Flowering Time in Switchgrass is Affected by an Amino Acid Variant in a Key Gene

Background

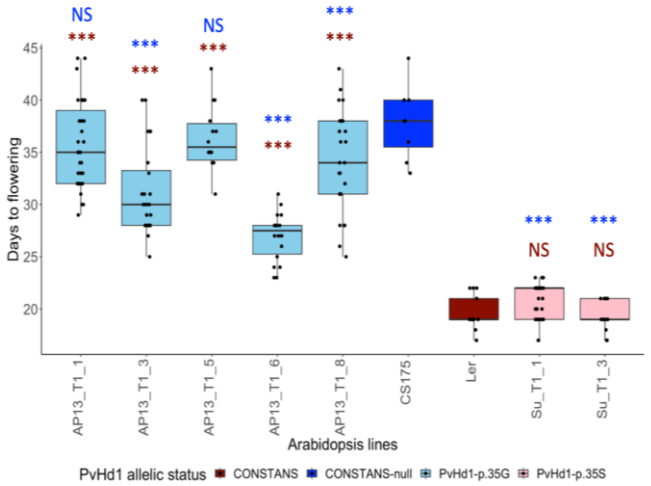
- Biomass yield is the main driver that determines fuel cost for switchgrass as a bioenergy feedstock. Delayed floral transition contributes to higher biomass production. Hence, there is considerable interest to identify the genetic variants governing the differential photoperiodic flowering time.
- Mutations in floral development genes may explain the difference in flowering time between the early flowering upland ecotype and the later flowering lowland ecotype in switchgrass (*Panicum virgatum*).

Approach

- Quantitative trait loci (QTL) analyses were conducted on flowering time data collected over three years in an F_2 population segregating for upland-lowland traits. Genes underlying the Chr04K QTL were assessed for allelic variation between the upland and lowland parents.

Results

- The QTL analysis identified *PvHd1*, -- an ortholog of *Heading date 1* (*Hd1*) in rice and *CONSTANS* (*CO*) in Arabidopsis, as the strongest candidate gene. *Hd1* carries a mutation in a highly conserved amino acid in lowland compared to upland switchgrass.
- Protein modeling predicted that the P35G PvHd1 variant, found in low land allele leads to a more compact protein; this result was supported by the higher temperature needed to denature the *in vitro* lowland allele compared to the upland allele.
- Transformation of both alleles in an Arabidopsis *CO*-null mutant demonstrated rescue of the early flowering phenotype seen in the *L*er wild-type for transformants carrying the upland allele. Transformants carrying the lowland allele had flowering times like the *CO*-null mutant or intermediate between the *CO*-null and *L*er wild-type, suggesting that the lowland allele has a reduced ability to induce early flowering.



Variation in flowering time between *CO*-null (dark blue), *L*er (red), and transformants with lowland (AP13) allele (light blue) and upland (Summer) allele (pink)

Significance

- Lowland ecotypes are preferred because of their high biomass yields. Typically, they undergo winter kill in Northern regions. Elucidation of the *PvHd1* mutation provides us with a tool to accelerate flowering of lowland switchgrass for better adaptation to Northern latitudes, ultimately broaden switchgrass cultivation areas.

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