



Screening for Tolerance to Saturated Soil Conditions for Cane Grown for Sugar and Biofuels Production

Louisiana sugar cane (*Saccharum spp.*) is often produced on heavy-textured soils which offer less than ideal conditions for growth and function of the root system especially with frequent and heavy rains common to the sugar cane growing area of South Louisiana. These fields rely on gravitational drainage and often remain saturated for extended periods during the growing and harvest season. Field research in Florida showed that growing sugar cane on soil with a high water table, which is similar to water-saturated soil conditions, resulted in a 25% yield loss. The considerable variability in yields among commercial varieties grown on high water table soils suggested that germplasm screening of promising sugar cane genotypes could result in varieties that maintain high yields when grown on saturated soils (Glaz et al., 2002).

In addition to sugar cane grown for sugar production, certain biomass crops, such as energy cane, may be well suited to marginal sites such as these heavy-textured and often saturated fields that do not favor sugar cane production. Energy cane is defined as high fiber sugar cane grown primarily as a biofuels feedstock and not solely for sugar production. Inter-generic and inter-specific *Saccharum* hybrids of commercial sugar cane with *E. arundinaceus* and *S. spontaneum* grew well under water-saturated soil conditions in Florida; these energy canes appeared to have good potential for biomass production in areas prone to water-saturated soil conditions (Deren et al., 1991). Thus, the objective of this research was to identify commercial sugar cane and energy cane varieties that exhibit tolerance to periodic saturated soil conditions under Louisiana growing conditions.

Field experiments were planted on August 2006 and 2007 at the USDA National Resource Conservation Service Plant Material's Center located in Galliano, LA on a Rita muck soil at a seeding rate of three running whole stalks with a 10% overlap. Plot size consisted of a single 1.8 m row that was 4.9 m long with four replications. Plant responses were measured in the plant-cane crops in 2007 and 2008. The plot size was smaller than desired due to limited access to machinery since this experiment was conducted in an area outside of the traditional cane-growing area of South Louisiana. Two energy cane varieties, L 79-1002 and US 01-12, and thirteen sugar cane varieties were evaluated for tolerance to saturated soil conditions during the plant-cane crop. For this article we will focus on the energy cane and the main commercial sugar cane varieties grown in Louisiana including: HoCP 96-540, L 99-226, and L 99-233. To simulate saturated soil conditions, sections of the field were flooded with surface water for five consecutive days each month from February to August. Other sections were levied off to provide a control representing ideal drainage.

Stalk counts were taken in August before hand-harvesting in September in both 2007 and 2008. A continuous section of row

was hand-cut to collect a 15-stalk sample. Stalks were weighed, stalk height was recorded, and stalk diameter was measured at the top, middle, and bottom of five stalks in each plot. Stalk volume was estimated from stalk diameter and height; this volume was used along with stalk weight to determine stalk density. After stalk measurements were taken, stalks were crushed using a roller mill to extract juice for juice quality, Brix and Pol, determinations. Variety correction factors developed previously for all varieties were used to account for differences in fiber levels used in the calculation of theoretically recoverable sucrose levels (kg/Mg). Cane yields (Mg/ha) were estimated based on stalk population and stalk weights. Sucrose yields (kg/ha) were based on cane tonnage and theoretically recoverable sucrose levels.

The commercial sugar cane varieties HoCP 96-540 and L 99-226 showed a respective 18 and 29% reduction in sucrose yields when grown in plots that were periodically saturated compared to the adequately-drained control plots. The decreases in sucrose yields were due to reductions in cane height (2-6%), stalk population (10-18%), stalk density (7-20%), cane tonnage (7-23%), and sucrose concentration (3-5%). In contrast, L 99-233 had similar sucrose yields for the saturated and control treatments. Under the periodically saturated conditions, the sucrose yields of L 99-233 (8600 kg/ha) were higher than that of HoCP 96-540 (8000 kg/ha) and L 99-226 (7500 kg/ha). The increase in sucrose yields with L 99-233 equates to an increase in gross revenue by \$375/ha. It must be noted that when these varieties were grown under conditions of adequate drainage in this experiment, L 99-233 had sucrose yields that were 1300 and 2000 kg/ha lower than HoCP 96-540 and L 99-226, respectively. These results suggest that soil properties and the possibility of soil saturation for extended periods should be considered when deciding which varieties to plant in each field.

The periodic saturation of the soil also reduced yields of the two energy cane varieties. Cane tonnage was decreased by 11 and 4% for US 01-12 and L 79-1002, respectively, where plots were periodically maintained under saturated conditions compared to the adequately-drained control plots (103 and 78 Mg/ha, respectively). However where the soil was periodically saturated, sucrose yields were increased by 640 and 1600 kg/ha for US 01-12 and L 79-1002, respectively, relative to the control plots (4000 and 1600 kg/ha). Depending on what is used to produce biofuels (fiber and/or sucrose), saturated soil conditions may improve energy yield per unit land area.

When oil prices peaked in July of 2008 at almost \$150 a barrel, biofuels seemed to have a promising future. Energy experts speculated that with few exceptions, energy from fossil fuels would be more costly than the same amount of energy

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supplied through biomass conversion. With oil recently trading as low as \$38 a barrel, the above statement is no longer valid. Fossil fuel prices will certainly rise again, and at some point supply will not meet demand. Sugar production has always been a mainstay crop for Louisiana, so research at the USDA ARS Sugarcane Research Laboratory at Houma, Louisiana, will continue to focus

primarily on sugar production, but biofuels production will eventually be a viable companion industry. Therefore, we are also committed to research focused on the agronomics of biofuel feedstock production.

Deren, C.W., G.H. Snyder, P.Y.P. Tai, C.E. Turick, and D.P. Chynoweth. 1991. *Biomass production and biochemical methane potential of*

seasonally flooded inter-generic and inter-specific Saccharum hybrids.

Biores. Technol. 36:179-184.

Glaz, B., S.J. Edme, J.D. Miller, S.B. Milligan, and D.G. Holder. 2002.

Sugarcane cultivar response to high summer water tables in the Everglades.

Agron J 94:624-629.

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La saturación periódica del suelo también redujo los rendimientos de las dos variedades de caña de energía. El tonelaje de caña decreció en un 11 y 4% para la US 01-12 y la L 79-1002, respectivamente, cuando las parcelas fueron periódicamente mantenidas en condiciones saturadas, en comparación a las parcelas testigo adecuadamente drenadas (103 y 78 Mg/ha, respectivamente). Sin embargo, en los lugares donde el suelo estuvo periódicamente saturado, los rendimientos de sacarosa se incrementaron en un 640 y 1600 kg/ha para la US 01-12 y la L 79-1002, respectivamente, comparados con las parcelas testigo (4000 y 1600 kg/ha). Dependiendo del propósito para producir biocombustibles (fibra y/o sacarosa), las condiciones saturadas de suelo pueden aumentar el rendimiento de energía por unidad de área.

Cuando los precios del petróleo alcanzaron un máximo de casi \$150 el barril en julio del 2008, los biocombustibles parecieron tener un futuro prometedor. Los expertos en

energía especularon que con pocas excepciones, la energía a partir del petróleo llegaría a costar más que la energía suplida con la conversión de biomasa. Pero el reciente descenso de los precios del petróleo a niveles tan bajos como \$38 el barril, la anterior afirmación ya no tiene validez. No hay duda de que los precios del crudo subirán nuevamente y llegará un momento en que el suministro no supla la demanda. La producción de azúcar ha sido siempre un cultivo prevalente en Louisiana, de manera que las investigaciones en el Laboratorio del USDA en Houma, Louisiana continuarán enfocándose principalmente en la producción de azúcar, aunque la producción de biocombustibles eventualmente se convertirá en una industria paralela factible. Por consiguiente, estamos también comprometidos a realizar investigaciones enfocadas al aspecto agronómico de la producción de materia prima para biocombustibles.

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Translated by Hera Acuna.

Email: hacuna@nc.rr.com

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Sugar Industry Equipment, Inc.

Post Office Box 40962 • Baton Rouge, LA 70835-0962
Telephone: 225-298-5519 E-Mail: sugar@sugarandpower.com
Fax: 225-298-0863 <http://www.sugarandpower.com>

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