Stem anatomy of switchgrass plants developed by divergent breeding cycles for tiller digestibility

G. Sarath[1], K.P. Vogel[1], R. Mitchell[1] and L.M. Baird[2]
[1]USDA-ARS, 344 Keim Hall, University of Nebraska, PO Box 830937, Lincoln, NE 68583-0937, Email: gsarath1@unl.edu, [2]University of San Diego, San Diego, CA 92110, USA

Keywords: breeding strategy, anatomy, herbage digestibility

Introduction Switchgrass (*Panicum virgatum*. L.) is an important perennial forage and biomass crop that is native to the temperate prairies of the North America east of the Rocky Mountains. Breeding for improved forage *in vitro* dry matter digestibility (IVDMD) has been conducted using post-heading, whole-tiller IVDMD as the selection criterion (Hopkins *et al*., 1993; Vogel *et al*., 2002). One breeding cycle (C-1) for low IVDMD and three cycles for high IVDMD (C1, C2, C3) were completed in a switchgrass population adapted to the USA mid-latitudes. Sward trials demonstrated that whole plant IVDMD had been improved (Hopkins *et al*., 1993). This study reports on changes in plant anatomy of plants from populations divergently bred for whole tiller IVDMD.

Materials and methods Seedlings of each population were transplanted on 1.1 m centres into a replicated field nursery in eastern Nebraska, USA in 2002. After heading, ten tillers of each plant from the C-1 and C3 populations were sampled in 2002 and 2003 and dissected into leaf, stem, and sheath. Based on tissue IVDMD, lignin, cell wall, cellulose, and hemicellulose concentrations, ramets of specific plants were transplanted into greenhouse pots where the cloned plants were grown to maturity. Plants from the C-1 and C3 populations were sampled for anatomical analysis. The anatomy of the second internode below the peduncle was evaluated by light microscopy using conventional procedures.

Results Four representative micrographs of internode sections stained for lignin (Maule's stain) are shown in Figure 1. Sections from C-1 plants (low IVDMD population) showed a large amount of lignified fibres cells just below the epidermis (A & B). Additional zones of lignification were seen around vascular bundles. The cell walls of the cortical parenchyma in these plants exhibited greater secondary cell wall deposition. Plants from the C3 (high IVDMD) population had fewer cortical fibres below the epidermis and in the lignified sheaths surrounding the vascular bundles (C). There also was substantially less secondary cell wall thickening. Some plants of the C3 population had high stem lignin concentration but still had altered plant anatomy (D).

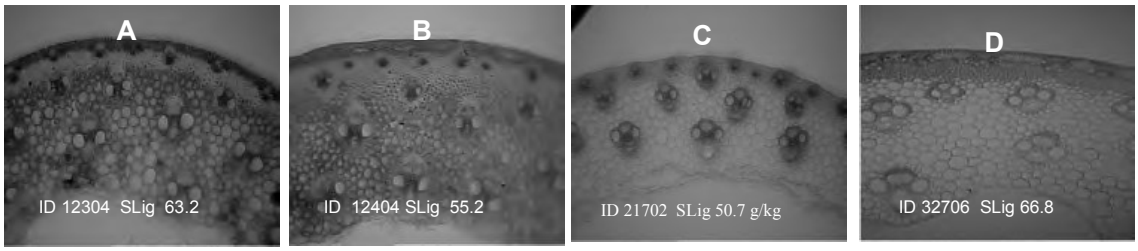

Figure 1 Internode sections stained for cell wall composition. ID = plant ID number; SLig = stem lignin

Conclusions Multiple cycles of breeding for IVDMD produced plant populations which differ significantly in digestibility and lignin concentration (data not shown). In the stems of switchgrass, changes in lignin appear to involve two primary mechanisms: (1) the loss or decrease in cortical fibres and (2) changes in secondary cell wall deposition. These results indicate that plant anatomy can be significantly impacted through a simple selection tool, strongly suggesting that the genes that control these functions will be attractive targets for future manipulation.

References

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