Interactive effect of relative humidity and elevated CO_2 on C and N metabolism of two barley genotypes

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While elevated CO_2 (eCO_2) might stimulate carbon assimilation, previous studies show that impaired nitrogen assimilation can condition responsiveness of photosynthetic apparatus. Switches in RH can influence nutrient uptake due to its effect on the transpiration rate. Our goal was to investigate the interactive effects of eCO_2 and RH on plant physiology and C/N coordination in source/sink organs of two barley genotypes (Harrington and RCSL-89). Physiological and biochemical analyses were performed in 11-week-old plants grown under ambient and eCO_2 (700 ppm) at 65% RH and 5 days after being exposed to a RH of 45%. eCO_2 increased photosynthesis while the fall of RH increased transpiration rate. eCO_2 decreased flag leaf dry matter, but increased ear biomass with no significant interactions with RH. eCO_2 inhibited N metabolism and decreased transcripts for Rubisco in both genotypes at leaf level. However, ear N content highlighted that eCO_2 enhanced N assimilation and/or translocation to the ears (+40% in Harrington and +31% in RCSL-89), probably due to the large availability of carbon skeletons for the synthesis of nitrogen compounds. In fact, the foliar glucose, fructose and sucrose content decreased in Harrington and fructans in RCSL-89, but not starch. A lower RH (higher transpiration) decreased slightly ear N content in Harrington (-16%) and severely in RCSL-89 (-47%), associated with an accumulation of sugars and ammonium in both genotypes while photosynthetic genes were upregulated, especially in RCSL-89. When lower RH was combined with a high carbon supply (eCO_2) favoured N assimilation and translocation to ears in Harrington (+91%) and RCSL-89 (+56%). Sugar content decreased mainly in Harrington, linked to a lower expression of fructosyltransferases and revealing a good C/N coordination supporting grain filling. In summary, eCO_2 stimulated nutrient allocation to grain filling in well-fertilised barley plants, particularly when transpiration rate was stimulated by lower RH in a genotype-specific manner.