CABBI
CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

# Constitutive Down-regulation of Liguleless Alleles in Sorghum Drives Increased Productivity and Water Use Efficiency

## Background/Objective

Plant architecture influences the microenvironment throughout the crop canopy. Plants with a more erect leaf architecture allow more light to reach lower canopy leaves. An anatomical feature of grasses that impacts leaf angle is the articulated junction of the sheath and blade, which bares the ligule and auricles. Mutants of the liguleless genes *Sb*LG1 and *Sb*LG2 lack ligules and auricles and show no articulation at this junction, resulting in leaves that are near vertical. Ideally, leaves will be more vertical, but too vertical is damaging to light interception. Here a different approach was taken, down-regulation of the liguleless genes to achieve a less severe phenotype. They were used in the field to test the hypothesis that within the same genetic background, this downregulation would significantly increase canopy light penetration, photosynthesis, biomass production, and grain yield without more water use.

## Approach

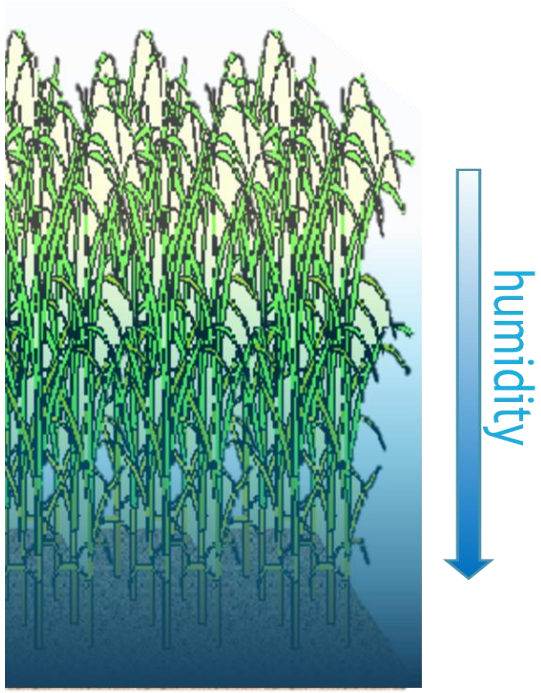
A hair-pin element was assembled into a binary vector and introduced into sorghum, grain genotype RTx430, to create a sorghum with reduced leaf angles. Derived sorghum events carrying this hair-pin were characterized at the molecular and phenotypic level in the greenhouse. Three lead independent events were selected for erect leaf angle and used for replicated 4-row plot field trials over two growing seasons.

## Results

Derived transgenic events harboring the hair-pin failed to develop ligules and displayed reduced leaf angles to the vertical, but less vertical than in null mutations. Under field settings, plots sown with these events showed an increase in photosynthesis in lower canopy levels, increased shoot biomass and seed yield, without an increase in water use.

## Significance/Impacts

This study provided proof-of-concept of the value of bioengineering sorghum leaf angle to confer greater photosynthetic carbon gain, biomass production, and yield without greater extraction of soil water. These findings are an important step in a design-build-test-learn cycle towards the creation of the ideotype sorghum ‘smart canopy’, showing measured increase in leaf blade angle as a means to sustainably deliver boosts in both grain and biomass for the bioeconomy.




**Example humidity gradient of a crop canopy.**

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