Violation of Assumptions in Analysis of Variance Obscure Interpretation of Binary Data: The Case for Cross Resistance in Sugarcane to the Sugarcane and Mexican Rice Borers

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The Mexican rice borer, *Eoreuma loftini* (Dyar), has supplanted the sugarcane borer, *Diatraea saccharalis* (F.), as the dominant insect pest of the Texas sugar industry. It continues to expand its range and now threatens the sugar industry in Louisiana, where the sugarcane borer is still the dominant pest. Cross-resistance in sugarcane to the two pests would capitalize on an ongoing ‘Recurrent Selection for Sugarcane Borer’ (RSB) program in Louisiana to benefit both the Texas and Louisiana sugar industries.

In 2004 80 sugar cane varieties from the Texas (50) and Louisiana (30) breeding programs were planted in Texas into a randomized complete block design with four replications. The Texas varieties were selected at random with no prior knowledge of their reaction to either pest while some of the Louisiana varieties originated from the RSB gene pool. Individual plots were 6 m in length. Random 10-stalk samples were collected from each plot in 2005 (plant cane) and 2006 (first ratoon cane) for damage evaluation. Damage was measured as percent borer-damaged internodes by both pests.

Compared to the sugarcane borer, the Mexican rice borer was the predominant species responsible for borer-damaged internodes in both the plant (23% ± 0.62 vs. 7% ± 0.33) and first ratoon (21% ± 0.55 vs. 5.2% ±0.35) cane crop-years. There appeared to be similar (22%) levels of Mexican rice borer damage among the Texas and Louisiana varieties, while the difference in sugarcane borer damage between the Texas (6.4 ±0.32) and Louisiana (5.1 ±0.36) varieties was apparently minimal. However, because the proportion of borer-damaged internodes is inherently a binary data and should follow a binomial distribution, several assumptions are violated when performing the analysis of variance (ANOVA). This could obscure subtle but important trends in the data. Further analyses of the data were, therefore, carried out by applying a mixed ANOVA-Regression model using the Proc Mixed command and a Log Linear Regression (Odds Ratio) model using the Proc Genmod command implemented in the SAS software.

When percent borer-damaged internodes for sugarcane borer was fitted as a covariate in the ANOVA-Regression model, the data suggested evidence of cross-resistance between the Mexican rice borer and the Sugarcane borer among the Louisiana ($Pr > |t| = 0.0008$) but not the Texas ($Pr > |t| = 0.2083$) varieties. Results from Log Linear Regression suggested that Louisiana varieties were 29% (19 – 39%: Confidence Interval) more likely to be damaged by the Mexican rice borer compared to Texas varieties whereas Texas varieties were 51 % (or 31 – 75%: Confidence Interval) more likely to be damaged by the sugarcane borer compared to Louisiana varieties. The implications of these results to the Louisiana and Texas sugar industries will be discussed.

Status of Sugarcane Orange Rust in Florida

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In late June 2007, an outbreak of rust was observed in Florida on CP 80-1743, a variety previously resistant to brown rust caused by *Puccinia melanocephala*. The rust appeared only on the upper leaves and the pustules were all young actively sporulating and symptoms did not appear typical of brown rust. Closer morphological observations followed by molecular verification identified the pathogen as *Puccinia kuehnii*, the causal agent of orange rust a sugarcane disease previously found only in South East Asia and Australia. Unlike brown rust, orange rust development did not diminish with warmer temperatures of summer and continued to develop on this variety throughout the remainder of the growing season. Growers reported a decrease in sucrose in CP 80-1743 resulting from defoliation and the growth of new shoots late in the season. In February 2008, CP 80-1743 plant crop fields had severe orange rust development that has not decreased since then. Consequently, this variety is no longer recommended for commercial production in Florida. Due to the longer period of orange rust development it may be more damaging than brown rust. Disease ratings for current commercial cultivars, disease distribution within Florida, the Caribbean basin, and Central America and screening methodology will be discussed.

FREE AMINO ACIDS- DETERMINANT OF SUGARCANE RESISTANCE/SUSCEPTIBILITY TO STALK BORERS AND SAP FEEDERS

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Sugarcane is attacked by a complex of insect pests including stalk borers and leaf sucking insects. Larvae of stalk borers such as the Mexican rice borer have chewing mouth parts and feed on the whole leaf tissue, whereas most plant sucking insects such as aphids have stylets and feed on the phloem sap. Our studies have shown that the composition and concentration of free amino acids, primary plant metabolites, have significant roles in determining sugarcane susceptibility/resistance to aphids and stalk borers. The Mexican rice borer prefers drought stressed plants and has a strong ovipositional preference for senescing leaves. High performance liquid chromatography analysis of whole leaf tissues indicates that several free essential amino acids increased in sugarcane leaves under drought stress. This increase was associated with Mexican rice borer oviposition and injury. Analysis of phloem sap composition of susceptible and resistant varieties revealed that two essential free amino acids were missing in the phloem sap of the aphid-resistant variety. Furthermore, analysis of honeydew samples indicated that

aphids feeding on the resistant variety were unable to obtain two essential and two non-essential free amino acids.

Impact of Brown Rust in Louisiana and 2007 Fungicide Testing Results

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Brown rust, caused by *Puccinia melanocephala*, has been a cyclical problem in Louisiana since it first appeared in the 1970s. Control of brown rust has relied on the development and cultivation of resistant varieties. The amount of loss caused by the disease was not documented until after the number one commercial variety, LCP 85-384, experienced a sudden and severe rust epidemic in 2000. Yield loss estimates determined by comparing plots treated with fungicides to non-treated plots have ranged from 16-21% for cane tonnage and 11-28% for total sucrose yield. The most consistent effect on yield has been a reduction in stalk weight, but stalk population and stalk sugar content also can be adversely affected. The magnitude of the demonstrated losses strongly suggested that the feasibility of an alternative control measure based on fungicide applications should be explored. Fungicide efficacy experiments were continued during 2007. Multiple fungicides were compared singly and in combination. Image analysis performed on leaves collected from different treatments was used to determine and compare the ability of fungicides to reduce brown rust severity. Yield components were then determined and compared at the end of the growing season. Strobilurin fungicides were more effective than triazole fungicides in reducing rust symptom severity and preventing yield loss. Although, combinations of the two fungicide types often provided numerically superior results to the application of a strobilurin fungicide alone. The results indicate that treatment with some fungicides can provide economic benefits for sugarcane farmers when a variety is severely affected by rust. The spring epidemic period in Louisiana can last more than two months, so multiple applications of fungicides are needed. The yield response to fungicide treatment was greater when the epidemic began at the end of April compared to mid-May. Fungicides applied in late June did not improve yield. Additional research is needed to determine when and how to use fungicides to maximize economic benefit, but the research has demonstrated that fungicides can provide an alternative brown rust control measure in Louisiana that will be helpful when varieties become susceptible to rust. Host plant resistance will continue to be the most desirable control method for brown rust. However, the adaptability of the pathogen and difficulty in quickly changing varieties in sugarcane has created periods when rust causes significant economic losses. A fungicide control program can minimize losses during those times. The introduction of orange rust, caused by *Puccinia kuehnii*, into Florida and coming introduction into Louisiana has created an additional need for a fungicide control option.

Sugarcane Brown Rust – Determining Genetic Variation in the Pathogen and Identifying Potential Novel Sources of Resistance

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A major reason for the withdrawal of sugarcane cultivars from production in is the breakdown of resistance to brown rust caused by *Puccinia melanaocephala*. Genetic characterization of diversity among races of *P. melanocephala* would help in breeding for resistance to the pathogen. Breeding for durable resistance could also be improved through the identification and utilization of novel sources of resistance, such sources may be present within *Saccharum spontaneum*. The objectives of this work were i) to develop SSR markers for the brown rust pathogen *P. melanocephala* and ii) to characterize the sensitivities of a set of *S. spontaneum* clones taken from the sugarcane world collection.

Several approaches were examined for developing SSR markers to *P. melanocephala*. SSR markers for the cereal rust fungi *P. graminis, P. striiformis* and *P. triticina* were examined but all were ineffective against DNA from *P. melanocephala*. Secondly, mining the *P. graminis* genome for SSR's followed by genus level homology searches by BLAST analysis also proved to be a poor means of identifying sequence candidates for cloning SSRs. Finally DNA of *P. melanocephala* was used to produce a genomic library enriched for primarily dinucleotide repeats. Several hundred enriched fragments were sequenced and assembled, of these 120 were amenable to primer design.

To identify potentially novel sources of brown rust resistance, approximately 200 clones of *Saccharum spontaneum* were retrieved from the sugarcane world collection and tested for brown rust susceptibility using previously described whorl inoculation methods. Three tillers from each clone were inoculated and experiments were repeated three times, disease severity was recorded according to a five point scale of 0 (resistant) to 4 (highly sensitive). Clones were observed in each rating category.

Approaches to utilizing the analysis of variation in *P. melanocephala* through SSR genotyping and these potentially novel sources of resistance within *S. spontaneum* are discussed.

Virus Strains Causing Mosaic in Louisiana and Florida Sugarcane

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Mosaic caused by *Sugarcane mosaic virus* (SCMV) and *Sorghum mosaic virus* (SrMV), respectively, affects sugarcane in Louisiana and Florida. Between 2004 and 2007, surveys were conducted in both states to determine which virus and virus strains were causing mosaic of sugarcane. In Louisiana, leaf samples were collected from 317 sugarcane plants expressing mosaic symptoms; and in Florida, 108 leaf samples were collected from plants with and without mosaic symptoms. Reverse transcriptase-polymerase chain reaction (RT-PCR) was used to identify SCMV and SrMV isolates associated with the diseased plants. No SCMV isolate was found affecting sugarcane in Louisiana, and no SrMV isolate was identified among the Florida samples. Once the virus was identified, RT-PCR-based restriction fragment length polymorphism (RFLP) analysis was used to identify the strain of each isolate.

Among the Louisiana isolates, SrMV strains I, H, and M were associated with 66%, 14%, and 6% of the samples, respectively. In 7% of the samples, the virus isolate was identified as SrMV from RT-PCR results, but the RFLP analysis indicated that the strain was different from strains H, I, or M, the strains previously described for SrMV. Further characterization of these isolates is needed to determine if they represent new strains of SrMV. No RT-PCR product was produced by either the SCMV- or the SrMV-specific RT-PCR primer set for 10% of the plants showing mosaic symptoms suggesting that another virus may cause sugarcane mosaic in Louisiana. Only *Sugarcane mosaic virus* strain E was associated with the Florida samples and only from plants expressing mosaic symptoms.

Twenty six of the Louisiana samples, including 20 that tested negative to the presence of SCMV or SrMV, and all the Florida samples were analyzed with RT-PCR for the presence of *Sugarcane streak mosaic* (SCSMV), a virus that has been reported to cause mosaic symptoms in sugarcane grown in several Asian countries. No sample tested positive for SCSMV.

Although SCMV and SrMV have been reported to cause mosaic in Louisiana, SCMV has not detected in the state during this and earlier surveys for over 30 years. Some Louisiana commercial varieties are known to be susceptible to SCMV through artificial inoculation or from having been planted in an area where SCMV is found naturally; however, further investigation is needed to determine the susceptibility to SCMV of current Louisiana commercial varieties and germplasm sources being used as new parental material in the breeding program.

In Florida, the only virus associated with mosaic in this survey was SCMV strain E. Plants of two Florida commercial varieties (CP 72-2086 and CP 89-2143) with mosaic symptoms were sampled in both states. In Florida, they were infected with SCMV; and in Louisiana, they were infected with SrMV indicating SrMV is a potential threat to commercial Florida varieties. As sugarcane breeders and pathologists continue to identify new sources of resistance to mosaic, an awareness of the genetic diversity of the virus pathogens that cause mosaic is needed when screening new germplasm.

Prospects for Fungicidal Management of Sugarcane Orange Rust

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Since its initial detection in June 2007, orange rust, incited by *Puccinia kuehnii*, has been a serious concern for Florida sugarcane growers. At least one major sugarcane cultivar, CP80-1743, appears at least moderately susceptible to the disease. While host-plant resistance has been relied upon solely for the control of brown rust caused by *Puccinia melanocephala*, first observed in Florida in 1979, brown rust resistance has frequently not been durable. This fact, and fears of the significant yield losses that occurred when orange rust attacked Q124 in Australia, have stimulated the industry to seek a crisis exemption for fungicidal control. Based upon need and preliminary trials demonstrating efficacy against rust diseases, on April 18th, 2008, an exemption was granted for the use of two fungicides of dissimilar chemistries, the strobilurin fungicide pyraclostrobin, and the triazole fungicide metconazole. Both small-plot replicated experiments and commercial-sized experiments are currently being conducted to determine: 1) fungicidal efficacy, 2) yield response to fungicidal control, and 3) the economic feasibility of fungicidal control. Favored by warmer optimal temperatures than those that favor brown rust, it is anticipated that the window of susceptibility that exists for cultivars susceptible to orange rust will be of considerable duration, requiring multiple applications. Economics and label restrictions on fungicide use will necessitate that growers consider the following: cultivar susceptibility, rust inoculum levels, timing of fungicide initiation, application interval, fungicide sequencing, fungicide rate, and crop plant-back or rotation restrictions. These considerations will be discussed. While it is realized that chemical control of sugarcane rust should not be the primary line of defense against rust, it is hoped that it will prove to be an additional tool in managing these two important pathogens.

Plant Cane Response to Primary Shoot Damage by Lesser Cornstalk Borer Larvae

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Lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller) (Lepidoptera: Pyralidae) feeds on sugarcane shoots and causes dead hearts and symmetrical rows of feeding holes in emerging leaves. To determine plant compensation capability for this damage, an experiment was conducted using three sugarcane varieties (CP 78-1628, CP 89-2143, and CP 88-1762) having different growth habits (fast, medium, and slow emergence, respectively). Experimental units

consisted of 5 gal buckets filled with mineral soil planted with two single-eyed seed pieces. Four third instar *E. lignosellus* larvae were added to each bucket when plants reached the 3, 5, or 7-leaf growth stages. Feeding damage in the form of dead hearts, completely dead plants, and symmetrical rows of holes in the leaves was observed. The number of secondary shoots and the height of three month old plants also was recorded. Lesser cornstalk borer damaged shoots were shorter than those of undamaged plants of all three varieties. In CP 78-1628 and CP 88-1762, the number of secondary shoots produced was greater in damaged than undamaged plants, but the reverse was true for CP 89-2143 where undamaged plants produced more secondary shoots compared to damaged plants.

The Effects of Reduced Soil Insecticide Rates on Wireworm Damage to Sugarcane

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Wireworms (larval Elateridae) are perennial pests of newly planted sugarcane causing stand loss directly by damaging growing points and indirectly by introducing disease. Two organophosphate insecticides, phorate and ethoprop, are currently labeled for controlling wireworms. The United States Environmental Protection Agency is considering reducing the maximum allowable rates for these insecticides; however, efficacy of lower rates is unknown. Four rates of phorate and ethoprop (100, 75, 50 and 25% of current maximum field rates), a no treatment check and a wireworm free control were evaluated in simulated field experiments conducted in 5 gallon buckets filled with Lauderhill Muck soil and artificially infested with 10 wireworm (*Melanotus communis*) per bucket. After 60 days the contents of the buckets were emptied to evaluate damage to the plant and count the surviving wireworms. Both insecticides resulted in fewer live wireworms and reduced damage to sugarcane shoots, roots, and seed pieces compared to the no treatment control. Phorate at 25 to 75% of maximum field rates provided significantly less stand reduction than all ethoprop rates below the maximum. The full and 75% rate of ethoprop provided equivalent wireworm mortality to all rates of phorate. Phorate did not show a significant rate response and provided the same high level of control (equivalent to the wireworm free control) at all rates of formulated product from 19.5 down to 4.9 lb/ac. Ethoprop did show a rate response with a consistent and significant drop in efficacy from 20 down to 5 lb/ac. However, even the low rate of ethoprop provided some control. The results of this trial will help grower managers choose the most effective rates of insecticide for maintaining wireworm control while reducing organophosphate usage in their fields.

Seasonal Fiber Responses of Three Sugarcane Cultivars to Soil Type and Crop Cycle

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Fiber content is an important trait of sugarcane (*Saccharum* spp.) cultivars. Sufficient fiber is needed to generate electricity for the sugarcane mill and refinery, but excessive fiber reduces sugar recovery. The purpose of this study was to determine the effects of sample collection date, soil type, and crop cycle on the fiber contents of CP 72-2086, CP 78-1628, and CP 89-2143 in Florida. Samples from three replications of each cultivar in six final-stage experiments of the Florida sugarcane cultivar development program were collected as early as September and as late as February. Plant-cane, first-ratoon, and second-ratoon experiments at one location with a Torry muck soil and one location with a Pompano fine sand soil were sampled. After stripping leaves and extraneous matter from stalks, approximately 100 g of bagasse collected from a 3-stalk sample processed through a Jeffco cutter grinder was placed in a cloth bag. Soluble solids were removed by washing the bagasse twice in 30-minute cold water cycles in a washing machine. Fiber was calculated as the dry sample weight divided by its fresh weight. CP 78-1628 often had higher fiber content than CP 72-2086 or CP 89-2143 which usually had similar fiber contents. Seasonal fiber content was generally equally well explained by either a linear increase from September through February or by a quadratic response characterized by an increase from September through December or January followed by a moderate decline in February. Genotype x month interactions occurred in several experiments, but there were no consistent trends identified that characterized these interactions. Relationships among the three cultivars often differed due to month of sample, soil type, and crop cycle. Preliminary results after the first year of this study suggest that sampling procedures to reduce variability along with changes that allow for monthly sampling at representative soil types among plant-cane, first-ratoon, and second-ratoon experiments would substantially improve estimation of fiber contents of new sugarcane genotypes prior to their release as commercial cultivars.

Mechanical Planter Modifications 2007

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In 2007, funding from the American Sugar Cane League was directed toward modifications to a front end drum planter. The Modified planter was tested at two different locations during the 2007 planting season. In the first test the modified planter used 26.5% more

seed cane than the hand planted check. It distributed an average of 5.9 piles and 3.9 gaps per 1000 row feet. A pile was defined as any spot with more than ten stalks and a gap was defined as an unplanted space of three or more feet. In the second test the modified planter used 15.6% more seed cane than the hand planted check, while the partially modified planter and the unmodified planter used 41.9% and 36.5% more seed cane respectively. The modified planter distributed an average of 12 piles and 2.5 gaps per 1000 row feet. The partially modified planter distributed and average of 24 piles and 1.2 gaps and the unmodified planter distributed an average of 27.5 piles and 2.2 gaps per 1000 row feet. An economic analysis showed that in this test the modified planter was operated at 39.5% less cost per acre than the hand planted check while the partially modified planter had 45.5% more cost per acre and the unmodified planter had 35.2% more cost per acre than the hand planted check.

The Maturity Profile of Sugarcane Variety HoCP 00-950 and its Economic Significance

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The maturity profile for the plant-cane and first-ratoon crops of variety HoCP 00-950 was determined in maturity trials at the USDA, ARS, Sugarcane Research Laboratory research farm in Schriever, LA. Results show that HoCP 00-950, the most recently released sugarcane variety for Louisiana, matures significantly earlier than varieties previously released in Louisiana and also maintains higher overall sucrose content throughout the season. On September 25, 2007, about when the harvest season began, the TRS (theoretical recoverable sugar) for HoCP 00-950 was 127 kg/ha, while the TRS for HoCP 96-540, the variety currently occupying the largest amount of acreage, was only 95 kg/ha. By November 5, the TRS for HoCP 00-950 was 152 kg/ha, while the TRS for HoCP 96-540 was only 123 kg/ha. At the time of the final measurement on December 3, TRS for HoCP 00-950 was 169 kg/ha, while the TRS for HoCP 96-540 was 144 kg/ha. When considering how differential harvesting, hauling, and grinding costs per metric ton (Mg) of sugar produced can affect gross returns per hectare in high versus moderate sucrose varieties, the economic advantage of processing high sucrose varieties could be substantial. In fact, cost analyses show that it may be just as profitable to process 67 Mg/ha (30-ton/acre) cane with a mean TRS of 150 kg/ha, as it is to process 100 Mg/ha (45-ton /acre) cane with a mean TRS of 110 kg/ha. The cost of handling 33 additional metric tons of cane per hectare offsets the advantage of producing 10% more sugar. Combined results from outfield tests (plantcane – third ratoon) actually show that cane yields in HoCP 00-950 and HoCP 96-540 are equivalent, and that sugar yields are greater in HoCP 00-950. In 2007 (22 outfield tests), the sugar yield advantage was 15%. Historically, high sucrose varieties have been short-lived, because they tend to be harvested at the front end of the season, which does not allow enough carbohydrates to be translocated to underground crowns for adequate ratoon emergence. Thus, early-season harvesting often leads to poor ratooning, especially if it is done consecutively. Therefore, physiological aspects such as stubbling ability also need to be taken into account to

determine maximum economic return. It behooves the industry to learn to appropriately manage exceptionally high sucrose varieties such as HoCP 00-950, in order to maximize their duration in the industry and potentially increase profitability while maintaining genetic diversity.

Sugarcane Genotype Selection Using GGE Biplot Analysis for Comparing Location Contributions

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Selection for productive sugarcane (*Saccharum* spp.) cultivars in Florida has been more successful for organic than sand soils. The objectives of this study were to assess the contribution of the location with a sand soil in the final stage of multi-environment testing of sugarcane genotypes in Florida, and to identify locations with organic soils that, if replaced with a sand soil location, would be least likely to compromise cultivar selection for organic soils in Florida. Sixteen genotypes per location were harvested in two or three crop cycles from 2002 to 2005 at nine locations. Traits analyzed were cane and sucrose yields (Mg ha^{-1}) and theoretical recoverable sucrose (g kg^{-1}). Variations for genotypes, locations, crops, genotype x location (GL) interaction, and crop x genotype x location (CGL) interaction were highly significant for all three traits, but location usually was the largest contributor to variability in individual crop-cycle analyses. The location with a sand soil, Lykes, was generally not highly representative of locations or highly discriminating of genotypes. These results, in addition to the previously identified need to improve genotype selection on sand soils, suggest that it may be advantageous to add a location with sand soil to this testing program, although doing so may compromise genotype discrimination for theoretical recoverable sucrose (TRS) and sucrose yield. To sustain ability of the Florida sugarcane selection program to identify productive cultivars on organic soils while improving selection on sand soils, it was recommended to replace one location with muck soil (Osceola) with a sand-soil location.

Avian Species Richness, Relative Abundance and Diversity in Agricultural Fields of the Everglades Agricultural Area

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Continuing studies since 2002 have illustrated the potential for sugarcane and other crops grown in the Everglades Agricultural Area to serve as habitat for a variety of wildlife species. A comparative study of birds found in sugarcane and associated habitat such as ditches and edges found that there was comparable species richness and diversity as well as numbers of

birds compared with areas managed for wildlife. This study found 138 species of birds of which at least 20 were known to breed in the EAA. Sugarcane may provide important upland shelter and habitat for many of these birds either during the breeding season or for birds that are dispersing from nearby breeding habitat. During the winter the sugarcane fields may provide important habitat for wintering birds according to two of our studies. Thirteen species of wintering raptors were observed in natural areas and agricultural habitats of south Florida. Of these, seven were analyzed for relative abundance in both natural and agricultural habitat. Four were found to be present in higher numbers in agricultural fields and three showed higher numbers in natural habitat. A third study investigated the habitat use of wintering songbirds in sugarcane fields that were being harvested. The distribution of birds in the fields shifted as they were converted from tall sugarcane to fallow fields and then re-grew to medium height sugarcane. In this study, edge habitat such as that found bordering fields or ditches proved to be important for some species.

L 01-283 – A New Sugarcane Variety for the Louisiana Sugar Industry

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On May 6, 2008, the LSU Agricultural Center released a new sugarcane (*Saccharum* spp.) variety L 01-283 in cooperation with the U.S. Department of Agriculture Research Service and the American Sugar Cane League.

The cross for the new variety was made at facilities located at the Sugar Research Station in St. Gabriel, Louisiana in September, 1996. Photoperiod facilities were used to induce flowering in the parental clones. The female and male parents used for the cross of L 01-283 were L 93-365 and LCP 85-384, respectively. Each parent was a BC_4 derived clone from the *S. spontaneum* clone US 56-15-8. LCP 85-384 was Louisiana's leading commercial sugarcane variety from 1998 through 2007, achieving a peak acreage of 91 percent in 2004. L 93-365 was dropped from active testing for commercial consideration in the sugarcane breeding program in the summer of 1996. Seedlings from the cross were germinated in the greenhouse and planted in the field in April 1997. Single stool selection was done in September 1998. Early stage selection culminated in the assignment of a permanent varietal designation in 2001.

The main criteria that growers use when selecting varieties to plant is yield. To the sugarcane grower, sugar yield, cane yield and sugar per ton of cane are the main traits of interest. L 01-283 had plantcane sugar yields equal to that of HoCP 96-540 in Outfield Variety Testing conducted from 2005 - 2007. This new variety had significantly higher sugar yields and sugar per ton of cane than HoCP 96-540 in the first and second ratoon crops. Cane yield in all crops was similar to HoCP 96-540. The variety is characterized as having excellent ratooning ability with a high population of medium sized diameter stalks. L 01-283 is an erect variety that is similar to HoCP 96-540 for this important harvesting characteristic.

Disease resistance is another important component of variety selection. L 01-283 is resistant to smut, brown rust, leaf scald, and *Sorghum mosaic virus* under natural field conditions. The effect of yellow leaf disease and orange rust on the yield on L 01-283 is unknown. The new variety may sustain significant yield loss in stubble crops from ratoon stunting disease (RSD). To realize the maximum yield potential of L 01-283, healthy seed cane that is free of RSD must be planted.

Resistance to the sugarcane borer is a key aspect necessary for reducing the number of insecticide applications. L 01-283 is moderately resistant to the sugarcane borer and would be a good choice to plant in areas where insecticides cannot be applied. The new variety should be scouted for timely insecticide applications.

The American Sugar Cane League provides seed to any Louisiana sugarcane grower requesting an allotment. For L 01-283, seed will be made available to growers in late summer of 2008.

The arrival of a new sugarcane variety is a highly anticipated event. Louisiana's sugar industry has continually looked towards the public sector for the development of new varieties. L 01-283 should pay big dividends in the future for Louisiana's sugarcane growers and processors.

Improved Fertilizer use Efficiency with Controlled Release Sources on Sandy Soils in South Florida

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Sugarcane grown on sandy soils in south Florida typically under-produce sugarcane grown on muck soils due to poor water holding and nutrient retention capacities of these soils. Use of controlled released fertilizer that satisfies crop nutrient demand has the potential for improve yields and reduce nutrient leaching. The fertilizer nitrogen (N) source (standard soluble), controlled release fertilizer (CRF), controlled release N with soluble P and K (CRN), and the combination of soluble and CRF) serve as the main plot factor with rate being the sub plots. The soluble fertilizer plots were applied based on 100% and 75% of an annual N rate of 290 kg ha^{-1} yr^{-1}, resulting in 290 and 218 kg ha^{-1} yr^{-1} in three to five splits per year. A 12 month CRF formulation was applied plots at planting. A product containing controlled release N was blended with soluble sources of P and K to produce a CRN treatment and was applied at planting. To investigate a management program combining both soluble fertilizer and CRF, a fourth set of plots had 20% of the same annual N rates applied as soluble N at planting with the remaining 80% applied 3 months later as CRF with a 6 month release formulation. The CRF and CNR products and the combination soluble and CRF fertilizers were applied at annual N rates based on 75% and 50% of the 290 kg ha^{-1} yr^{-1} base N rate, resulting in 218 and 145 kg N ha^{-1} yr^{-}

[1]. The statistical design was a randomized complete block. Equal amounts of phosphorus and potassium were applied to all plots each year. The test hypotheses for this study are: the use of CRF in sugarcane production can 1) reduce annual application costs, 2) reduce annual N application rates, 3) provide adequate N nutrition for growth and carbohydrate accumulation, 4) maintain adequate yields, and 5) reduce the potential loss of N to the environment. Leaf N for all treatments and rates were nearly equal through mid-summer except the CRN 50% treatment was significantly lower ($P>0.05$) than other treatments. The soluble fertilizer 100% treatment was significantly higher than all other treatments after an application then fell to similar leaf N concentrations between applications. Cane dry biomass prior to harvest was not significantly different ($P>0.05$) for any fertilizer source or rate. Two years of harvest indicate that the 75% CRF 75% and combination soluble fertilizer and CRN 75% treatments had significantly greater yields compared with the soluble N 100% treatment. With recent increases in fertilizer prices, reduced rates of controlled release forms and reduced application costs can save growers money with no reduction in sugar yield per acre.

Response of Sugarcane to Mill Mud Application on a Sandy Soil

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A significant proportion of sugarcane (*Saccharum* spp.) in south Florida is grown on sandy soils where loss of productivity is attributed, at least in part, to the oxidation of soil organic matter. Practices that improve soil organic matter content should result in improved sugarcane productivity on these soils. A field experiment was carried out to quantify the long-term response of sugarcane to mill mud application on an Immokalee sand (sandy, siliceous, hyperthermic Arenic Haplaquods). The treatments consisted of mill mud rates that theoretically provided a soil surface cover of 0, 3, 6, and 12 inches in thickness, arranged in a randomized complete block design with 4 replications. The experiment was planted in mid-October 2000 and five sugarcane crops (plant, 1st, 2nd, 3rd, and 4th stubble) were harvested during the 2001-2002 through the 2005-2006 harvest seasons. Mill mud application increased cane production by 51-88% and sugar production by 41-53% over the five-year period and provided the potential for doubling the life cycle of the sugarcane crop. Predicted mill mud rates for maximum cane and sugar production varied by the choice of model to fit the data points. When a linear-response-and-plateau model was used, predicted rates for maximum cane and sugar production were 7.8 and 6.4 inches of mill mud cover, respectively. However, when a quadratic model was used, the corresponding predicted rates were 11.2 and 9.2 inches of mill mud cover, respectively. The choice of mill mud rate, therefore, can be influenced by whether the intent is to maximize cane (for biomass or bagasse) or sugar production. Field application of mill mud is an effective means of using a byproduct that presents a logistical problem for sugarcane mills to improve the productivity and sustainability of sandy soils.

Boundary Lines Used to Determine Sugarcane Production Limits at Leaf Nutrient Concentrations Less Than Optimum

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Leaf nutrient analysis is a useful diagnostic tool to complement soil testing as a best management practice with sugarcane (Saccharum spp). Leaf analysis is currently used by a limited number of Florida sugarcane growers, but it has the potential to play a more vital role in growers' fertility programs. With the objective of enhancing usefulness of leaf analysis, this study was conducted to determine sugarcane production limits at leaf nutrient concentrations less than optimum. Eight Florida sugarcane growers participated in a survey of leaf nutrient values in 2004, 2005, and 2006. A total of 412 leaf samples were collected from individual commercial sugarcane fields from which there were 389 harvest data/leaf data combinations. Fields were selected to be representative of plant cane, first ratoon, and second ratoon crops, mineral and organic soils of the area, and major commercial sugarcane cultivars. Leaf Si, Mg, and Mn concentrations had the strongest correlations with tonnes cane ha^{-1} (TCH) on organic soils, and leaf N, Mg, and Si concentrations had the strongest correlations with TCH on mineral soils. Boundary lines were used to define practical limits of TCH for leaf nutrient concentrations less than optimum. A table was developed which provides approximate leaf concentrations of nine nutrients at which 10 and 25% losses in relative TCH were estimated. Boundary line analysis indicated that sugarcane production was most limited in survey fields by insufficient Mg, Fe, N, and Si on mineral soils and by insufficient Si and Mn on organic soils.

NIR Technology for Sugarcane Quality Analyses at the LSU AgCenter's Sugarcane Sucrose Laboratory

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Sugarcane (*Saccharum* spp.) growers are paid for the amount of sugar in each ton of cane delivered to the factory as well as molasses. To determine sucrose content in sugarcane, truck loads are cored for a sample, which is sent to the laboratory for a labor intensive set of analyses. Each sample is shredded and a 1000 g sub-sample is used for analysis. The sample is pressed to extract the juice. The remaining compressed bagasse sample is weighed both wet and dry, which is used in fiber content estimates. The juice is filtered and clarified prior to obtaining Brix by refractometer and pol (Z°) by saccharimeter. Sediment (mud) is estimated with a volume

estimate of the sediment after centrifugation in a small tube. All of these readings are used to determine the theoretical pounds of sugar in each ton of sugarcane.

There is increased interest in using NIR (near infrared reflectance) in sugarcane research programs. NIR provides a quick analysis of many samples for several traits with minimal sample preparation. NIR refers to the regions of light immediately adjacent to the visible light range falling between 750 and 3500 nanometers. Molecules have a fundamental frequency (wave length) and series of overtones. Organic molecules exist in energy states that absorb NIR wavelengths (energies). It is the energy state of a particular molecule that allows one to perform a measurement with NIR. However, the complex spectra obtained with NIR are of little value unless the spectra are associated with laboratory results. This is part of the chemometric calibration process to determine equations for each trait of interest.

Sugarcane researchers obtain much of the same information as does the factory with the exception of a sediment estimate. Most research samples are hand-harvested and are free of soil. Previous research has shown the limitation of NIR at the factory level where field soil and consistent preparation present a problem. However, in research applications, many groups such as the Australians (BSES) and South Africans (SASRI) have used NIR for sugarcane quality analysis for over 10 years.

In 2007, the Sugar Research Station purchased a SpectraCane automated NIR analyzer for sugarcane quality components. Starter calibrations were made available for Brix, fiber content, moisture, and pol. To build more robust calibrations for Louisiana conditions, 389 sugarcane samples were run in parallel with standard laboratory techniques. Each laboratory sample was analyzed for Brix, pol, fiber content, and moisture. These data were sent to Analytical Technologies, a division of BIOLAB Limited where old calibrations were then replaced with new calibrations based on the Louisiana analyses.

A series of linear regressions were used to associate the relationship between NIR generated data and data generated from the laboratory. R^2 values for Brix, fiber content, moisture, and pol were 0.96, 0.85, 0.94, and 0.94, respectively. Only data generated from the LSU AgCenter were used in the fiber content calibrations because of differences in the calculation of fiber content compared to Australian methods. The Australian data were useful for the Brix, moisture, and pol calibrations. In 2008, additional laboratory analyses for fiber content will be collected at the LSU AgCenter to build more robust calibrations for Louisiana conditions.

The laboratory crew was able to run one sample per minute with less labor than needed for standard laboratory analyses. As with any new technology, there was a learning curve. The LSU AgCenter experience with NIR analyses for assessing sugarcane quality was positive.

Use of Foliar Analysis to Improve Sugarcane Production

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Foliar analysis is an effective tool for diagnosing plant nutrient deficiencies and imbalances. However, the time lag involved in leaf sampling, sample handling and analysis, interpreting analytical results, determining the appropriate corrective fertilization treatment, and applying the fertilizer usually precludes a significant portion of the grand growth period of sugarcane (*Saccharum* spp.). As a result, use of leaf analysis with sugarcane, if any, has been restricted to the final stubble crop in an attempt to determine possible nutrient requirements of the subsequent plant-cane crop. The objective of this presentation is to provide an overview of foliar analysis as an important tool for diagnosing and correcting nutrient deficiencies and imbalances in sugarcane, to present two major approaches to interpreting the results of foliar analysis, namely the critical nutrient level (CNL) or sufficiency range (SR) and the diagnosis and recommendation integrated system (DRIS), and to share our experience with foliar analysis as a means of providing "in-crop" corrective fertilizer applications to sugarcane. Paired comparisons established in commercial sugarcane fields over a five-year period showed that use of foliar analysis to make "in-crop" supplemental fertilizer applications resulted in significant increases in cane and sugar production of plant and first-stubble crops.

Analysis of Sugarcane Yield Response to Annual Nitrogen Fertilization

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Nitrogen (N) is the highest expense among fertilizer inputs in sugarcane production. With the drastically rising cost of N fertilizer and increasing public concerns on environmental quality, N should be applied on a need basis. Sugarcane N fertilizer requirements are commonly determined based on field yield average and/or recommended optimum rates. Three N x variety tests were conducted from 2004 to 2007 at the LSU AgCenter Sugarcane Research Station in St. Gabriel, LA on a Commerce silt loam to determine the optimum N requirement of current sugarcane varieties. The tests included three cane varieties (2004 to 2006 – LCP85-384, CP70-321, HoCP91-555: 2005 to 2007 – LCP85-384, Ho95-988, L97-128: and 2007 – LCP85-384, HoCP96-540 and L99-226) and four N rates that ranged from 0 to 179 kg N ha^{-1}. Treatments were arranged in a randomized complete block design with four replications. Linear plateau models were used to estimate optimum N rates using non-linear regression analysis in SAS. Optimum N rate for plant cane was not determined because of the absence of plant cane response to N fertilization ($p<0.05$). Linear-plateau models estimated N rates ranging from 44 to 106 kg N ha^{-1} for optimum stubble cane and sugar yield of the varieties tested. Stubble cane and sugar yields of LCP85-384, the predominant sugarcane variety in Louisiana, were optimized with N applications of 44 to 81 kg N ha^{-1}. Estimates of sugarcane responsiveness to N fertilization (RI; highest yield of N fertilized plot divided by the yield of check plot) ranged from 1.0 to 2.5, where 1.0 indicates an absence of response to N fertilization and 2.5 indicates a 150% increase in yield due to N application. Temporal variation in RI was higher than variation across varieties. The high inter-annual variation both in the estimated optimum N rates and responsiveness of sugarcane to N fertilization imply that yield level and available soil N in-season are important considerations in developing robust N management decisions to improve N use efficiency in sugarcane production.

Effect of Residue Management on Sugarcane Yield Grown on Sharkey Clay

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In this study we investigated the effect of sugarcane residue (mulch cover) resulting from the combine harvester on sugarcane yield (biomass and sugar) and quantified the decay of residue post harvest. Three residue management practices were implemented at the St. Gabriel Research Station, where sugarcane variety HoCP91-555 was planted on October 21, 2003 on a Sharkey clay soil. The three treatments were; (i) burning the mulch after harvest, off-barring and cultivating in the spring; (ii) sweeping the mulch off the top of the row after harvest, off-barring and cultivating in the spring; and (iii) leaving the mulch on the field after harvest, off-barring and cultivating in the spring. The last treatment where the mulch is not removed may be best regarded as a no-till treatment which is a commonly used soil conservation measure. Sugarcane population, yield, and amount of mulch residue left on the soil surface were measured for each treatment. We summarized results for an entire growing cycle; i.e., plant cane, first, second and third stubble (2004-2007). Yield results indicated that for Sharkey clay, the burn treatment highest yields were consistently obtained when compared to the sweep and no-till treatments. Although these results are consistent with earlier findings for the same sugarcane variety HoCP91-555 grown on Commerce soil, the results were not significant at the 0.05 level. The amount of residue left on the surface for the first, second and third stubbles were consistently lower than that for the plant cane. Moreover, these results are consistently lower than earlier results for HoCP91-555 grown on Commerce loam soil. Such differences may be attributed not only to the different soil type but variation among growing seasons as well as combine setting during harvest.