

Summary

Hyperaccumulation of heavy metals in plants is increasingly being addressed in scientific research worldwide. The reason for this is the increasing pollution of the environment with toxic trace metals, one of the primary sources of which is industry at large. Some trace metals, such as cadmium and lead, have no physiological function and are toxic even in small amounts, posing a severe threat to living organisms. Metals also include zinc, which, being a trace element, is necessary for trace amounts for optimal plant growth and development, while in high concentrations, it exhibits toxic effects. Most plant species accumulate toxic trace metals primarily in their roots. Nevertheless, there is a group of plants that accumulate from 50 to as much as 500 times more of a given metal in their aboveground parts compared to the content in the substrate, and yet these plants are able to grow and thrive despite the high metal content in their shoots. Such plants are referred to as hyperaccumulators. Often, hyperaccumulators are found in metal-contaminated areas and can be used in phytoremediation. Despite the increasing number of known species capable of hyperaccumulation, there is still little knowledge about the mechanisms of this phenomenon.

This dissertation aimed to detect and compare the physiological characteristics of several different populations of *Arabidopsis arenosa* in natural sites and metal-contaminated habitats, as well as under controlled conditions under Zn or Cd treatment. In order to investigate the ability to accumulate trace metals and the effect on physiological parameters, the content of selected elements in leaves and roots was analyzed, and photosynthetic activity and pigment content in leaves were measured.

Arabidopsis arenosa is a species closely related to *A. halleri*, considered a model species in the study of mechanisms related to tolerance and accumulation of high Cd and Zn concentrations. However, *Arabidopsis arenosa* also shows high resistance to these metals. Previous studies have shown that *A. arenosa* accumulates metals mainly in the roots, transporting only a small portion of Cd and Zn from the roots to the shoots. Both of the species mentioned above can be observed on the same sites heavily contaminated with metals in southern Poland.

The chapter titled Eksperyment I covers field and laboratory research to characterise the ecophysiology of *Arabidopsis arenosa* growing in its natural environment. Chlorophyll *a* fluorescence and pigment content were measured at 14 sites scattered across Central Europe.

Then, in the laboratory, the total metal content and the content of bioavailable forms of metals were determined in collected soil samples. Moreover, in the collected plant material, the content of selected metals in shoots and roots and the level of ploidy were examined. The presented results clearly indicate that populations from metalliferous areas show features of Zn hyperaccumulation (found for 5 out of 6 populations M) and, less frequently, Cd hyperaccumulation (3 populations M). Moreover, hyperaccumulation of Zn and/or Cd was observed only for tetraploid populations.

The chapter titled Eksperyment II compares metal accumulation and tolerance abilities in 5 selected populations of *A. arenosa* grown under controlled conditions. Two diploid populations tested were from nonmetalliferous sites, and another 3 autotetraploid populations were from metalliferous sites. Photosynthetic activity, gas exchange parameters and leaf pigment contents were measured in plants treated with Cd or Zn. The content of selected elements in both leaves and roots was also investigated. It was shown that metal-induced damage to the photosynthetic apparatus in populations from metalliferous areas was significantly less compared to populations from nonmetalliferous sites.

The results obtained in the present dissertation shed new light on hyperaccumulation in *A. arenosa*. It should be noted that it was a significant achievement to present, for the first time, several tetraploid populations exhibiting Cd and Zn hyperaccumulation characteristics. On the one hand, differences in physiological parameters between the populations studied were noted; on the other hand, harsh environmental conditions caused a similar physiological response, such as high metal pollution. All these features suggest that *A. arenosa*, especially as a new hyperaccumulator of Cd and Zn and a model of autoployploidization, can be considered a fascinating object of research, especially when studying the mechanisms of accumulation and tolerance of toxic trace metals in plants.