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Enhancing Tree Resilience to Climate Change: Biotechnological Strategies and Genome Editing

T1.12 Forest genetics tools to improve forest resilience to climate change and forest health

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Abstract: Various breeding and silvicultural strategies are being pursued to adapt forest tree species and even entire forests to climate change. In particular, traits such as drought stress tolerance and resistance to already existing but also novel pathogens are two major tree breeding objectives. However, the velocity of climate change is a major problem that is difficult to reconcile with the long generation cycles of forest trees. Here, the implementation of biotechnology provides promising approaches. Plant biotechnological tools, such as tissue culture, genetic engineering and genome editing, as part of plant breeding, can contribute to a rapid climate change adaptation of forest trees. Advantageously, biotechnological treatments are not dependent on flowering and fruiting.

New possibilities and great potential are offered by genome editing techniques such as CRISPR/Cas, which are already being used intensively in crop research and for an increasing number of tree species. Some methods already developed for crop species have yet to be transferred to forest tree species. Even though the basic CRISPR/Cas mechanism seems to be rather universal, the insertion of the Cas nucleases needs to be further addressed when working with different tree species. In addition to classical, gene technology-based approaches to research, DNA-free approaches are also being pursued to generate nature-identical genetic modifications.

Genome editing is being used to characterize the function of genes and to unravel biochemical pathways. A better understanding of the genetic basis of morphological and physiological traits can support genotype-based breeding. Although most of the abiotic and biotic traits are encoded by numerous genes, modifying a few genes can quantitatively increase the resilience against the effects of climate change. However, at least in Europe, regulatory aspects have to be considered when dealing with genome editing.