EVALUATING THE EFFECTS OF COMBINE-HARVEST RESIDUE MANAGEMENT ON SOIL AND WATER QUALITY AND SUGARCANE PRODUCTION IN LOUISIANA

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Specific Goals and Objectives:

Specific objectives of the project are to evaluate the effects of four combine-harvest residue management treatments on runoff water quality and sugarcane growth, development and yield at two sites within the Vermilion-Teche watershed and to educate the public, scientific community and the sugarcane industry concerning the research findings as they relate to opportunities for enhanced sugar production and a cleaner environment.

Description of Treatments and Water Sample Collection System:

Combine-harvest residue management treatments include two treatments designed to mitigate the adverse effects of retained residue – the applications of stabilized urea plus composted biologicals and the shredding of the residue for accelerated decomposition – and two treatments currently employed by the industry – ground burning of the residue and post-harvest retention of the residue. A randomized block experimental design is being used to statistically evaluate treatment effects. Two replications only are being used for water quality sampling, but four replications are being employed for cane and sugar yield determination.

At both sites end-of-field collections are made using H-flumes and ISCO samplers instrumented with submerged probe flow modules. Samplers were calibrated to composite 300ml samples at 50 gal/min flow. Analyses are made for TSS, TDS, turbidity, TKN, nitrite and nitrate nitrogen, chloride, bromide, sulfate, total P and BOD5. Field determinations are made for EC, pH and DO.

Crop agronomic data include the monitoring of crop development and the measuring of cane tonnage, sugar yield and nutrient leaf concentration. Soil analyses include the evaluation of macro and certain secondary and micro nutrients, as well as soil N and C. Soil respiration and temperature measurements are being taken at the Youngsville site. Rate of disappearance of harvest residue is also measured.

Preliminary Results:

Residue Degradation:

Measurements on the rate of residue degradation are shown in table 1. Preliminary observations suggest that the treatments designed to enhance residue degradation did not enhance degradation of the residue materially.

Table 1. Residue Degradation.

Residue Management Treatment	Tons of Harvest Residue Dry Matter/Acre			
	Jeanerette		Youngsville[1]	
	December	March	January	March
Burned	5.94	1.11	3.55[1]	0.14
Retained	4.86	2.84	3.55	1.72
Urea/compost	5.30	3.24	3.55	1.21
Shredded	7.87	5.45	3.55	1.66

[1] – Youngsville site used only the plots scheduled for burning to estimate initial residue dry matter.

Production of sugarcane tonnage and sugar:

Relative comparisons among the residue management treatments for cane and sugar yields are shown in tables 2 and 3. Sugarcane yield was indifferent to residue management as none of the treatments was statistically superior.

Table 2. Tonnage and Sugar Yields for Jeanerette.

Residue Management Treatment	Tons cane/acre	Lb sugar/acre	Lb sugar/ton
Burned	40.4	9246	229
Retained	39.4	8976	227
Urea/compost	39.7	8945	226
Shredded	39.1	8555	219
P =	.91	.68	.47
CV =	6.7%	8.9%	4.1%

Table 3. Tonnage and Sugar Yields for Youngsville.

Residue Management Treatment	Tons cane/acre	Lb sugar/acre	Lb sugar/ton
Burned	28.7	7803	271
Retained	26.6	7346	276
Urea/compost	24.3	6526	267
Shredded	26.4	6973	264
P =	.11	.14	.26
CV =	8.3%	9.9%	3.2%

Water Quality Results:

Collectible rainfall events during 2006 for the Jeanerette and Youngsville sites numbered 18 and 12, respectively. Not all treatments were represented at all collection dates, and these omissions are treated as missing data for statistical purposes. Comparing actual flow measurements to predicted flows using NRCS models revealed disparities, especially for the

Youngsville site. There was good agreement between actual and predicted flow for the Jeanerette site and, therefore, total water quality parameter loads were calculated using measured flow for most collections and adjusted flow within acceptable confidence limits for approximately 10% of the samples. Two of the 18 collection events at the Jeanerette site were subject to water back flow into the flumes and, therefore, only 16 of the 18 collection events are being considered for this report. The tabular means for the Jeanerette site are shown in table 4 (*These data are preliminary and subject to revision*). Discussion concerning flow estimates is on going for the Youngsville site and, therefore, only data from the Jeanerette site is included in this preliminary report.

Table 4. Loads in Runoff for the Jeanerette Site[1]

Water Quality Parameter	Treatment Load Totaled for 16 of 18 Events			
	Burned	Retained	Urea/compost	Shredded
TSS, ton/a	2.20	1.85	2.70	2.84
BOD, lb/a	12.07	10.77	10.12	12.36
Total P, lb/a	0.489	0.388	0.373	0.530
Nitrate, lb/a	19.02	14.39	22.44	20.43

[1]Data are preliminary and may change to reflect adjustments to estimated flow.

Preliminary Observations:

While there were not significant differences among the treatments for sugarcane yield at either site (tables 2 and 3), the trend, however, for burning to yield higher subsequent production is consistent with reports in the literature of a 5 to 10% yield advantage for burning.

Total soluble solids (TSS) for the residue burned and residue retained plots averaged 2.20 and 1.85 tons/acre, respectively. TSS was consistently higher for the burned plots until full canopy occurred in late June and July, after which time the two industry-employed treatments were comparable in soil loss. It appears the disparity between burning and not burning in tons of soil removed was primarily due to higher soil removal in the burned plots prior to crop canopy.

Nitrate concentrations were higher for the urea/compost treatment. It is clear that the application of stabilized urea (at the high rate of 180 lb N/acre) in the fall is not an environmentally acceptable practice.

Unfortunately, neither the urea/compost nor shredded treatment, which were designed to help mitigate the adverse effects of retained residue, had positive effects on either soil or nitrate loss.

SALINITY IN THE SUGAR BELT

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Summary:

The tidal surges accompanying Hurricanes Katrina and Rita in August and September 2005 deposited a considerable amount of salt throughout the coastal parishes of Louisiana. Commodities particularly hard hit were sugarcane and rice, especially from Hurricane Rita. A survey, conducted shortly after the water subsided in the areas planted to sugarcane, revealed soil salinity levels in several areas of six to eight times the published damage threshold level of 1,100 ppm. Out of concern that the 2006 crop was in jeopardy, three methods were used to evaluate the effects of salinity on sugarcane production. The first approach was to monitor changes in salinity and to measure yield at the original sites selected for sampling in October 2005. Secondly, microbial products, designed to reduce soil salinity, were evaluated at the two highest salinity sites identified in the survey. The last method was to sample partially flooded fields to compare soil salinity and yield levels between the submerged and the un-flooded areas of the fields.

Table 1 shows the changes in salinity and sugar yield for six of the sites in the original salinity survey completed immediately after Hurricane Rita.

Table 1. Changes in soil salinity and subsequent 2006 sugar yields for the original survey sites.

Site	Initial salinity, ppm 0-12 in. depth	Salinity at harvest, ppm 0-12 in. depth	Yield, lb sugar/acre
Vermilion 1	338	156	14,076
Vermilion 2	1,083	1,084	5,189
Iberia 1	2,428	860	9,333
Iberia 2	572	106	9,085
St. Mary	2,554	736	11,152
Terrebonne	3,212	186	14,234

Averaged over all the sites, salinity decreased 69% from the time of the survey to the harvest season. Sugar yield averaged 10,512 pounds per acre, based on hand-harvested samples. It must be pointed out that all three sites that had initial salinity levels above the published damage threshold of 1,100 ppm had excellent yields. The one site with high salinity at harvest, Vermilion 2, had the lowest yield.

Products designed to reverse the negative impact of soil salinity were evaluated at the two highest soil salinity sites (table 2). The two products were microbial-based soil amendments composed of *Bacillus spp.*, actinomycetes, cyanobacteria, algae, protozoa and microbial byproducts. They are believed to help displace sodium from cation exchange sites, making the sodium subject to leaching. While the products appeared somewhat effective in reducing

salinity in the sugarcane rooting zone (Ag Blend™ and Soil Builder™ reduced salinity more than the control – data not shown), the yield among the three treatments was not significantly different at either location. Continued research is needed to further evaluate the potential for crop and soil improvement effects by these products.

Table 2. The evaluation of SuperBio® biological products[1] for the amelioration of soil salinity.

Treatments	Vermilion site, lb sugar/acre	Terrebonne site, lb sugar/acre
Control	8,497	6,249
Ag Blend™	8,853	5,883
Soil Builder™	8,744	5,936
LSD (.05)	NS	NS

[1]Mention of proprietary products does not indicated endorsement by the LSU AgCenter

The final approach was to compare sugarcane production on flooded and non-flooded areas of partially flooded fields. Fields were chosen by aerial maps, with articulated flood surge lines, and by growers' eyewitness accounts. Although the trend in table 3 suggests that flooding adversely affected production, the data were highly variable (see Coefficients of Variation in table 3) and treatment means for all parameters were not significantly different.

Table 3. Comparison of flooded and non-flooded areas of 14 partially flooded sugarcane fields.

Field position	tons cane/acre	lb sugar/acre	lb sugar/ton	Salinity at harvest, ppm
Flooded	27.8	6,259	226	878
Non-flooded	30.3	7,218	240	333
LSD (.05)	NS	NS	NS	NS
C.V.	22.9 %	22.9 %	11.6%	221.7%

While high soil salinity levels existed at the time of the initial survey in October 2005, rainfall was sufficiently heavy to leach much of the salt from the root zone by harvest of 2006. Average salinity was considerably below the published damage threshold by the fall. Nevertheless, when factoring in all sites across the five parish area in which samples were taken, there was a moderate but statistically significant decrease in plant cane tonnage as salinity increased (R^2=.46). The association between soil salinity and yield in the stubble phase of the production cycle was not as strong.

In summary, evaluating the effects of soil salinity on sugarcane yield was made difficult because conventional unsalted control plots were not available for comparison. Also, differential rainfall amounts and the direct effects of the flood waters served as confounding effects across the many locations from which data were collected. While several high-salinity sites produced acceptable yields, there was statistical evidence that the overall trend was for soil salinity and flood waters to reduce yield. It is believed, however, that the adverse effects of soil salinity were minimized by Louisiana's high rainfall environment. At harvest, over 90% of the plots across all studies had soil salinity levels well below the published damage threshold. The outlook for future sugarcane production in the affected areas is encouraging.

METRIBUZIN AND ATRAZINE ADSORPTION BY SUGARCANE RESIDUE

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The influence of crop residue on the fate and efficacy of applied herbicides in soils is one of the primary focuses associated with conservation measures in today's agriculture. We are not aware of published research that correlates the effectiveness of residue remaining on the soil surface, following sugarcane harvest, with the retention of applied herbicides and their movement in the soil. In this study, we quantified the retention of two commonly used herbicides namely, atrazine and metribuzin, by the sugarcane residue in an effort to characterize their behavior in soils. Changes in the characteristics of herbicide retention as a function of the age of the residue while decaying in the field were also investigated. Such information is a prerequisite for quantifying the role of the residue in minimizing leaching losses of applied chemicals in soils.

Materials and Methods

To quantify the influence of residue on herbicide retention, the rate of decay of the sugarcane residue was measured. Bulk samples of sugarcane residue (varieties LCP85-384 and CP70-321) were collected from field plots at the Sugar Research Station, St. Gabriel, Louisiana. The "384 variety" was grown on a Sharkey clay soil whereas the "321 variety" was grown on a Commerce silt loam. The decay of residue for CP70-321 was monitored after harvesting of the third ratoon during one growing season (1999-2000), whereas the LCP85-84 variety was monitored following three successive growing seasons (plant cane, and first and second ratoons) during 2000 to 2003.

To assess herbicide retention of the residue over time after harvest, adsorption by the residue was carried out in the laboratory using the batch technique of Selim and Zhu (2005). The residue was collected randomly within each plot, by measuring multiple 1.0 m^2 areas then dried at 55°C for 24-h and weighed. A portion of dry residue was cut into 1 cm sections for herbicide retention studies. Residue samples were collected at different times following harvest during three growing seasons. Adsorption was initiated by mixing 1 g of dried residue samples with 30 mL of various herbicide concentration solutions in a 40 mL Teflon centrifuge tube. Six initial atrazine/metribuzin concentrations ranging from 2.98 to 29.8 mg/L for atrazine and from 2 to 98 mg/L for metribuzin in 0.005 $M\ CaCl_2$ were used. All concentrations were spiked with radio-labeled (C14) atrazine/metribuzin. Each mixture was shaken for specified reaction time, centrifuged, and with a 0.5 mL aliquot was sampled from the supernatant. Analyses for C14 were carried out on sampled supernatants using liquid scintillation counting methodology.

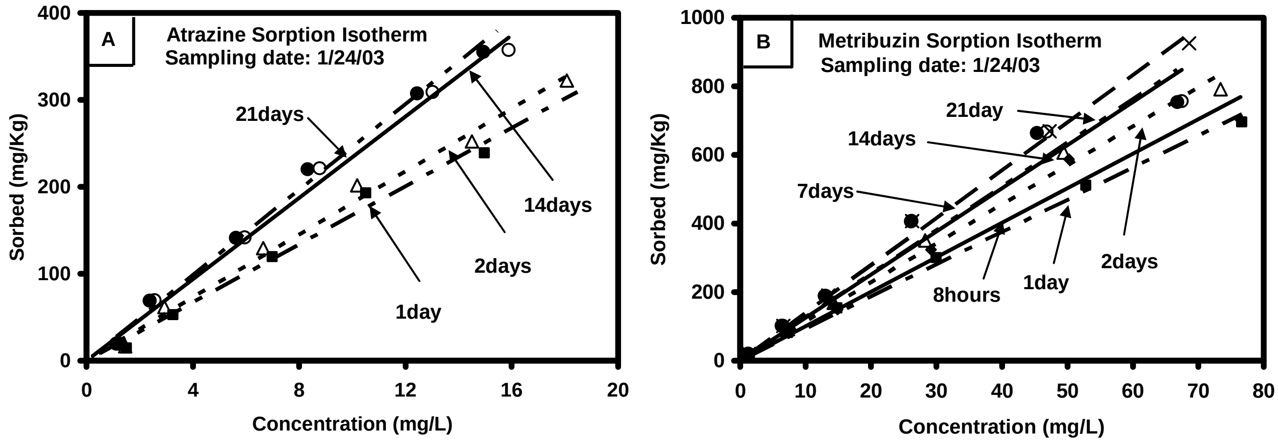

Fig. 1. Adsorption isotherms for atrazine (A) and metribuzin (B) for sugarcane residue (variety LCP85-384) at different reaction times.

Results and Discussion

Adsorption isotherms represent the amount retained by the residue versus the remaining herbicide concentration. A family of isotherms is shown in Figure 1. These isotherms were well described using a linear type model ($S = K_d C$) where S is the amount of herbicide sorbed (mg/kg of residue), C is solution concentration of atrazine or metribuzin (mg/L). Here K_d (mL/g) represents herbicide distribution or affinity coefficient and is the slope of the isotherms. For atrazine, the K_d increased with time from 18.77 to 25.46 mL/g after 1 and 21 d, respectively. For metribuzin, modest K_d increase with reaction time was observed (10.58 to 14.20 mL/g). These increases are representative of strong kinetic sorption of atrazine and to a lesser extent for metribuzin by the residue. Such K_d values for the residue are an order of magnitude higher than that found for soils such as Commerce silt loam (Selim and Zhu, 2005). This was expected since organic matter is the principal component affecting adsorption of herbicides in the soil.

In Figure 2A, we present the residue on a dry matter basis versus time following harvest for four growing seasons (1999-2003). A rate of residue decay was derived based on linear regression where the slope represents the mass of residue degradation over time. For CP70-321 grown on Commerce silt loam, the estimated rate of decay was 22.4$\pm$3.5 kg/ha/day. For LCP85-384 grown on Sharkey clay, the rates of degradations were 20.4$\pm$3.8, 16.7$\pm$ 4.3, and 13.1$\pm$ 8.7 kg/ha/day for the three growing seasons (plant cane, first and second stubble), respectively. Regression analysis suggests a linear model provided a good description of the decay of the residue for all growing seasons. Moreover, the respective slopes of the regression lines were not significantly different. We also carried out nonlinear regression to estimate the rate of decay based on first-order decay. We found out that the half life for the residue decay ranged from 126 to 171 days.

The retention capability of the residue for atrazine and metribuzin versus time of residue decay in the field following harvest is depicted in Figure 2B. Here herbicide retention was quantified to find out the changes of adsorption due to residue decay following harvest. As expected atrazine K_d was significantly higher than that for metribuzin. The retention was similar over the three growing seasons (and did not change with the age of the decaying residue over three growing seasons (2000-2003). Such a finding is significant and implies that only one K_d value is needed to quantify herbicide retention irrespective of the age of residue. Our conclusion is valid for both herbicides. This finding is consistent with that of Dao (1991) for metribuzin adsorption on wheat straw following harvest.

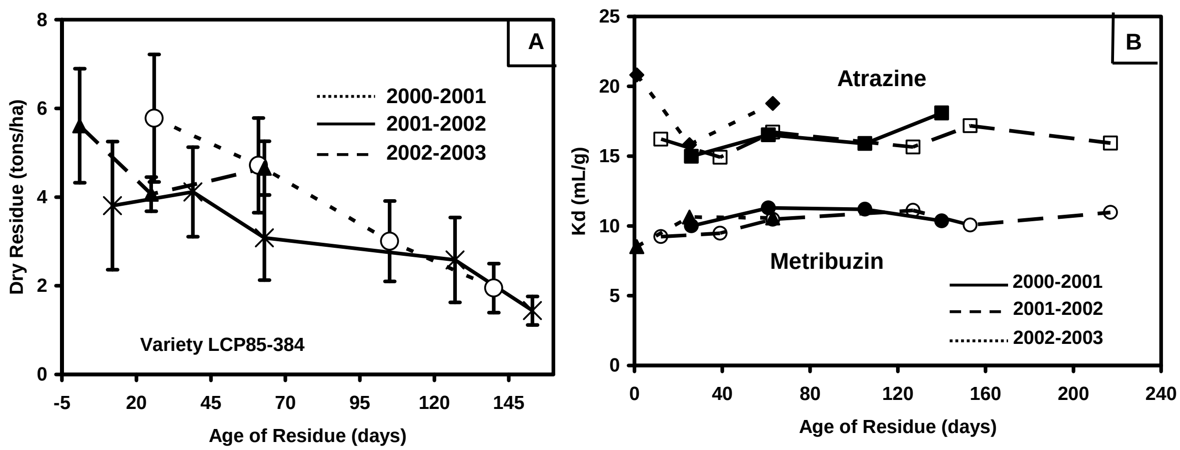

Fig. 2. (A) Field decay of sugarcane residue following harvest; and (B) Distribution coefficient (K_d) for atrazine and metribuzin by the sugarcane residue versus age of residue for three consecutive growing season (for LCP85-384).

Summary and Conclusions

Adsorption experiments were performed to quantify atrazine retention by the sugarcane residue as a function of time. Atrazine retention was consistently stronger than metribuzin and was well described using a linear model. A partitioning coefficient (K_d) for herbicide retention increased with reaction time from 18.77 to 25.46 mL/g after 1 and 21 day, for atrazine, and 10.58 to 14.20 mL/g for metribuzin. Moreover, atrazine retention did not change significantly with the age of the decaying residue over three growing seasons. Consequently, a single retention parameter is necessary to describe atrazine or metribuzin retention regardless of when herbicide application is made. Based on four growing seasons (1999-2003), the amount of crop residue remaining on the soil surface following harvest ranged from 3 to 7 t/ha. Based on first-order decay, the rate of residue decay on the soil surface ranged from 13.1 to 22.4 kg/ha/day. We conclude that atrazine and metribuzin retention by the sugarcane residue exhibited kinetic behavior as indicated by increased K_d with time of retention. We further conclude that atrazine and metribuzin retention did not change significantly with the age of decaying residue. Therefore, for each herbicide, atrazine and metribuzin, one K_d value is needed to quantify retention behavior regardless of when the herbicide is applied.

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USLE “C” Values for Louisiana Sugarcane

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Keywords: soil erosion, sugarcane, USLE

ABSTRACT

USLE cropping and management “C” values were calculated by crop stages for Louisiana sugarcane. Actual soil loss and rainfall erosion index measurements were used in the calculation of the “C” values. The annual average “C” value is 0.104. The annual variation is from 0.150 during the first quarter to 0.036 for the fourth quarter. Conservationists can use these “C” values to assign design values for conservation cropping management practices in the Universal Soil Loss Equation.

INTRODUCTION

USLE cropping and management “C” values were calculated by crop stages for Louisiana sugarcane. Conservationists can use these “C” values to assign design values for conservation cropping management practices in the Universal Soil Loss Equation.

The cropping and management “C” factor for the Universal Soil Loss Equation (USLE) is defined as the ratio of soil loss from land cropped under specified conditions to the corresponding loss from tilled continuous fallow land (Wischmeier and Smith, 1965). Some soils erode more easily than others; therefore, the loss for fallow conditions must be evaluated for the same type soil as on land cropped under specified conditions. The distribution of rainfall erosion index “R” factor by crop stages must be considered in computing “C” values as described by Wischmeier and Smith (1965). The erosion index of a given storm is defined as the product: kinetic energy of the storm in MJ/ha times the 30-minute intensity in mm/hr times 10^{-2}.

SITUATION ON THE LAND

Sugarcane lands in Louisiana are usually managed in 4-yr rotations. The crop is usually planted in September. The crop starts growing and grows until frost. It starts growing again in the spring and will be harvested in the October to December period. This is followed by 2 ratoon crops, then 11 months of fallow to control weeds and diseases. Throughout the 11 months fallow period, the land is bare and unprotected; tillage operations are frequent, so as to reduce weed growth and decrease weed and disease problems during the next cycle sugarcane production. The old rows are broken out to cover stubble in middles about 4 months before turn-plowing, which leaves the field flat. Three months later the rows are formed for sugarcane planting.

PROCEDURE

The USLE factors are described by Wischmeier and Smith (1965). The USLE takes the form:

$$A = RKLSCP \qquad [1]$$

where

A = the soil loss per unit area per year,
R = the rainfall erosion index factor,
K = the soil erodibility factor,
L = the slope-length factor,
S = the slope-gradient factor,
C = the crop management factor,
P = the erosion-control practice factor.

The value of "C" for any crop stage, t, can be calculated by:

$$C_t = A_t / R_t \, K \, L \, S \, P \qquad [2]$$

MATERIALS AND METHODS

The experimental site was at the Louisiana Agricultural Experiment Station's Sugar Research Station located 20 km south of Baton Rouge. Six leveed plots (140 m by 18 m) 0.25 ha in size (nine rows spaced 1.8 m apart and 140 m long and sloped 0.25%) were located on a Commerce silt loam soil (Aeric Fluvaquent, fine-silty, mixed, non-acid, thermic) (Camp 1976 and Rogers et al. 1985). This soil has a hydraulic conductivity of 5 mm/hr. The water table rises to the bottom of the rows during the winter rains. During the summer, the water table falls to 4m below the rows. To measure and sample surface runoff, a sump was installed on the low side of each plot. The sump was a corrugated metal pipe 1.2m in diameter and 3m in depth. A float-controlled electric sump pump was installed in each sump to discharge the runoff through a water meter and into a surface drainage ditch. The pump was ½ HP with a flow rate of 80 l/min. An automatic water sampler at each sump was used to collect runoff samples at 20 minute intervals during runoff. Runoff samples were analyzed by the Department of Agricultural Chemistry for total solids. Using the amount of surface runoff that was measured with the water meters and concentrations provided by the Department of Agricultural Chemistry, total loadings were calculated.

Analytical Data

The soil loss "A" in MT/ha was measured for a specific cropping practice by sampling the runoff water and calculating the soil loss load. Rainfall was measured by a universal recording rain gauge and the rainfall erosion index factor "R" in MJ*mm/ha*h was calculated for each storm. The method used for calculating "R" was described in Wishmeier and Smith (1978). The "R" was calculated in english units. This value was multiplied by 17.02 (Foster et. al. 1981) to transfer the "R" into metric units of MJ*mm/ha*h.

The soil erodibility factor "K" was 0.083 t*ha*h/ha*MJ*mm for Commerce silt loam soil. This was determined by Barnett et al. (1978) using a rainfall simulator.

The slope length factor “L” was 1.39. This was calculated for a slope length of 170 m using the procedure in Wischmeier and Smith (1965).

The slope steepness factor “S” was 0.08. This was calculated for a slope steepness of 0.25% using the procedure in Wischmeier and Smith (1965).

The support practice factor “P” was 1.0 for up and down tillage. This was from Wischmeier and Smith (1965).

CROP STAGES

The sugarcane season was divided into the following crop stages.

Winter: From January 1st to last spring freeze. The fields are bare because the vegetation was frozen last fall.

First Quarter: This is from the last freeze date to ¼ of the way through the growing season. The plants are short and only cover ¼ of the soil surface.

Second Quarter: This is from ¼ to ½ of the way through the growing season. Plants are of medium height and cover ½ of the soil surface.

Third Quarter: This is from ½ to ¾ of the way through the growing season. Plants are tall and cover ¾ of the soil surface.

Fourth Quarter: This is from ¾ of the way through the growing season to harvest. Plants are very tall (over 3 m) and cover all of the soil surface.

Fall: From harvest to December 31st. The field is covered with residue.

RESULTS AND DISCUSSION

The average annual rainfall for St. Gabriel, Louisiana, from 1994 to 2005 was a 96% of normal 1444 mm (Table 1). The year 1997 had the maximum rainfall of 1790 mm (119% normal). Year 2000 had the least rainfall with 1023 mm (68% normal). June was the wettest month with 219 mm and December was the driest with 94 mm (Table 2).
The average annual runoff was 510 mm (35% of rainfall) (Table 1). The year 1997 had the maximum runoff with 809 mm. The year 2000 had the least runoff with 144 mm. June had the maximum runoff with 85 mm (Table 2). August had the least with 12 mm.

The average annual USLE “R” Factor was 10910 MJ*mm/ha*h (Table 1). The year 1997 had the maximum “R” with 18702 MJ*mm/ha*h. The year 200 had the minimum “R” with 6380 MJ*mm/ha*h. June had the maximum “R” with 2732 MJ*mm/ha*h (Table 2). February had the minimum “R” with 403 MJ*mm/ha*h.

The average annual soil loss from 1994 to 2005 was 9.58 MT/ha (Table 1). The maximum soil loss occurred in 1994 with 20.83 MT/ha. The year 2000 had the minimum soil loss with 1.39 MT/ha. The year 2000 has a very small soil loss because it was a drought year with only 68% normal rainfall and 28% of annual average runoff. June had the maximum amount of soil loss with 1.75 MT/ha and August had the minimum amount of soil loss with 0.16 MT/ha.

Table 3 lists the data for the winter stage. From 1994 to 2005, a total of 2805 mm of rain and 1586 mm of runoff occurred. This resulted in 16.377 MT/ha soil loss and an USLE "R" of 15480 MJ*mm/ha*h to equal an USLE "C" of 0.112. This stage is from January 1st to the last spring freeze. The fields are bare and the water table is at the bottom of the rows during this season.

Table 4 lists the data for the first quarter stage. A total of 1769 mm of rain resulted in 986 mm of runoff and 21.058 MT/ha soil loss. With a USLE "R" of 15171 MJ*mm/ha*h, this equaled an USLE "C" of 0.150. This stage is the first quarter of the growing season starting with the last spring freeze date. The cane is less than 1 m tall during this period.

Table 5 lists the data for the second quarter. A total of 1802 mm of rain resulted in 952 mm of runoff, 24.967 MT/ha of soil loss, and a USLE "R" of 22974 MJ*mm/ha*h. This equaled an USLE "C" of 0.118. The second quarter of the growing season is a period of early summer high intensity convective storms. The cane is less than 2 m tall.

Table 6 lists the data for the third quarter. A total of 1764 mm of rain resulted in 530 mm of runoff, 8.804 MT/ha of soil loss, and a USLE "R" of 18047 MJ*mm/ha*h. This equaled an USLE "C" of 0.053. The water table is approximately 1.2 m deep during the third quarter of the growing season. The cane is less than 3 m tall.

Table 7 lists the data for the fourth quarter. A total of 1485 mm of rain resulted in 523 mm of runoff, 3.314 MT/ha of soil loss, and a USLE "R" of 9926 MJ*mm/ha*h. This equaled an USLE "C" of 0.036. This fourth quarter of the growing season is hurricane season. This season is usually very dry unless there is a hurricane, then it can be very wet. The cane is more than 3 m tall and the canopy completely covers the ground.

Table 8 lists the data for the fall period. A total of 1680 mm of rain resulted in 862 mm of runoff, 10.547 MT/ha of soil loss, and a USLE "R" of 9062 MJ*mm/ha*h. This equaled an USLE "C" of 0.126. This is the period from harvest to December 31st. The field is covered with residue. Rainfall increases as the end of the year with the start of winter rains. The winter rains are low intensity and long duration storms.

Table 9 lists the data for fallow period. Every fifth year the sugarcane field is fallowed from the time the fields are dry enough to cultivate in the spring until the new crop of sugarcane is planted in the first part of September. The St. Gabriel sugarcane plots were in fallow during 1996 and 2001. A total of 1150 mm of rain resulted in 467 mm of runoff and 6.202 MT/ha of soil loss, and an USLE "R" of 18671 MJ*mm/ha*h. This equaled a USLE "R" of 0.036. The fallowing operation reduces the percentage of rainfall that becomes runoff.

Table 10 lists the data for the plant period. This period goes from when the sugarcane is planted the first part of September until December 31st. The cane grows and establishes itself until is killed with the first fall freeze. The cane may grow to 0.5 m during this period. Sugarcane was planted in the St. Gabriel plots in September 1996 and September 2001. A total of 498 mm of rain resulted in 208 mm of runoff and 22.902 MT/ha of soil loss, and an USLE "R" of 4982 MJ*mm/ha*h. This equaled a USLE "R" of 0.498. During this period the soil is loose from the planting operation and erodes very easily. Most of the erosion (14.18 MT/ha) was caused by 107 mm of rainfall in October 2001.

Table 11 is a summary table of the USLE "C" values for Louisiana Sugarcane. The average annual "C" value was 0.104. It varied from 0.150 during the first quarter to 0.036 for the fourth quarter.

CONCLUSIONS

The "C" values presented in this study were derived from field measurements of soil loss and rainfall erosion index. These items were measured from instrumented runoff sugarcane plots located at St. Gabriel, Louisiana. The average annual "C" value was 0.104. The values varied from 0.150 during the first quarters of growth to 0.036 during the fourth quarter of growth. Values were also calculated for the fallow and plant periods of the sugarcane cycle. The values were 0.036 for the fallow period and 0.498 for the plant period.

Table 1: Annual Rain, Runoff, Soil Loss, and USLE "R" Values

Year	Rain (mm)	Runoff (mm)	Soil Loss (MT/ha)	USLE "R" MJ*mm/ha*h*y
1994	1434	651	20.83	12150
1995	1581	676	11.95	10480
1996	1365	367	11.31	11962
1997	1790	809	14.41	18702
1998	1334	505	3.83	9256
1999	1193	346	2.47	8762
2000	1023	144	1.39	6380
2001	1721	572	19.20	17325
2002	1697	563	11.86	9920
2003	1306	458	3.98	6822
2004	1581	643	7.11	9140
2005	1302	380	6.69	10022
AVERAGE	1444	510	9.58	10910

Table 2: Monthly Average Rain, Runoff, Soil Loss, and USLE "R" Values

Year	Rain (mm)	Runoff (mm)	Soil Loss (MT/ha)	USLE "R" MJ*mm/ha*h
JAN	122	63	0.68	606
FEB	96	54	0.53	403
MAR	118	58	0.88	635
APR	108	38	0.98	1040
MAY	89	27	0.87	783
JUN	219	85	1.75	2732
JUL	132	25	0.27	1118
AUG	97	12	0.16	710
SEP	128	30	0.62	982
OCT	126	30	1.50	919
NOV	114	47	0.56	570
DEC	94	41	0.79	412
TOTAL	1444	510	9.58	10910

Table 3: Winter Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	236	157	4.350	2005	0.235
1995	168	87	0.579	644	0.098
1996	278	99	1.077	2726	0.043
1997	197	141	1.422	1001	0.154
1998	682	437	3.545	4466	0.086
1999	96	30	0.165	332	0.054
2000	70	23	0.063	618	0.011
2001	326	165	0.327	1207	0.029
2002	199	76	2.880	836	0.373
2003	114	83	0.626	848	0.080
2004	315	209	0.686	862	0.086
2005	124	79	0.656	293	0.243
TOTAL	2805	1586	16.377	15840	0.112

Table 4: First Quarter Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	186	122	5.152	1463	0.382
1995	379	334	5.667	2595	0.228
1997	393	187	2.935	4354	0.075
1998	56	3	0.006	323	0.002
1999	67	15	0.186	1025	0.020
2000	48	10	0.327	369	0.096
2002	176	54	3.629	1899	0.207
2003	208	150	1.424	1183	0.130
2004	192	94	1.600	1838	0.094
2005	64	17	0.132	122	0.117
TOTAL	1769	986	21.058	15171	0.150

Table 5: Second Quarter Sugarcane USLE “C” Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	384	225	9.300	5180	0.194
1995	171	62	2.345	1063	0.239
1997	416	317	8.635	8572	0.109
1998	0	0	0.000	0	0.000
1999	273	109	0.069	2797	0.003
2000	0	0	0.000	0	0.000
2002	103	22	0.853	1075	0.086
2003	50	14	0.223	320	0.076
2004	371	202	3.516	3789	0.100
2005	34	1	0.016	177	0.010
TOTAL	1802	952	24.967	22974	0.118

Table 6: Third Quarter Sugarcane USLE “C” Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	141	79	1.408	1276	0.120
1995	121	8	0.165	1185	0.015
1997	168	55	0.552	2782	0.022
1998	190	40	0.159	2137	0.008
1999	33	8	0.092	256	0.039
2000	74	10	0.540	591	0.099
2002	347	88	0.659	2527	0.028
2003	184	31	0.350	1430	0.026
2004	53	14	0.076	347	0.024
2005	453	197	4.804	5516	0.094
TOTAL	1764	530	8.804	18047	0.053

Table 7: Fourth Quarter Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	151	23	0.097	1003	0.010
1995	118	23	0.060	1380	0.005
1997	134	45	0.157	750	0.023
1998	89	26	0.122	1374	0.010
1999	193	93	0.155	1956	0.009
2000	0	0	0.000	0	0.000
2002	326	196	1.701	1701	0.108
2003	217	80	0.654	800	0.089
2004	169	32	0.302	374	0.087
2005	88	5	0.067	585	0.012
TOTAL	1485	523	3.314	9926	0.036

Table 8: Fall Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1994	104	45	0.521	537	0.105
1995	284	163	3.315	2045	0.166
1997	86	64	0.708	553	0.139
1998	0	0	0.000	0	0.000
1999	127	91	1.808	506	0.387
2000	368	100	0.456	1690	0.029
2002	165	127	1.275	705	0.196
2003	207	100	0.703	1307	0.058
2004	170	90	0.926	690	0.145
2005	169	82	1.016	1028	0.107
TOTAL	1680	862	10.547	9062	0.126

Table 9: Fallow Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1996	298	148	4.719	3778	0.135
2001	852	319	1.483	14894	0.011
TOTAL	1150	467	6.202	18671	0.036

Table 10: Plant Sugarcane USLE "C" Values

YEAR	RAIN (mm)	RUNOFF (mm)	SOIL LOSS (MT/ha)	R (MJ*mm/ha*h)	C
1996	330	120	5.551	3488	0.171
2001	168	88	17.392	1494	1.261
TOTAL	498	208	22.902	4982	0.498

Table 11: USLE "C" Values for Louisiana Sugarcane

Crop Stage	USLE "C" Factor
Winter	0.112
First Quarter	0.150
Second Quarter	0.118
Third Quarter	0.053
Fourth Quarter	0.036
Fall	0.126
Annual Average	0.104

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