IMPACT OF GROWTH ENVIRONMENT VARIABILITY ON ALFALFA YIELD, CELLULOSIC ETHANOL TRAITS, AND PAPER PULP CHARACTERISTICS

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Alfalfa is a promising bioenergy feedstock due to its high yield, nitrogen-fixation capacity, high net energy ratio, potential for planting in rotation with corn, and valuable protein co-product (leaf meal). Our objective was to examine the effect of growth environment on biomass yield, cellulosic ethanol traits, and paper pulp fiber characteristics of alfalfa. Landscape position (hilltop and mild slope), season of harvest (four harvests/year), and multiple years (2005 and 2006) were sources of environmental variation with two replicates of each landscape position. Alfalfa was harvested at bud maturity stage to determine whole herbage yield and stem proportion. Alfalfa stem samples were analyzed for cell-wall carbohydrate and lignin concentration. A lab-scale conversion test was developed to assess differences in susceptibility to sugar release for ethanol production via dilute acid/high-temperature pretreatment and enzymatic saccharification. Stems were also de-fibered using Franklin Solution to measure relevant fiber characteristics (fiber length, width, and fines). Yield varied across harvests in 2005 (880 to 3,840 kg ha^{-1}) and 2006 (2,400 to 9,520 kg ha^{-1}) with higher yields in 2006. Stem proportion was less variable between years, but typically declined with later harvests (23 to 54.8 percent). Cell-wall glucose concentration varied dramatically across harvests and years (197.8 to 321.9 g kg^{-1} DM) and glucose release efficiency was similarly variable (45.1 to 84.7 percent). Xylose concentration (60 to 112.5 g kg^{-1} DM) and release (59.8 to 82.2 percent) were also variable among harvests and years. Pulp fiber length did not vary with growth environment; however, fiber width and fines content differed among harvests and years. Landscape position was not a significant source of variation for alfalfa biomass trait. Industries hoping to utilize alfalfa biomass, harvested multiple times each year, for cellulosic ethanol and paper manufacturing must be prepared for significant feedstock quality variation due to growth environment.

KEY WORDS: alfalfa, environment, yield, cellulosic ethanol, fiber length

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