Abstract

Ultrastructure and photochemical characteristics of maize (*Zea mays* L.) chloroplasts under influence of root flooding

The aim of my diploma work was to evaluate the influence of hypoxic and posthypoxic stress on photosynthetic apparatus. Maize (*Zea mays* L.) of two genotypes was chosen as experimental plant. The genotype 2023 had better growth fitness, the CE704 was of worse fitness. On young maize plants, experiments were performed imposing hypoxic stress by flooding of root system and then posthypoxic stress after transfer of experimental plants into optimal cultivation conditions.

Morphological and physiological characteristics of the plants, quantity of photosynthetic pigments, photochemical activities of isolated chloroplasts (photosystem II activity as a Hill reaction activity, photosystem I activity) and especially ultrastructure of chloroplasts in leaf mesophyll cells (using transmission electron microscopy and stereology) were followed.

Roots of experimental maize plants (33 days after sowing) were flooded in pots during 9 days (hypoxic stress, A). Control plants were during that period watered optimally, other cultivation conditions (daylength, temperature) were the same for both groups of plants. 20 days after transfer of flooded plants into optimal cultivation conditions, both groups of plants (experimental and control) were tested again for posthypoxic stress (B). The experiment had two independent repetitions (I. and II.). Mature, not more growing leaves were used as the source of experimental material (coleoptile was leaf 0, 4. leaf was used for IA and IIA, 5. leaf was used for IB and IIB, for chloroplast ultrastructure study was also 4. leaf used for IB and IIB).

The results showed that the reaction of maize plants on the flooding stress depended considerably on their genotype and even on experimental series. The quantity of chlorophylls and carotenoids in the leaves declined under hypoxic and posthypoxic stress as compared with control, usually significantly. The ratio of chlorophylls to carotenoids was always lower under stress than in control plants. AHR per leaf area unit or per dry mass unit did not differ significantly between stressed and control plants, but AHR per chlorophyll quantity unit was higher in stressed plants, mostly significantly. It seemed that photosystem II was more effective under stress. The differences in photosystem I activity between stressed and control plants were mostly not significant. There were also mostly not significant differences only between both groups of plants in specific leaf mass and their relative water content.

Concerning chloroplasts ultrastructure, there was higher volume density (relative partial volume in chloroplast) of granal and intergranal thylakoids, harbouring photochemical reactions, in II. than in I. experimental series. However, the influence of hypoxic as well as posthypoxic stress on thylakoid volume density was mostly not significant in both series (more thylakoids under posthypoxic stress as compared with control for genotype 2023 in II. series was an exception). In plastoglobules, lipoid substances from thylakoid membranes accumulate during leaf senescence or under stress conditions. In CE704 genotype, it was significantly higher volume density of this compartment under stress conditions comparing with control, more considerably under posthypoxic stress than under hypoxic one – stress and leaf ageing probably summed up here. In 2023 genotype, situation was the same as in I. series, but in II. series, the difference was not significant under hypoxy, and significant, but in reverse

sense under posthypoxy (more plastoglobules in control plants). Also chloroplasts shape was with various significancy influenced by cultivation conditions, the chloroplasts were usually more flat under stress conditions.

It is possible to summarize, that root flooding influenced the photosynthetic apparatus of maize, however not very strongly and unambiguously. The quantities of photosynthetic pigments in the leaves were most affected, the activity of photosystems and chloroplast ultrastructure was influenced less.