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Review

Potential transgenic routes to increase tree biomass

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ABSTRACT

Biomass is a prime target for genetic engineering in forestry because increased biomass yield will benefit most downstream applications such as timber, fiber, pulp, paper, and bioenergy production. Transgenesis can increase biomass by improving resource acquisition and product utilization and by enhancing competitive ability for solar energy, water, and mineral nutrients. Transgenes that affect juvenility, winter dormancy, and flowering have been shown to influence biomass as well. Transgenic approaches have increased yield potential by mitigating the adverse effects of prevailing stress factors in the environment. Simultaneous introduction of multiple genes for resistance to various stress factors into trees may help forest trees cope with multiple or changing environments. We propose multi-trait engineering for tree crops, simultaneously deploying multiple independent genes to address a set of genetically uncorrelated traits that are important for crop improvement. This strategy increases the probability of unpredictable (synergistic or detrimental) interactions that may substantially affect the overall phenotype and its long-term performance. The very limited ability to predict the physiological processes that may be impacted by such a strategy requires vigilance and care during implementation. Hence, we recommend close monitoring of the resultant transgenic genotypes in multi-year, multi-location field trials.

Keywords:

Tree architecture, photosynthesis, resource utilization, flowering, stress resistance, multi-trait engineering

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