

Enhancement of Tree Growth by Decrease in Xyloglucan Tethers

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An ongoing goal in the field of forest-tree biotechnology is to induce woody plants to grow faster and to increase cellulose deposition. Since woody plants have a long generation time, it is difficult to apply traditional breeding methods for their improvement. The improvements mentioned above are required not only to increase the production of timber, paper materials and energy but also to ameliorate problems from rising atmospheric carbon dioxide levels by virtue of the large carbon sink offered by trees. In this study, we sought to accelerate the growth in a forest tree by taking advantage of knowledge about growth mechanisms gained from herbaceous plants.

We examined the constitutive degradation and removal of wall xyloglucan to the loosening of the cell wall. For the expression of a xyloglucanase in poplar, we used 28 kDa xyloglucanase (*AaXEG2*) isolated from *Aspergillus aculeatus* [1]. We also exchanged the native signal sequence of the enzyme for that of poplar cellulase (*PaPopCell1*) to ensure efficient secretion [2]. The transgenic expression of xyloglucanase increases the length of stems in poplar. The decreased Young's modulus in the elongating regions of the transgenic lines is consistent with a decreased amount of xyloglucan tethers between cellulose microfibrils.

Overexpression of xyloglucanase in poplar caused an increase in cellulose content and density in the cell walls. Since the deposition of cellulose was increased in the secondary xylem of the transgenic lines as well as in the primary wall, it is possible that cellulose deposition is affected by xyloglucan cross-links. If cellulose formation is restricted by the entanglement with xyloglucan, the relaxation by resulting from cleavage of cross-linking xyloglucans may accelerate cellulose biosynthesis and deposition. We suggest that modification of sink tissue function may be a widely applicable strategy for enhancing carbon fixation. Future forestry could be greatly improved by such trees and begin a new era of wood production and quality.

REFERENCES

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