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The sweet side of global change - elevated CO_2 increases non-structural carbohydrates in trees but not drought and N fertilization

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Non-structural carbohydrates (NSC) play a central role in plant functioning as energy carriers and building blocks for primary and secondary metabolism. Many studies have investigated how environmental and anthropogenic changes, like increasingly frequent and severe drought episodes, elevated CO_2, and atmospheric nitrogen deposition, influence NSC concentrations in individual tree species. However, this wealth of data has not been analyzed yet to identify general trends using a common statistical framework. Here we compiled data from 57 experimental studies on 71 tree species and conducted a meta-analysis to evaluate general responses of stored soluble sugars, starch and total NSC in different tree organs (foliage, stems/branches and roots) to drought, elevated CO_2 and nitrogen deposition. Our results indicate that drought significantly decreased total NSC in roots (-17.3%), but not in foliage and stems/branches. Elevated CO_2 significantly increased total NSC in foliage (+26.2%) and roots (+12.8%), but not in stems/branches. By contrast, total NSC from N fertilization significantly decreased in roots (-17.9%), increased in stems/branches (+6.1%), but had no significant effect in foliage. These results pave the way for understanding general dynamics of NSC concentrations in trees following drought, elevated CO_2 and N fertilization, and highlight knowledge gaps where further investigations are required.