

**Developing association mapping in polyploid perennial grasses: I. Switchgrass (*Panicum virgatum*)**

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Switchgrass (*Panicum virgatum* L.) is a polyploid perennial forage grass with a high biomass production potential that has been targeted for biofuels. To enable genomic selection and genome-wide association analysis in this species, germplasm resources, including both bi-parental linkage populations and association populations, were developed. We genotyped a total of 540 plants, using a genome-wide, high throughput approach called genotyping-by-sequencing (GBS). Three genetically distinct subgroups were identified using these markers: Lowland tetraploid [4X], upland tetraploid [4X] and upland octoploid [8X]. This same germplasm was simultaneously phenotyped for multiple morphological and developmental traits, related to flowering time and plant architecture, as well as, biomass quantity and quality. Summary statistics for a subset of these are shown below. The data were collected from 18 lowland 4X populations (total plants =136), 14 upland 4X populations (n=120), and 27 upland 8X populations (n=226), all of which were grown in Ithaca, NY for three field seasons. All phenotypes are significantly associated with ecotype/ploidy level at  $\alpha=0.05$ , and are highly heritable. This work focuses on statistical models that use the genotypic and phenotypic data collected from our highly diverse association populations for quick and accurate identification of genomic regions of interest, as well as favorable lines for use in breeding programs. The challenges that arose during the development of these models are presented and addressed. Successful implementation of these approaches has the potential to reduce standard breeding cycles of perennial grass species from five or more years to one or two years.

Heritabilities, means, and standard deviations for three subgroups of switchgrass.

Ecotype/Ploidy	Phenotype	Heritability <sup>§</sup>	Mean	S.D. <sup>¶</sup>
Lowland/4X	Anthesis Date <sup>†</sup>	0.97	3901.92	542.68
	Standability <sup>‡</sup>	0.87	5.89	1.80
	Leaf Width (mm)	0.91	13.86	2.89
	Plant Height <sup>°</sup> (cm)	0.87	84.73	29.81
Upland/4X	Anthesis Date	0.95	3586.43	474.21
	Standability	0.87	5.42	1.63
	Leaf Width	0.82	12.29	2.63
	Plant Height	0.84	88.35	22.68
Upland/8X	Anthesis Date	0.90	3883.74	422.17
	Standability	0.93	4.40	1.91
	Leaf Width	0.83	13.53	2.35
	Plant Height	0.74	90.39	19.47

<sup>†</sup>Measured in growing degree days (86°F/32°F)

<sup>‡</sup>Measured using a visual scale (0 (prostrate) – 10 (upright))

<sup>§</sup>Heritability on a line mean basis

<sup>¶</sup>S.D., Standard deviation

<sup>°</sup>Plant height measured from base of longest flowering stem to the node at the base of the panicle.