused by the development of industry, transport, agricultural chemization, and intensive urbanization, is becoming increasingly important at the present time. This problem has become particularly acute due to the pollution of the environment with heavy metals. The most dangerous environmental pollutants among heavy metals are cadmium and lead. As a result, the negative impact of heavy metals on the initial stages of growth and development of seed peas (Pisum sativum L.) and soft wheat (Triticum aestivum L.).
***Keywords:*** *Pisum sativum, Triticum aestivum, heavy metals.*

## 1 Introduction

Currently, the increasing human impact on the biosphere is of a global nature, and in this regard, the issues of environmental pollution with many toxic substances, including heavy metals (TM), have become urgent. Thus, urban soils in comparison with the regional background can be enriched with zinc, lead, cadmium, copper, arsenic, mercury.

In recent years, the role of plants that purify the air, water and soil from toxic compounds has become apparent. But plants also suffer from environmental pollution. They seem to be much more affected by toxic substances and react more strongly to those concentrations of harmful substances that do not leave visible changes in humans and animals, that is, plants can serve as indicators of environmental pollution soil Contamination with heavy metal compounds negatively affects plant development, productivity and quality of crop production [1].

The most dangerous of a number of heavy metals are considered to be cadmium and lead. Both of these metals belong to class I.

The main source of lead pollution is the world's automobile fleet, dust from the construction industry, metallurgical enterprises, pesticides, and phosphate fertilizers. The transfer of lead suspended in the air to biota can occur directly or indirectly. In plants, lead

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accumulation due to precipitation can occur directly-through the aboveground parts of plants, or indirectly - through the soil. The nature and extent of lead accumulation most likely depends significantly on the stage of plant growth. Thus, the content of lead in some plants during active growth increases in comparison with its accumulation in late autumn [2, 3].

Increased lead content causes functional disorders in pigment complexes and a decrease in the content of chlorophyll in tissues. In plants, under the influence of lead, growth processes are suppressed, the content of vitamin C and provitamin a decreases.

Part of the lead enters plant organisms as a result of passive absorption by roots. A small amount of metal enters the leaves and stems from the root system. An increased concentration of lead in plant roots is associated with the formation of insoluble complexes, their accumulation in cells and weak accumulation in other parts of the plant [4].

The amount of lead that accumulates on the leaf blade depends on its roughness, pubescence, the presence of waxy plaque, resinous substances, etc. Probably, the lead is fixed in the wax coating and does not wash off. Most of the lead that accumulates in leaves is in a passive state and does not move to other organs and tissues of plants.

Lead accumulates in plants, causing physiological and functional disorders in plants. Lead in a high enough concentration inhibits seed germination, slows down the growth of roots in length, as well as the formation of root hairs. The leaves of lead-poisoned plants have chlorosis, especially between the veins. Very strongly affected young leaves [5,6].

Sources of environmental pollution with cadmium are diverse — coal burning, the use of phosphate fertilizers, waste from plastics production, metallurgy, electronic and semiconductor industries, motor transport, and others related to human activity [7].

There is a direct relationship between the content of cadmium in the soil and its entry into plants, but there seems to be no such relationship between the absorption of this element and the reaction to it. Symptoms of excessive intake of cadmium in plants are manifested in a gradual change in the colour of the tips of leaves and petioles to reddish-brown and purple. At the same time, the leaves curl, become chlorotic and fall off.

In experiments with rice, it has been shown that this element slows down the growth rate of plants. By the power of its action on plants, cadmium surpasses many other TM. Near enterprises that emit cadmium into the atmosphere, there is a sharp decrease in productivity and even the death of cultivated plants.

One of the reasons for inhibiting the growth of plants growing in the presence of cadmium is a sharp decrease in the intensity of photosynthesis.

At the same time the accumulation of cadmium occurs mainly in the roots of rice and wheat plants, but some of the cadmium enters other organs as well [8].

The constant impact of man-made pollution on agricultural and medicinal plants causes the accumulation of toxic substances, including heavy metals, in those organs that are used as food or medicinal raw materials for humans. And this has a serious impact on people's health: the number of many chronic diseases is growing: allergic, neuropsychiatric, cardiovascular, pulmonary, oncological, and many others [9].

The aim of the study was to study the effect of increasing doses of Pb and Cd salts on the morphometric parameters of seedling peas and soft wheat.

Objects of research: seeds and sprouts of seed peas (Pisum sativum L.) family Legumes varieties Ambrosia (early-maturing sugar-type peas) and wheat (Triticum aestivum L.) family Bluegrass, or Cereals.

## 2 Experimental

### 2.1 Research methods

1. Determination of germination and seed germination energy

The seeds of the main crop were thoroughly mixed and 4 samples of 100 seeds were counted out in a row to determine germination. Seeds were sprouted in Petri dishes on filter paper, placing them in a thermostat, where the temperature set for each crop was maintained. Evaluation and accounting of sprouted seeds in determining the energy of germination and germination was carried out in accordance with the requirements of GOST 12038-84. In this case, the day of laying seeds for germination and the day of counting the energy of germination or germination were counted in one day.

Normally sprouted seeds were counted twice: the first time the germination energy was determined, the second-the germination rate (these indicators were calculated as a percentage), then the average percentage of germination and seed germination energy was calculated.

2. Methods of setting the vegetation experience

The vegetation experiment was carried out in laboratory conditions using soil cultures. This method allows you to dissect and identify the influence of individual plant growth factors, maintain certain boundaries of external conditions: the supply of plants with moisture, aligned root nutrition and the same lighting and temperature conditions for all plants [10].

Experience scheme:

Control-without adding salts of Cd and Pb.

Option 1-dose of salts Cd and Pb in accordance with the maximum permissible concentration (MPC).

Option 2-the dose of salts Cd and Pb, increased twice (2 MPC).

For increased accuracy and reliability of the results of the experiment, the control and variants had three repetitions.

Preparation of the soil for laying experience. In the experiment, we used ready-made soil for seedlings "Agronom", purchased in the store "Seeds". the pH of the soil was 5-6, this level of soil acidity did not contribute to the formation of fungus in the soil. Without allowing drying, the soil was brought to a state of homogeneous mass by careful mixing, removing stones, large particles and sieving through sieves with holes of 3 mm.

Previously, the soil was analyzed for the content of cadmium and lead by atomic absorption method. As a result of the analysis, the content of cadmium and lead in the used soil did not exceed the MPC.

Preparation of vessels and filling of vessels. The vessels were selected close in height, volume and mass. Vessels were washed, rinsed with distilled water and dried; similarly, pallets and drainage were prepared.

The total number of vessels is as follows: 3 variants x 3 repetitions x 2 cultures x 2 metals = 36 vessels. The weight of the soil was 0.5 kg, and the soil was weighed on an electronic scale.

Sowing of crops. Before sowing, the soil surface was leveled, slightly watered with distilled water, then a hole was made 1.5-2 cm deep and seeds were placed in them: 30 seeds in each vessel.

Preparation of salt solutions and their introduction into the soil. After sowing the seeds, solutions of lead and cadmium salts were prepared. The study used metal salts in the form of acetates: $Pb(CH_3COO)_{2}*2H_2O$ and $Cd(CH_3COO)_{2}*2H_2O$. Doses of heavy metals per vessel were calculated based on the maximum permissible concentration (MPC) in the soil: the total lead content is 32 mg/kg, cadmium - 2 mg/kg (taking into account the weight of the soil in each vessel of 500 g or 0.5 kg: lead – 16 mg, cadmium – 1 mg).

Heavy metal salts (29.3 mg of lead salt and 2.4 mg of cadmium salt), weighed on analytical scales, were introduced into the soil in a dissolved state. Salt was added to 100 ml of distilled water and thoroughly mixed until the salt crystals dissolved. Then salt solutions were poured evenly on the soil. Care, monitoring, and accounting.

During the experiment, the length of the plant stem was measured. During 30 days, 8 measurements were made (on 4,8,13,17,21,25 and 30 days). Measurements were made using an electronic caliper brand Digital caliper. The caliper was used only until the stem growth reached 155 mm, since the device is not designed for a large amount of measurement. Then measurements were made with a tape measure. After each measurement, the crops were watered with distilled water.

The plants were watered with distilled water every three days for 30 days. During the vegetation period, they were monitored and the results recorded in a log.

## 3 Results and discussion

Morphometric indicators of the influence of Cd salts on the growth and development of seed peas.

The study found that the control seedlings appeared three days after planting. The same indicators of germination were observed in seedlings that were affected by heavy metals in an amount equal to the MPC. But pea seedlings affected BY 2 MPC of heavy metals appeared only on the 4th day after sowing. Germination in control plants exceeded 90%, and the germination of pea seedlings at a metal concentration equal to MPC1 was 82% , and at a metal concentration twice as high (2 MPC) - 79% (respectively). Based on this, it is obvious how strong a slowing effect Cd salt has on the growth and development of peas.

According to the latest measurements of the length of the pea stem, on day 30, there was the following difference in the growth of the stem: plants growing at MPC1 were inferior in growth by 27.2 mm, and at MPC2-by 63.7 mm. And at the end of the growing season, the growth and development phases of peas far exceeded the development of peas affected by increasing doses of Cd salt.

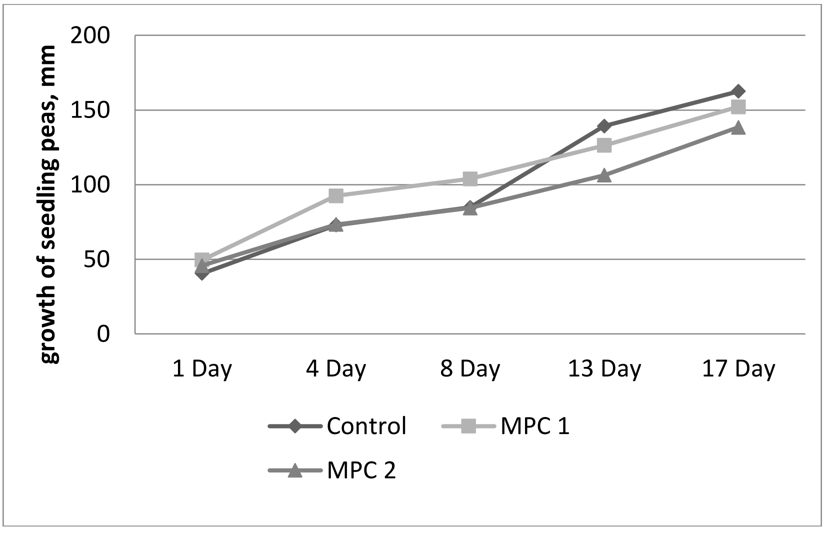


**Fig 1.** Effect of increasing doses of Cd salts on the growth of seedling peas (mm)

Morphometric indicators of the effect of Pb salts on the growth of soft wheat seedlings.

In the course of our study, it was found that in the control seedlings appeared three days after sowing. The same indicators were observed in seedlings that were affected by the Pb salt at a dose of PC 1. but the seedlings of variants with the introduction of 2 PC appeared only on the fourth day after sowing. It was also noted that 96% of pea seeds sprouted in the control, and in the variants of PC 1 - 84% and 2 PC - 81%, respectively. Hence, it is obvious that Pb salt has such a negative effect on the growth and development of soft wheat.

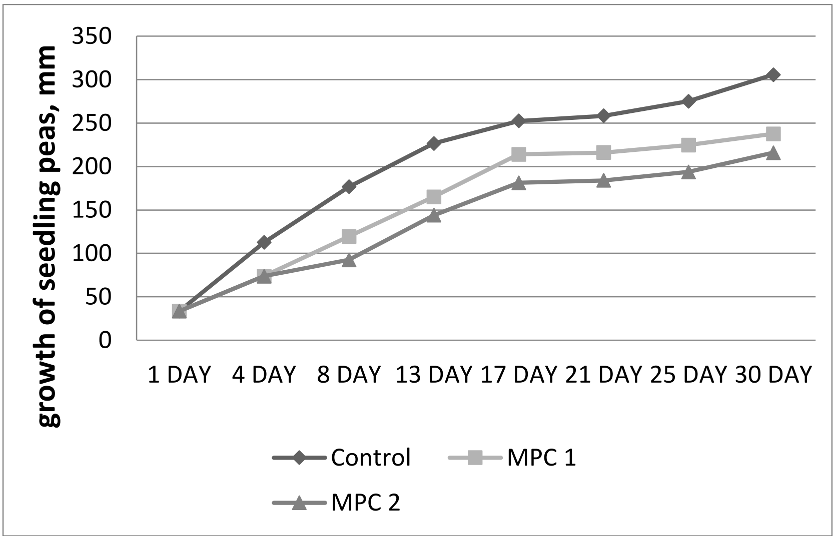


**Fig 2.** Effect of increasing doses of Pb salts on the growth of soft wheat seedlings (mm)

Morphometric indicators of the influence of Cd salts on the growth and development of soft wheat.

The study found that the control seedlings appeared three days after sowing. The same indicators of germination in seedlings that were affected BY 1 MPC of heavy metals at a dose of 1 MPC. But wheat seedlings affected BY 2pdc heavy metals appeared only on the 4th day after sowing. Germination in control plants exceeded 95%, and the germination of pea seedlings at mpc1 was 83% And 2 MPC -80%. Based on this, it is obvious how much negative impact Cd salt has on the growth and development of wheat.

According to the latest measurements of the length of the wheat stalk on day 30, there was the following difference in stalk growth: when adding salt in a dose equal to MPC1, there was a decrease in growth (conceded in growth) by 70.8 mm, and 2 MPC - by 89.7 mm. And at the end of the growing season, the growth and development of wheat in control far exceeded the development of wheat affected by increasing doses of Cd salt.

Analysis of the effect of heavy metals on morphometric indicators of pea and wheat seed. After the conducted experiments to identify the effect of increasing doses of Pb and Cd salts, we can say. The data obtained as a result of the vegetation experiment show that both salts have a negative impact on the morphometric indicators of plants. Thus, seed peas were more resistant to the effects of increasing doses of heavy metal salts. Wheat, starting from the fourth day of measurements, has already shown how strongly affected the cadmium and lead salts on morphometric indicators. But in peas, the effect of doses of these salts appeared about 11 days.

For seed peas, cadmium had a more negative effect compared to lead. And in wheat, only a dose of Cd equal to MPC1 had a more negative effect compared to Pb salt. The Cd 2 MPC dose had a less negative effect than the Pb 2 MPC salt. In General, both salts had a significant negative impact on the growth and development of wheat during the entire 30 days, it was clear how harmful the effect of the salts was.

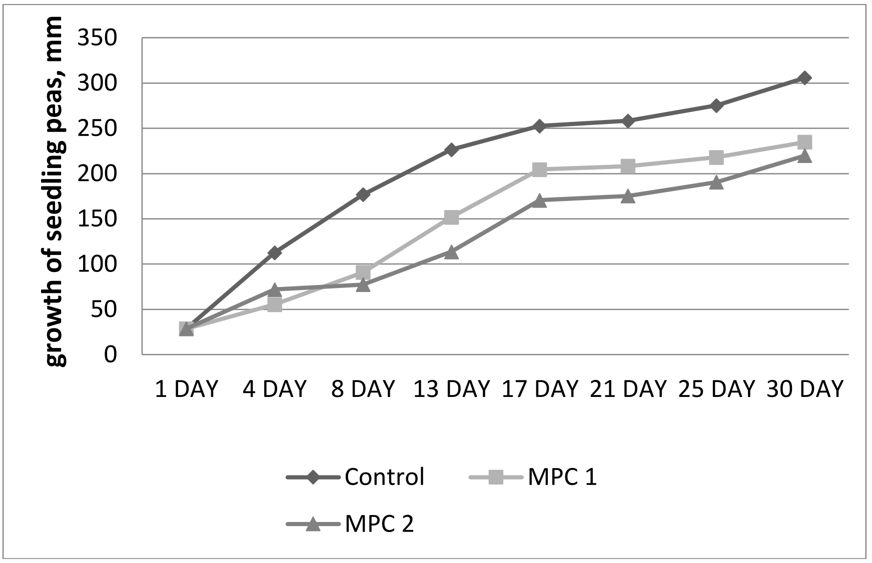


**Fig 3.** Effect of increasing doses of Cd salts on the growth of soft wheat seedlings (mm)

Both salts had a negative effect on the germination of seeds. They reduced the germination rate of plants by 10-14%. And for 30 days, it was noticeable how depleted the plants, both peas and wheat. Peas that were affected by increasing doses of Pb and Cd salts were highly dependent on irrigation. All plants were watered every 3 days, but they needed watering already on day 2, since on the third day they were already a little wilted, and some plants in the middle of their development withered and died.

In control wheat plants, compared with plants grown at MPC1 and MPC2, there was a faster maturation, and they were one phase of development all the time ahead.

Based on all the above, we can conclude that increasing doses of Cd and Pb salts have a detrimental effect on the growth and development of experimental plants throughout the entire observation period. (for all plant life processes).

## 4 Conclusion

Both salts had a negative effect on seed germination, reducing it by 10-14%.

In control plants, compared with plants that grew when salt was added to the soil in concentrations equal to MPC1 and MPC2, more intersessive growth was observed, and during the entire observation period they outstripped the growth and development of experimental plants.

As a result of the experiment, it was found that Cd salts had a more negative effect on the growth of soft wheat than Pb salts. From the first to the 18th day, this negative effect of Cd salts is more evident. From the 20th to the 30th day of observation, the negative impact of Cd slowed down.

Cd salts also had a more negative effect on pea seedlings than Pb salts. In peas, the effect of doses of Pb and Cd salts began about day 11.

During the entire 30 days of observation, it was noticeable how depleted the plants, both peas and wheat. Some plants that grew at a salt concentration equal to 2 MPC, gradually dried up and died.

Based on all the above, we can conclude that increasing doses of Cd and Pb salts have a detrimental effect on seed germination, growth and development of experimental plants.

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