Sorghum is a resilient cereal that can be used to produce grain, sugar, and biomass. To fully exploit sorghum diversity and accelerate genetic improvement for different end uses, we need to understand which alleles are critical for distinguishing grain, sweet, and biomass sorghum ideotypes. To address this need, we performed genome-wide association and genomic prediction separately in panels of sweet sorghum and biomass sorghum. We find that different alleles at the sorghum *Dry Stalk (D)* locus increase yield in sweet sorghum and biomass sorghum. In sweet sorghum, green juicy midribs (*dd*) are associated with higher juice and sugar yield. In biomass sorghum, white dry midribs (*D-*) are associated with lower moisture, lower stalk lodging, and higher biomass yield. Analysis of *D* locus NILs confirms these phenotypic effects and suggests that the *D* locus affects vascular development.