Evaluation of Sugarcane Resistance to the Sugarcane Aphid in Louisiana

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The sugarcane aphid, *Melanaphis sacchari* (Zehntner), although a minor pest of sugarcane in Louisiana, is spreading throughout the industry and is the main vector of sugarcane yellow leaf virus. Host plant resistance is a management option successfully employed against various aphids in different cropping systems. Our studies were aimed at exploring possible sources of resistance to the sugarcane aphid in commercial or near-commercial germplasm of sugarcane in Louisiana. Five sugarcane cultivars (L 97-128, LCP 85-384, HoCP 96-540, HoCP 91-555, and Ho 95-988) were screened in greenhouse pot studies for antixenosis, antibiosis, and tolerance. Antixenosis tests did not show difference in aphid preference, but antibiosis tests indicated pronounced variation among varieties. The days in reproduction and number of nymphs produced were highest in L 97-128, while HoCP 91-555 depicted the strongest antibiosis with the least number of days in reproduction and fewest numbers of nymphs produced. Based on r_m (intrinsic rate of aphid increase) values, it is estimated that L 97-128 can produce almost four times more numbers of sugarcane aphids as compared to the resistant variety i.e. HoCP 91-555. Other varieties showed intermediate levels of antibiotic resistance. Tolerance tests revealed similar results with HoCP 91-555 showing maximum tolerance and L 97-128 showing least tolerance in terms of chlorophyll content recovery based on SPAD index readings. From these studies, an efficient and rapid system of aphid resistance evaluation is being established for the Louisiana varietal development program.

Temporal Changes of Genetic Diversity in Sugarcane Breeding Populations

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Concerns over the decline of genetic diversity within sugarcane (*Saccharum* spp.) breeding programs need be addressed to define better breeding strategies aimed at achieving greater genetic gains. The objectives of this study were to reconstruct the divergence in USDA-ARS Canal Point breeding populations as temporal changes from early (1960) to recent (2000) years. A replicated field test was established in March 2005 at the Canal Point Station with 61 sugarcane genotypes that encompassed historical cultivars released from 1960 to 2000. A set of wild relatives were also included as representative founders of this population. These genotypes were divided into five populations or "decades" and characterized phenotypically and with molecular markers using sucrose-related target region amplification polymorphism (TRAP) primers. A multivariate nonparametric approach was used to assess the spatial (temporal) autocorrelation of genetic divergence based on the TRAP profiles. An increase in % polymorphism was detected from the first decade (26.4%) to the last decade (56.15%) using the TRAP markers with an overall polymorphism of 58.3%. Genetic distance ranged from 0.04 (CP

95-1039 and CP 70-1133) to 0.30 (CP 99-1542 and CP 98-1335) with an average of 0.22. Significant (P≤0.01) and positive genetic structure was detected up to the second decade of breeding when spatial autocorrelation revealed a decline in genetic diversity. The CP breeding population has maintained a relatively constant (but a negative spatial autocorrelation) level of genetic diversity since then. Marker-trait associations will be presented and spatial autocorrelation relating genetic distance with the phenotypic data will be also investigated. These results will be discussed in the context of sugarcane breeding strategies, relating introgression breeding with the size of the genetic diversity.

Sugarcane Genotype Repeatability in Replicated Selection Stages and Commercial Adoption

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The sugarcane (interspecific hybrids of *Saccharum* spp.) breeding and selection program at Canal Point, Florida recently increased the number of genotypes advanced to its final selection stage, Stage IV, from 10 or 11 to 13. The number of reference cultivars in Stage IV has also been increased from one or two to three. These changes resulted from findings that the number of replications could be decreased without reducing experimental precision in Stage IV. The major purpose of this study was to determine if increasing the number of genotypes advanced to Stage IV would improve the likelihood of identifying successful cultivars. A secondary objective was to determine if genotypes could be expected to have similar yields in Stage IV and the penultimate stage, Stage III. Data were reviewed from 24 cycles of Stage III and 16 cycles of Stage IV. Correlations of genotype performance in Stage III and Stage IV were significant but low for sugar yield (Mg sugar ha^{-1}) (r = 0.27) and economic index (\$ ha^{-1}) (r = 0.28). No genotype that ranked worse than 15^{th} in both sugar yield and economic index in Stage III was later used on more than 1% of Florida's annual sugarcane acreage. Several high yielding genotypes are often not advanced from Stage III to Stage IV due to disease susceptibility, poor agronomic type, or low sugar content. Therefore, it is usually necessary to select from genotypes ranking worse than 15^{th} in Stage III to advance as few as 10 new genotypes to Stage IV. It is unlikely that advancing 13 rather than 11 genotypes to Stage IV will cause an increase in the number of productive commercial cultivars identified in Stage IV until other changes in the program improve the quality of genotypes advanced to Stage III.

Exploiting Gene Analogues as Markers for Disease Resistance: Sequence Isolation and Characterization

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Selecting for disease resistance is a constant challenge in sugarcane breeding. The evaluation of clones for disease reaction is lengthy and constrained by resources. Clone selection using markers for disease resistance would make the process more efficient, however, useful markers need to be identified. Useful molecular approaches that have been used to make favorable advances in other crops can be transferred and applied to sugarcane, which offers unprecedented opportunities for selecting disease resistance through marker assisted selection. Despite their isolation from diverse crop and model species and providing resistance to varied pathogens, plant disease resistance genes show a remarkable level of similarity. Generally they include either a Nucleotide Binding Site-Leucine Rich Repeat (NBS-LRR) or a Kinase region (domain). NBS-LRR and Kinase domains in turn contain several sequence motifs' that are highly conserved between species. Here we report the isolation of NBS-LRR and Kinase disease resistance genes in sugarcane by utilizing conserved genic regions of the same genes in other species. Sugarcane clone US 01-1158, an F_1 progeny from an inter-specific cross between *Saccharum spontaneum* and *S. officinarum* was used as the source of template DNA. This clone is resistant to infection from Sugarcane Yellow Leaf Virus (SYLV) the causal agent of Yellow Leaf Syndrome (YLS) and is moderately resistant to *Puccinia melanocephala,* the causal agent of brown rust. DNA isolated from US 01-1158 was amplified using degenerate primers that target conserved motifs in NBS-LRR resistance genes and kinase genes. The amplification products were sequenced and the nucleotide sequences assembled into contiguous sequence alignments (contigs). A sequence consensus of each contig was compared to sequences in the National Center for Biotechnology Information (NCBI) database using Basic Local Alignment Search Tool x (BLASTx). The sequences showed significant similarities to previously accessioned NBS-LRR and kinase genes associated with disease resistance thereby confirming them as gene analogues. To examine their potential as markers for disease resistance, variations in the gene analogue sequences we have isolated from clone US 01-1158 will be associated with disease reaction in the remaining F_1 population and in other breeding populations. This work therefore is the first step in a process of exploiting the potential of resistance gene analogues in sugarcane cultivar selection.

Sugarcane Yield and Morphological Responses to Long-term Flooding

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Sugarcane in south Florida is often subjected to flooding in the summer months or following hurricanes. While there has been considerable research on the response of sugarcane cultivars to high water tables, there is a lack of information on cultivar morphological adaptation and yield response to long-term flooding. An experiment was established in Belle Glade, FL to examine the effect of a 3-month summer flood (July – September) on the growth and yield of cultivars CP80-1743 and CP72-2086. Harvest samples were taken early, mid- and late-season. Flooding cane in the summer caused sequentially greater yield reductions throughout the harvest season in plant cane. Sucrose yield for flooded cane, compared to the non-flooded control, were 7.8 vs. 11.6 tons sucrose ha^{-1} early, 9.2 vs. 12.8 tons sucrose ha^{-1} mid-season and 7.8 vs. 12.3 tons sucrose ha^{-1} at late harvest. While one of the objectives of the study was to mimic the effect of a hurricane, ironically the hurricanes of 2004 caused all treatments in the first ratoon crop to be flooded making flood treatment comparisons impossible. In the second ratoon crop, flooding significantly reduced sugarcane tonnage and sucrose yield by 54-64% across sampling dates. Yield penalties were caused through reduced tonnage rather than sucrose content. Morphological changes in response to flooding were remarkably similar in the plant cane and second ratoon crops, with flooding leading to significantly greater aerenchyma pipe length and diameter. Both cultivars responded to flooding by producing aboveground adventitious roots at the expense of belowground root biomass. A significant genotype x flood interaction on pipe length and diameter was noted, with CP72-2086 producing constitutive aerenchyma under non-flooded conditions. Our results indicate a severe yield penalty caused by a 3-month summer flood in these cultivars. However, differing genotypic morphological responses to flooding indicate that aerenchyma development up the stalk may be a useful screening tool to identify potentially flood-tolerant genotypes.

'LCP 85-384' – The Rise and Fall of a Monoculture

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The release of LCP 85-384 was a major milestone for Louisiana sugarcane breeding efforts. The new variety was released in 1993 by the LSU AgCenter in cooperation with the USDA-ARS and the American Sugar Cane League. Yield data upon release to Louisiana's growers provided overwhelming evidence that LCP 85-384 had superior sugar yields, approximately 20% greater than the varieties grown at that time. The variety also possessed excellent resistance to many of Louisiana's major sugarcane diseases that include *Sorghum mosaic virus*, brown rust, smut, and leaf scald. The main weaknesses of LCP 85-384 were its

propensity to lodge and its susceptibility to the sugarcane borer, which were overcome by a switch to combine harvesting and the use of insecticides, respectively. LCP 85-384 was quickly expanded in acreage upon its release. In 1998, it became the most widely grown sugarcane variety in Louisiana when it occupied 43% of the state's acreage. Its majority status continued with its peak of planted acreage occurring in 2004 when LCP 85-384 occupied 91% of Louisiana's sugarcane acreage. With slim profit margins, growers were not willing to diversify much acreage with other lower yielding sugarcane varieties. Beginning in 2000, brown rust was first seen in the once resistant variety. In each subsequent year, increasing amounts of brown rust were observed in LCP 85-384. Yield loss assessments in 2004 and 2005 conducted by plant pathologists indicated cane yield decreases of approximately 7 tons/acre. Concurrently, Louisiana sugar production dropped dramatically due to the combined effects of hurricanes and the yield decline observed in LCP 85-384. Breeding efforts to develop comparable varieties were at first hindered by the initial success of LCP 85-384. Not many experimental clones in the program produced similar yields. HoCP 91-555 was released in 1999 but had little impact. In 2003, HoCP 96-540 was released, and this was followed with the release of L 97-128 and Ho 95-988 in 2004. Both HoCP 96-540 and L 97-128 have been expanded rapidly to replace LCP 85-384. These two varieties have exhibited excellent sugar yield potential, are less likely to lodge, and have greater resistance to brown rust. Ho 95-988 has been expanded, but at a slower rate due to top breakage and more recent observations of brown rust in the once resistant variety. Two new variety releases, L 99-226 and L 99-233 will also offer excellent sugar yield potential and moderate resistance to brown rust. Breeding efforts continue as the work to diversify Louisiana's sugarcane acreage continues. Louisiana has learned a hard lesson on the risks of monocultures

L 99-226 and L 99-233 – Two New Sugarcane Varieties for the Louisiana Sugar Industry

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On April 25, 2006, the LSU AgCenter released two new sugarcane varieties, L 99-226 and L 99-233, in cooperation with the U.S. Department of Agriculture's Agriculture Research Service Sugarcane Research Laboratory in Houma and the American Sugar Cane League. The crosses for the two new varieties were made at facilities located at the St. Gabriel Research Station in September, 1994. Photoperiod facilities were used to induce flowering in the parental clones. The female and male parents used for the cross of L 99-226 were HoCP 89-846 and LCP 81-30, respectively. The female and male parents of L 99-233 were CP 79-348 and HoCP 91-552, respectively. Seedlings from these crosses were planted in the field in April 1995 followed by single stool selection in September 1996. Early stage selection culminated in the assignment of permanent varietal designations in 1999. 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 99-226 had the highest sugar yield and sugar per ton of cane of any variety for all crops reported for Outfield Testing (2003- 2005). This new variety also had the highest cane yield in the plant-cane and first stubble crops. The variety is characterized as having a moderate population of large stalk diameter stalks. L 99-233 produced significantly higher sugar and cane yields than LCP 85-384. Its sugar per ton of cane is similar to LCP 85-384. This new variety is characterized as having a high population of small diameter stalks. L 99-233's high cane yield in second stubble is an indication that the variety is an excellent stubbling variety. Harvesting characteristics are important for sugarcane varieties. Both new varieties tend to lodge, with L 99-233 lodging more severely than L 99-226. Because of their propensity to lodge and their high cane yield, these varieties are better suited to combine harvesting systems. Disease resistance is another important component of variety selection. L 99-226 and L 99-233 are moderately resistant to smut, brown rust, leaf scald, and *Sorghum mosaic virus* under natural field infection. The effect of yellow leaf disease on the yield of both L 99-226 and L 99-233 is unknown. These new varieties may sustain significant yield loss in stubble crops from ratoon stunting disease. To realize the maximum yield potential of these varieties, healthy seed cane, free of ratoon stunting disease, must be planted. Resistance to the sugarcane borer is a key aspect necessary for reducing the number of insecticide applications. L 99-226 is resistant to the sugarcane borer. A new sugarcane variety with resistance to the sugarcane borer is needed in the Louisiana sugar industry. Growers have very limited options as the majority of acreage in Louisiana is planted to susceptible varieties. L 99-226 is a good choice to plant in areas where insecticides cannot be applied. L 99-233 is susceptible to the sugarcane borer and should be scouted for timely insecticide applications. The American Sugar Cane League provides seed to any sugarcane grower requesting an allotment. For L 99-226 and L 99-233, seed will be made available to growers in late summer of 2006. Louisiana's sugar industry has continually looked towards the public sector for the development of new varieties. The arrival of new sugarcane varieties is a highly anticipated event. L 99-226 and L 99-233 should pay big dividends in the future for Louisiana's growers and processors.

Effect of Ratoon Stunting Disease on Yield of Sugarcane Cultivars Recently Released in Louisiana

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The yield response of six recently released Louisiana cultivars to infection by *Leifsonia xyli* subsp. *xyli*, the causal bacterium of ratoon stunting disease, varied in field trials conducted between 2001 and 2005. Sugar yields were compared to LCP 85-384, the leading Louisiana cultivar released in 1993, in two crop cycles that included plant- cane, first-ratoon, and second-ratoon crops. No yield loss was observed in HoCP 96-540 released in 2003 or in cultivars Ho 95-988 and L 97-128 released in 2004. These cultivars also had the lowest percent colonized vascular bundles (CVB) among the cultivars tested (2, 9, and 14%, respectively). Moderate yield

loss of sugar was observed in HoCP 91-555 (5%) released in 1999 and in L 99-226 (6%) released in 2006. Although loss of sugar in HoCP 91-555 and in L 99-226 was similar to that of LCP 85-384 (5%), percent CVB was much higher in HoCP 91-555 (49%) and in L 99-226 (69%) than in LCP 85-384 (23%). Cultivar L 99-233, also released in 2006, is considered to be highly susceptible to *L. xyli* subsp. *xyli* infection because of the high yield loss observed (22%) and high percent CVB (86%). All cultivars tested were infected with *L. xyli* subsp. *xyli* and practices to control infection through the use of pathogen-free seed cane and cleaning equipment to prevent mechanical spread should continue in all cultivars. Although moderate yield loss was observed among some cultivars, those with high percent CVB have the potential for rapid spread of ratoon stunting disease and control in these cultivars may be more difficult.

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Sugarcane Plant Crop Response to Silicon and Magnesium Amendments on Organic and Mineral Soils in Florida

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Application of calcium silicate as an amendment for sugarcane production is an accepted practice on sands and low-mineral organic soils in Florida. Magnesium is often limiting in mineral soils in south Florida and magnesium deficiencies are becoming more common in organic soils as well. Calcium silicate application can decrease leaf magnesium concentration, so it is important to examine the influence of silicon treatments on magnesium nutrition. This study is being conducted to provide more detail about maintenance rates of silicon amendments and to compare sources and methods of application as well as to examine the response of sugar production to magnesium amendments. Two small-plot studies were established in fall 2004, one on a Margate sand (siliceous, hyperthermic Mollic Psammaquent) and the other on an Okeelanta muck (sandy or sandy-skeletal, siliceous, euic, hyperthermic Terric Haplosaprist). Significant increases in tons sugar/acre were found at each location in the first year with calcium silicate application, but not with magnesium silicate application. In general, broadcast application of calcium silicate (1.5 or 3 tons/acre) resulted in higher tons sugar/acre than furrow application (1000 lb/acre). Application of magnesium as dolomite, as magnesium sulfite/sulfate blended with calcium silicate, or as a magnesium sulfate/oxide blend increased percent sugar yield, particularly at the sand location, but did not significantly increase tons sugar/acre. These experiments will be continued for 2 more years and used to update University of Florida/IFAS recommendations for sugarcane.

The Effect of Reducing Particle Size of Combine-Harvest Residue, Soil Incorporation, and Other Residue Management Inputs on Soil Microbial Respiration and Crop Productivity of Sugarcane

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There is a need to identify effective alternatives to burning combine-harvest residue in order to remove it from the top of the plant bed. Success with mechanical removal of residue to row middles is countered by slow degradation and impediments to drainage and cultivation from the concentrated residue bulk. Research with other crops has shown that reducing residue particle size can hasten residue decomposition as measured by increased soil microbial respiration (SMR). Incorporating residue with soil should hasten decomposition and treatment with adjuvant chemicals might also. The objective of this research was to determine the effect of various management treatments of sugarcane harvest residue on subsequent soil microbial respiration and crop productivity. Averaged over two years, compared to normal residue size from the harvester, further shredding of the residue resulted in significantly higher SMR and stalk population. All other yield parameters were not affected by reducing residue particle size *per se*. Adjuvant treatment with non-ionic surfactant was not effective, but application of 66 kg slow release N /ha did tend to increase SMR and plant population slightly. Incorporating residue into soil also resulted in higher SMR. Soil incorporation of residue when contrasted with all other treatments across two years produced significantly ($P \leq 0.05$) higher stalk population, higher cane yield, higher CRS, and higher sugar yield than non-incorporation treatments. The combination of reducing particle size and soil incorporation resulted in faster degradation of the previous harvest's residue (higher SMR). Soil incorporation of residue was more thorough when the particles size was smaller. This may have had some short term effects, but additional residue shredding was not necessary for higher yield when residue was soil incorporated. Regardless of particle size, soil incorporation of harvest residue in late fall, early winter could be a component of a reduced tillage system for sugarcane whereby spring tillage operations could be minimized or eliminated and any nutritional or physical benefits of residue could be retained.

Quantifying the Rodent Community in the Everglades Agricultural Area and the Relative Impact of Individual Rodent Species on Sugar Cane

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Rodents inflict millions of dollars in damage to sugar cane crops and farm equipment in the Everglades Agricultural Area (EAA) each year. However, little is known about the rodent community structure in this region, and the relative impact of individual rodent species on sugar cane is unclear. During the 2005 growing season, live-trapping surveys were conducted along sixteen 250-m lengths of field ditches located throughout the EAA to determine the composition of the rodent community and to obtain relative indices of rodent abundance. These surveys were

repeated three times during the year (post-harvest, mid-way through growing season, and pre-harvest) to examine seasonal changes in the populations. The EAA rodent community is comprised primarily of three species: cotton rat (*Sigmodon hispidus*), roof rat (*Rattus rattus*), and rice rat (*Oryzomys palustris*). Following sugar cane harvest, abundance of all species declined drastically. As the growing season progressed, abundances of all three species increased; however, because cotton rat is the most fecund, it was the most abundant species by the end of the growing season. To determine the relative impact of each rodent species on sugar cane, a feeding trial experiment was conducted in which individuals (98 cotton rats, 36 roof rats, and 27 rice rats) were placed in separate cages with a standard length of sugar cane stalk (CP80-1743) for 24 hours. The amount of sugar cane consumed was then quantified. All three species consumed large amounts of cane during the trials, sometimes in excess of 100% of their body weight (grams consumed: cotton rat: 46.7 ± 34.5 s.d.; roof rat: 37.9 ± 36.8 s.d.; rice rat: 27.4 ± 28.1 s.d.). For the smallest species, the rice rat, percentage of body mass consumed in sugar cane was correlated negatively with air temperature during the trial (rice rat: avg. mass=79.4 g, r^2=0.35, P=0.001; cotton rat: avg. mass=118.9 g, r^2=0.05, P=0.02; roof rat: avg. mass=173.9 g, r^2=0.04, P=0.27). Even though the average per capita damage inflicted by the smaller rodents is lower than that of the larger rodents, they still are capable of inflicting relatively large amounts of damage to sugar cane crops, particularly in cold temperatures. Therefore, growers can expect to see spikes in rodent-inflicted damage to sugar cane during extended periods of cold.

Inheritance of Resistance to Ratoon Stunting Disease and Implications for Selection in Florida

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Ratoon Stunting Disease (RSD) (caused by *Leifsonia xyli* subsp. *xyli* (Davis et al.) Evtushenko et al.) may impart major economic yield losses in sugarcane, particularly in ratoon crops. Although control may be obtained by mechanical sanitation and the use of disease-free seed-cane, genetic resistance would add to its control. The germplasm from the USDA-ARS sugarcane breeding program (Canal Point, FL) has been evaluated for RSD susceptibility since 1993. Susceptibility to RSD was determined by a serological test specific to RSD. The number of colonized vascular bundles per imprint (CVB) was determined from inoculated tests of Stage 2 and Stage 3 genotypes from the Canal Point breeding program. Stage 2 yields and RSD evaluations are determined from independent, unreplicated tests with about 1500 genotypes. Stage 3 trials consist of replicated tests of about 130 clones at four locations while an independent RSD inoculation test of the germplasm is conducted using a replicated test. We estimated narrow-sense heritabilities of log-transformed CVB and yield components using a half-sib parental analysis. The narrow-sense heritability percent for CVB was low (h^2 = 7.8%) but similar to that estimated for stalk number and sugar yield. Non-additive genetic variance was not indicated. Within-test clonal repeatability analysis of the Stage 3 material indicated that the clonal repeatability was about 0.50 while spearman correlations of Stage 2 CVB with Stage 3 CVB averaged r = 0.21. This suggested that the within-test estimate is significantly inflated by the genotype x year variance. Correlations of CVB with the yield components of germplasm in

the Stage 2 and Stage 3 trials ranged from low (r <0.10) to no correlation.. Among the inoculation tests, the check cultivars often varied as did their responses within the tests, however they tended to fall into three categories: resistant (CVB near 0), moderately susceptible (5<CVB<10), and susceptible (CVB≥10). In this study we conservatively (CVB=0) or liberally (CVB<10) classified genotypes as resistant. Approximately 10% of the Stage 3 genotypes and 35% of the Stage 2 genotypes were conservatively classified as resistant, while approximately 70% of the Stage 3 and Stage 2 clones were liberally classified as resistant. There was no consistent trend in apparent resistance among the test years examined. Population means of the remaining genotypes were calculated after removing genotypes classified as susceptible. As expected from the poor correlations, this simulated selection effected little change in the mean of the remaining population. Genotype selection, however, looks for the exception not the average. Given the cultural control options available, selection for RSD resistance should be maintained as practiced, which involves cautious dropping of some susceptible genotypes and consideration when making crosses.

Silicon Fertilizer Effects on Electrolyte Leakage from Sugarcane Leaf Cells after Exposure to Freezing Temperatures

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Sugarcane grown in subtropical regions often sustains damage from freezing temperatures. Some sugarcane growers have reported that commercial fields fertilized with Si had less freeze damage than non-Si fertilized fields. The purpose of this study was to determine if fertilizer Si reduces freeze damage to sugarcane leaf cells. A factorial experiment with seven sugarcane genotypes (CP 78-1628, CP 80-1743, CP 88-1752, CP 89-2143, CP 57-603, Green German, and Muntok Java), two silicon (with and without Si fertilizer), and two soil (muck and sand) treatments, and four replications was conducted in a greenhouse for 13 months. Cell damage was determined after 6 (sample 1) and 13 (sample 2) months of growth by the electrolyte leakage method using dewlap leaf pieces after exposure to freezing temperatures. Higher electrolyte leakage percentages are an indicator of increasing cell damage. At sample 2, freezing temperatures caused greater electrolyte leakage from leaf cells in non-Si fertilized leaves (79%) compared to Si fertilized leaves (74%). There was a tendency for the same response at sample 1 (77 vs. 76%, respectively) as well as a high correlation (r=0.94**) between electrolyte leakage at sample 2 vs. sample 1. At harvest, Si fertilized treatments had higher shoot dry yields (763 g pot^{-1}) and percentage Si contents (0.18%) than non-Si fertilized treatments (601 g pot^{-1} and 0.15%, respectively). There were significant differences in electrolyte leakage due to freezing among genotypes with Muntok Java and CP 78-1628 having the highest (84%) and lowest electrolyte leakage (70%), respectively, averaged across both sample dates. Freezing temperatures caused greater electrolyte leakage in plants growing in muck soil (average 84%) compared with the sandy soil (average 78%). However, there were no significant differences in electrolyte leakage after freezing among genotypes growing in the muck soil for samples 1 and 2 (average 83 and 84%, respectively). In the sandy soil, there were significant differences in electrolyte leakage among genotypes. Electrolyte leakage ranged between 57 and 84% and 54 and 85% for samples

1 and 2, respectively. Our data indicate that Si fertilization reduces cellular damage in sugarcane leaves when exposed to freezing temperatures. The trait for freeze injury to sugarcane cells based on electrolyte leakage is best expressed in a sandy soil compared with a muck soil.

Biorational Insecticide Research to Develop and Preserve Insecticide Labels for Borer Management

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The goal of this presentation is to review research and management approaches designed to both preserve insecticide labels for long term use in sugarcane systems, as well as to outline studies leading to labeling of new environmentally friendly insecticide chemistries. Because toxicology sensitivity baselines have been developed on new insecticide chemistries before insecticides have been used in management, early detection of the beginnings of insecticide resistance has led to better preservation of the chemistries. One tebufenozide (Confirm®) control failure in field management of the sugarcane borer, *Diatraea saccharalis* (F) near Duson (LA) showed an LC5O of 3.8-fold and an LC90 of 7-fold in comparison to the susceptible strain. Attention to alternation of chemistries is showing a reversion to susceptibility in other areas with heavy tebufenozide use. Research will also be presented leading to the submission of the section 18 state label for novaluron (Diamond®). Studies will additionally show the physiological changes in *D. saccharalis* development leading in the evolution of insecticide resistance.

Ripener Influences on Sugarcane Yield in Louisiana

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The combination of Louisiana's climate-induced short growing season with the need to begin the harvest season earlier to makeup for shortages in milling capacity, and an overall need to increase production efficiencies at both the grower and processor level is forcing the industry to rely heavily on low rates of the herbicide, glyphosate, to enhance the natural ripening of the crop. Studies were conducted to evaluate: the ripening response of Louisiana's leading variety, LCP 85-384, to various formulations and rates of glyphosate applied to ratoon crops; the application of experimental ripeners to the ratoon crop and over the ratoon crops of a crop cycle; and the response of the newer varieties released to the Louisiana industry to glyphosate in comparison to LCP 85-384. In the first study, the Polado L®, Roundup Weathermax® and Touchdown iQ® formulations of glyphosate were applied on 7 September 2004 and 18 August 2005 to first-ratoon crops at acid equivalent (ae) rates of 0.125, 0.187, and 0.25 lbs ae/A with stalks being harvested at 4, 5, and 6 weeks after treatment (WAT) for juice analysis and yield estimations. Formulation by rate interactions was not significant suggesting that the formulations performed similarly in increasing the theoretically recoverable sugar (TRS) levels and sugar yields of the harvested crop when compared to the non-treated check. The TRS levels increased as the rate of glyphosate applied increased; however, the response at the 0.25 lbs/A rate was generally equivalent to the 0.187 lbs/A rate and greater than the 0.125 lbs/A rate. In a second study, the response of annual (late-August/early-September) applications of glyphosate (Polado L®) at 0.187 lbs/A and three alternative ripeners, imazapyr (Arsenal®) at 0.094 lbs active ingredient (ai)/A, nicosulfuron (Accent®) at 0.042 lbs ai/A, and trinexapac-ethyl (Palisade®) at 0.27 lbs ai/A to ratoon crops were compared. All of the treatments increased TRS levels 6 and 7 WAT of the treated crop when compared to the non-treated check. However, yearly increases in sugar levels with glyphosate at the standard rate of 0.187 lbs/A did not increase the total sugar yields for the three ratoon crops (12,300 lbs/A) when compared to the non-treated check (12,100 lbs/A). The reduction in the total sugar yield following repeated applications of glyphosate was attributed to a reduction in gross cane yield and not to a reduction in April shoot counts. Imazapyr, nicosulfuron, and trinexapac-ethyl did not reduce cane tonnages. As a result, total sugar yields for the ratoon crops were 1,200 to 2,000 lbs/A higher than the glyphosate standard. In a third study, glyphosate (Polado®) applied at 0.187 lb/A with a nonionic surfactant at 0.5% by volume consistently increased TRS levels 6 WAT in second-ratoon crops of LCP 85-384, HoCP 85-845, HoCP 91-555, HoCP 96-540, and L 99-233 to similar percentages when compared to the no glyphosate treatment. The standard rate of glyphosate did not increase TRS levels 6 WAT for L 97-128, suggesting that a longer treatment to harvest interval or higher rates of glyphosate may be needed to elicit a ripening response from this variety which has been characterized as the earliest maturing variety currently being grown in Louisiana. The seasonal application of glyphosate, regardless of formulation, at 0.187 lbs/A to enhance ripening continues to show positive benefits. Yield decline is a characteristic of all of the varieties released prior to LCP 85-384, and LCP 85-384 has in the last few years been showing similar signs of yield decline. Our results suggest that the repeated application of glyphosate to LCP 85-384 over the entire crop cycle may be exacerbating this problem as gross cane yields in subsequent ratoon crops of LCP 85-384 appear to be declining at a faster rate when glyphosate is applied annually over the crop cycle. The labeling of alternative ripeners such as imazapyr, nicosulfuron, and trinexapac-ethyl may not have a similar effect on ratooning ability as they do not appear to have as great an influence on underground stubble buds.

Field Evaluation of Foliar- and Soil-Applied Plant Nutrition Compounds in Sugarcane

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A field experiment was conducted in 2005 on a silty clay loam (Vertic Haplaquolls) to evaluate the response of LCP 85-384 to two soil-applied and three foliar-applied experimental plant nutrition compounds. The soil-applied compounds included an additive for increasing root mass (HM9840B) and a blend of organic acids (HM9754), while the foliar-applied compounds included two controlled-release nitrogen sources (HM9310 and HM9827A) and a potassium source (HM0523). The experimental design was a completely randomized design with four replications. Plots consisted of three rows, each 2 m wide and 12.2 m long. On April 22, 2005,

all plots, including the check (Trt. 1), received an application of 134 kg ha^{-1} of N using a 32%-N urea ammonium nitrate (UAN 32%). Compounds applied to the soil along with this initial UAN 32% application included HM9840B at 585 mL ha^{-1} (Trt. 2); HM9754 at a 1:20 L ha^{-1} ratio with UAN 32% (Trt. 3); and a combination of HM9840B at 585 mL ha^{-1} with HM9754 at a 1:20 L ha^{-1} ratio with UAN 32% (Trt. 4). Foliar treatments were first applied on July 22, 2005, and included HM9310 at 9.354 L ha^{-1} (Trt. 5); and HM9827A also at 9.354 L ha^{-1} (Trt. 6). These 2 foliar treatments (Trt. 5 and Trt. 6) also included a second application of the same foliar-applied compounds at the same rates on August 10, 2005. Another treatment included the foliar potassium source HM0523 applied once at 4.67 L ha^{-1} on August 10, 2005 (Trt. 7). The final foliar treatment (Trt. 8) was a combination of Trt. 4 and Trt. 7, namely the April 22, 2005 application of the two soil-applied compounds (HM9754 and HM9840B) followed with the August 10, 2005 application of the foliar potassium source HM0523. At present tissue samples are being analyzed and results will be available for the presentation. The application of the foliar-applied, controlled-release N products (HM9310 and HM9827A) produced higher tons of sugar per hectare (P=.03) and tons of cane per hectare (P=.09) than the check. The soil-applied compounds (HM9840B and HM9754) applied either alone or in combination and the foliar-applied K treatment (HM0523) did not differ significantly from the check for both sugar and cane yields. These results are based on only one year's observations and, therefore, conclusions about product efficacy or recommendations must await additional investigations.

Effect of Residue Management on Sugarcane Yield

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We investigated the effect of sugarcane residue (mulch cover) management, using residues deposited during harvest operations, on sugarcane yield (biomass and sugar) and also quantified the post-harvest decay of these residues. Three residue management practices were implemented at the St. Gabriel Research Station, where sugarcane variety HoCP91-555 was planted on 1 September 2001 on a Commerce silt loam 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 was 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. Based on four growing seasons (2002-2005), the amount of mulch following harvest ranged from 1.5 to 3.5 tons/acre and the rate of residue decay ranged between 10 to 20 lbs/acre/day. Early harvest of sugarcane resulted in early mulch decay or disappearance in the spring. Highest yield was that for the burn treatment which with 10 to 16% reduction in sugar when compared to the no-till treatment. Sugar yields from the sweep treatment were consistent with yields from no-till.

Wireworm Populations and their Control in Sand and Muck Soils of South Florida

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Soil insecticides are typically applied at planting in Florida sugarcane to reduce stand losses due to feeding by wireworms. Our objectives were to survey sand and muck soils for wireworms and to develop criteria to predict damage potential from this pest in plant cane. Surveys were conducted in second ratoon cane by visual timed examination of soil and associated plant material from 40 stools per field. Pre-plant evaluations were made in replicated plots by visual examination and by using two kinds of baits, corn and oatmeal. Half the plots were then subjected to an application of phorate granular insecticide. Treatment effects were assessed by tiller counts. Preliminary data suggested that, although wireworm numbers are relatively high and less variable in muck soils compared to sandy soils, little measurable response to the insecticide treatment can be observed in terms of increased tiller formation.

Evaluation of Sweet Sorghum as a Complementary BioEnergy Crop to Sugarcane in Louisiana

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The potential of growing sweet sorghum (*Sorghum bicolor*) as a complementary energy crop in an integrated feedstock production system with sugarcane is being investigated. Sweet sorghum varieties M81E, Theis, and Topper were evaluated during 2002, 2003, and 2005. The selected varieties were drill-seeded in early May of each year using two drills spaced 16 in. apart on top of a conventional 70-in sugarcane row. Experimental treatments were arranged in a randomized complete block design with four replications and plots consisting of a single row 72 ft. long. Sweet sorghum was sampled four times at 2-week intervals beginning in mid–July and ending in early–September. Each sample consisted of 10 hand-cut stalks with the leaves and, if present, the seed head removed. Estimated yields were calculated based on millable stalk counts made prior to initial July harvest dates. Sucrose, total hexose sugars, and fiber percentages were determined and estimates of total dry matter and ethanol from sugar yields were calculated. The effects of year, crop age, and variety on crop composition and overall yield were all significant in this study. Estimated dry matter yield ranged from 4 to 12 tons/acre, and sugar:fiber ratios ranged from 30:70 to 50:50, depending on year, harvest date, and variety. Mean sugar yields of M81E, Theis and Topper were not significantly different from each other at the each harvest date in July, August or September. Average total hexose sugar yield for M81E, Theis and Topper was 3.9 tons/acre/year, enough to produce 500 gal ethanol/acre from sugars alone. We did not observe a yield plateau for sugar at the end of our experiment as expected, suggesting that additional yield can be expected, perhaps with earlier plantings or later harvests in September. The growing season for sugarcane in Louisiana is shorter than in any other cane growing area of

the world. As a result, optimum cane sugar yields are generally obtained following late-October through December harvests. Results suggest that it may be possible to plant sweet sorghum during the spring and summer months on fallowed sugarcane fields for use as a complementary bio-fuel's feedstock. The integration of these two crops should further assure a continuous supply of feedstock to the processor.

Post-hurricane Survey of Soil Salt Content in Louisiana

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The unprecedented tidal surges accompanying Hurricanes Katrina and Rita inundated almost 16,000 hectares of sugarcane in south Louisiana. Most of the flood water receded quickly but the duration and depth of the water were sufficient in some areas to severely damage or kill a considerable hectarage of sugarcane. To what extent high sea water salt contents in soils will impact sugarcane over the long term remains uncertain for Louisiana environmental conditions. A protocol for soil salinity sampling was established to initiate a survey to determine the enormity of the soil salinization problem. Soil cores were taken at depths of 0-8 cm, 8-15 cm and 15–30 cm to determine the distribution of salt within the soil profile. Conducted across Iberia, St. Mary and Vermilion Parishes in October, 2005, the initial survey recorded salinities for the upper 8-cm soil profile ranging from 268 to 4,329 mg L^{-1} (each dS m^{-1} of saturated electrical conductivity, EC_e, is approximately 640 mg L^{-1}). Though salt levels decreased with depth of sampling, the saltiest site contained almost 2,000 mg L^{-1} in the 15–30 cm core. Sites were re-sampled in early February, 2006 to determine if sufficient leaching had occurred to reduce the salinity. Despite post-hurricane rainfall totaling over 25 cm, soil salinity levels were discovered to be essentially unchanged. Published reports suggest sugarcane is moderately sensitive to salt, with a threshold for yield loss at 1.7 dS m^{-1}. Recent research in Texas measured reductions in Brix, pol and purity and increases in fiber in response to unit dS m^{-1} increases in soil EC_e. For the soil re-sampling event in the Louisiana parishes, a majority of the sites contained soil surface (top 8 cm) salinity levels that exceeded the damage threshold of 1.7 dS m^{-1}. Soil salinity monitoring efforts will continue until sugarcane harvest, at which time a yield impact assessment will be made in an attempt to confirm the applicability of the salinity damage threshold for sugarcane grown in Louisiana.

Sugarcane Crop Water Use in Semiarid South Texas

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The primary factor limiting sugarcane production in South Texas is water. Sugarcane has the potential to produce 60 to 70 tons/acre in this region, and has been assumed to require 1 inch of water per ton of cane produced. Rainfall, however, averages only about 25 inches annually, therefore supplemental irrigation is necessary. Drought conditions and growing water demands require that available water be used as efficiently as possible. Thus good information about sugarcane crop water use is needed. This is best achieved by using reference evapotranspiration (ETo) based on weather data along with a crop coefficient (Kc) curve appropriate for local conditions. Previous efforts in South Texas have utilized a soil water balance approach including leaf area index and growing degree days to adjust crop coefficients. More recent efforts have utilized soil moisture monitoring to measure crop water use. Results suggest that sugarcane requires substantially less water than previously assumed. Sugarcane in South Texas is capable of producing 1.2 tons per inch of water, or 20% more cane on the same amount of water. However, this requires optimum soil moisture conditions which require efficient water application in terms of uniformity, amount and timing.

Evaluation of Family Appraisal Methods in Sugarcane

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In Louisiana, sugarcane (*Saccharum* spp. hybrids) breeders rely upon information obtained from family appraisal trials to make decisions that impact several important aspects of the breeding program. Decisions about parents to retain for future crossing, cross combinations to make, and numbers of crosses and seedlings per cross to plant and ultimately from which to select are all guided by information derived from family appraisal trials. Thus, efficient and practical family appraisal methods are vitally important to the long term success of any breeding program. In this study, we evaluated families in the seedling (Stage I, single stool) and first line trial (Stage II, clonal plots) stages for key traits in an effort to ascertain the reliability of the current (Stage I) family appraisal method. Seventeen sugarcane families derived from biparental crosses were evaluated in Stages I and II for stalk traits (number, height, diameter), Brix (measured in the field by hand-held refractometer), and number of clones selected visually. Sixteen random stools per family were measured in Stage I and planted to Stage II trials. Generally, traits were measured in Stage I with less precision (higher CV, %) compared with Stage II. Broad-sense heritabilities were generally greater in Stage II compared with Stage I. However, the Stage I data for traits such as stalk height, stalk diameter and Brix were more predictive of Stage II family performance than the other traits measured. Stalk diameter measured in both stages was the trait most correlated to number of clones selected in Stage II while stalk number was the least correlated. Using current Stage I plot techniques, it appears family appraisal could reliably be carried out in Stage I with emphasis on traits such as stalk diameter, stalk height, and Brix; emphasis on stalk number should only occur at later selection stages. Obtaining family appraisal data in Stage II rather than Stage I would ultimately provide the most robust estimates of family performance.