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Tree responses to rising CO_2 in field experiments: Implications for the futu

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ABSTRACT

The need to assess the role of forests in the global cycling of carbon and how th
the atmospheric concentration of CO_2 increases has spawned many experiments
Experiments using open-top chambers have been established at many sites to te
term responses of tree seedlings described in controlled-environments would be
growing seasons under field conditions. Here we review the results of those exp
framework of the interacting cycles of carbon, water, and nutrients, because tha
the ecosystem models that are being used to address the decades-long response

Our analysis suggests that most of what was learned in seedling studies was qua
evidence from field-grown trees suggests a continued and consistent stimulation
about 60% for a 300 ppm increase in [CO_2], and there is little evidence of the lo
sensitivity to CO_2 that was suggested by earlier experiments with tree seedlings
importance of respiration to a tree's carbon budget, no strong scientific consensu
concerning the potential direct or acclimation response of woody plant respirati
The relative effect of CO_2 on aboveground dry mass was highly variable and gre
by most syntheses of seedling studies. Effects of CO_2 concentration on static me
confounded with the acceleration of ontogeny observed in elevated CO_2. The tre
chamber experiments were in an exponential growth phase, and the large growth
CO_2 resulted from the compound interest associated with an increasing leaf area
expected to persist in a closed-canopy forest where growth potential is constrain
leaf area index. A more robust and informative measure of tree growth in these

annual increment in wood mass per unit leaf area, which increased 27% in eleva
support for the conclusion from many seedlings studies that root-to-shoot ratio i
CO_2; fine root production may be enhanced, but it is not clear that this response
forest. Foliar nitrogen concentrations were lower in CO_2-enriched trees, but to a
indicated in seedling studies and only when expressed on a leaf mass basis. The
litter C/N ratio would increase was not supported in field experiments. Also con
studies, there is little evidence from the field studies that stomatal conductance i
by CO_2, but this is a topic that demands more study.

Experiments with trees in open-top chambers under field conditions have provic
larger-scale responses of trees to elevated CO_2 under field conditions, confirmed
conclusions from previous seedling studies, and challenged other conclusions. T
obstacles to using these experimental results to predict forest responses to rising
are valuable nonetheless for guiding ecosystem model development and revealin
that must be addressed in new, larger-scale CO_2 experiments.

Key-words: atmospheric carbon dioxide, forests, global change, open-top chamb