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ORIGINAL PAPER

The effect of mechanical stimulation on root and shoot development of young containerised *Quercus robur* and *Robinia pseudoacacia* trees

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Abstract Thigmomorphogenesis is a well-studied process in agricultural crops and coniferous trees. Nevertheless, the effects on both shoot and root characteristics for deciduous woody species received little attention so far. In this study, the objective was to understand the effect of aboveground flexing treatments on the development of structural, mechanical and physiological root and shoot characteristics for two deciduous tree species, Black locust (*Robinia pseudoacacia* L.) and English oak (*Quercus robur* L.). Flexing treatments were performed using an electro-mechanical device with a rotating arm touching and bending the plants at regular intervals. A wide range of stem, shoot as well as root system characteristics was measured. The different flexing treatments altered above- and belowground plant development for both species, with strongest effects on *Quercus* and most significant differences between the control and the unidirectional flexing treatment. Some responses are in accordance with previous findings, such as stem eccentricity and reduced shoot elongation under unidirectional flexing, but others are renewing, such as the lower stomatal density and larger epidermal cell surface for the *Quercus* plants under variable flexing direction. Despite some common responses, both species frequently differed in the way they were affected. Belowground, *Quercus* plants under unidirectional flexing invested relatively more in their first order root and deeper second order roots, whereas *Robinia* plants allocated relatively more to fine root biomass and horizontal shallow roots. Both strategies potentially increased pull-out as well as overturning resistance in their own way. The presented findings are valid for young trees grown in small containers. Based on practical know-how and shortcomings experienced in the course of this experiment, methodological recommendations are formulated. We finally stress the complex variability in growth responses, especially for root systems, observed in different studies and related to dissimilarity in species, soil conditions, plant history or type of mechanical perturbation.

Keywords Biomechanics · *Quercus robur* L. · *Robinia pseudoacacia* L. · Root system architecture · Thigmomorphogenesis (TM)

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