

Inside-out: synergising leaf biochemical traits with stomatal-regulated water fluxes to enhance transpiration modelling during abiotic stress.

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Abstract

With continued global warming, plants are forecast to increasingly experience abiotic stress(es). Stomata on leaf surfaces are the gatekeepers to plant interiors, regulating gaseous exchanges that are crucial for both photosynthesis and outward water release. To optimise future productivity, accurate modelling of how stomata govern plant-environment interactions will be crucial. Here, we synergise optical and thermal imaging data to enhance transpiration modelling during water and/or nitrogen stress. By utilising hyperspectral data and partial least squares regression analysis of six plant traits and fluxes in wheat (*Triticum aestivum*), we have developed a new spectral vegetation index; the combined nitrogen and drought index (CNDI), which can be used to detect both water stress and/or nitrogen deficiency. Upon full stomatal closure during drought, CNDI reduces as leaf biochemistry changes unfold, and during a combined stress experiment (drought and nitrogen deficiency), this is reflected in CNDI showing a strong relationship with leaf relative water content ($r^2 = 0.70$). By incorporating CNDI transformed with a sigmoid function into thermal-based transpiration modelling, we have increased the accuracy of modelling water fluxes during abiotic stress. If employed using future remote sensing technologies, our findings have the potential to markedly improve agricultural water usage and yields.

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