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Growth strategy of Norway spruce under air elevated [CO_2]

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Plants will respond to globally increasing atmospheric CO_2 concentration ([CO_2]) by acclimation or adaptation at physiological and morphological levels. Considering the temporal onset, physiological responses may be categorized as short-term and morphological ones as long-term responses. The degree of plant growth responses, including cell division and cell expansion, is highly variable. It depends mainly on the specie's genetic predisposition, environment, mineral nutrition status, duration of CO_2 enrichment, and/or synergetic effects of other stresses. Elevated [CO_2] causes changes in tissue anatomy, quantity, size, shape and spatial orientation and can result in altered sink strength. Since, there are many experimental facilities for the investigation of elevated [CO_2] effects on trees: i) closed systems or open top chambers (OTCs), ii) semi-open systems (for example glass domes with adjustable lamella windows - DAWs), and iii) free-air [CO_2] enrichments (FACE); the results are still unsatisfactory due to: i) relatively short-term duration of experiments, ii) cultivation of young plants with different growth strategy comparing to old ones, iii) plant cultivation under artificial soil and weather conditions, and iv) in non-representative stand structure.

In this contribution we are discussing the physiological and morphological responses of Norway spruce trees cultivated in DAWs during eight consecutive growing seasons in the context with other results from Norway spruce cultivation under air-elevated [CO_2] conditions. On the level of physiological responses, we discuss the changes in the rate of CO_2 assimilation, assimilation capacity, photorespiration, dark respiration, stomatal conductance, water potential and transpiration, and the sensitivity of these physiological processes to temperature. On the level of morphological responses, we discuss the changes in bud and growth phenology, needle and shoot morphology, architecture of crown and root system, wood quality and above-ground and bellow-ground biomass increment. We found that Norway spruce ecological valence to low-light intensities and reduced soil water availability will increase. We also found that thinning will be the most powerful management tool for stand productivity enhancement as CO_2 assimilation is stimulated under high-light intensities and as Norway spruce is able to build secondary branch and root structures to reduce acclimation depression. Therefore, it is highly presumable that Norway spruce will profit from elevated [CO_2] under the conditions of sufficient nitrogen supply.

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