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RESEARCH PAPER

Chloroplast parameters differ in wild type and transgenic poplars overexpressing *gsh1* in the cytosol

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ABSTRACT

Poplar mutants overexpressing the bacterial genes *gsh1* or *gsh2* encoding the enzymes of glutathione biosynthesis are among the best-characterised transgenic plants. However, this characterisation originates exclusively from laboratory studies, and the performance of these mutants under field conditions is largely unknown. Here, we report a field experiment in which the wild-type poplar hybrid *Populus tremula* × *P. alba* and a transgenic line overexpressing the bacterial gene *gsh1* encoding γ-glutamylcysteine synthetase in the cytosol were grown for 3 years at a relatively clean (control) field site and a field site contaminated with heavy metals. Aboveground biomass accumulation was slightly smaller in transgenic compared to wild-type plants; soil contamination significantly decreased biomass accumulation in both wild-type and transgenic plants by more than 40%. Chloroplasts parameters, *i.e.*, maximal diameter, projection area and perimeter, surface area and volume, surface/volume ratio and a two-dimensional form coefficient, were found to depend on plant type, leaf tissue and soil contamination. The greatest differences between wild and transgenic poplars were observed at the control site. Under these conditions, chloroplast sizes in palisade tissue of transgenic poplar significantly exceeded those of the wild type. In contrast to the wild type, palisade chloroplast volume exceeded that of spongy chloroplasts in transgenic poplars at both field sites. Chlorophyll content per chloroplast was the same in wild and transgenic poplars. Apparently, the increase in chloroplast volume was not connected to changes in the photosynthetic centres. Chloroplasts of transgenic poplar at the control site were more elongated in palisade cells and close to spherical in spongy mesophyll chloroplasts. At the contaminated site, palisade and spongy cell chloroplasts of leaves from transgenic trees and the wild type were the same shape. Transgenic poplars also had a smaller chloroplast surface/volume ratio, both at the control and the contaminated site. Chloroplast number per cell did not differ between wild and transgenic poplars at the control site. Soil contamination led to suppression of chloroplast replication in wild-type plants. From these results, we assume that overexpressing the bacterial *gsh1* gene in the cytosol interacts with processes in the chloroplast and that sequestration of heavy metal phytochelatin complexes into the vacuole may partially counteract this interaction in plants grown at heavy metal-contaminated field sites. Further experiments are required to test these assumptions.