IMPACT OF SUGARCANE MULCH MANAGEMENT STRATEGIES ON WATER QUALITY AND CROP YIELD

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INTRODUCTION

Since 1995, the sugarcane industry in Louisiana gradually developed a new harvesting system which involves the use of a combine harvester that cuts the cane stalks into billets, which are directly loaded into wagons for transport to the mill. Extractor fans in the combine harvester separate leaf-material from the billets and the plant residue is deposited on the soil surface. Historically, this sugarcane residue has been removed by burning. In recent years this burning of the residue has become objectionable to the general public because of health issues related to inhalation of the smoke. Increasingly, it is difficult to justify this method as a Best Management Practice of residue management. Environmental concerns about burning and public concerns for clean air, especially in newly developed suburban areas adjacent to sugarcane plantations, have moved the sugar industry toward green harvesting that leaves the residue on the surface. Because of these concerns, there is a need to find economical alternatives for residue management to identify benefits from residue with respect to reducing soil erosion and improving surface water quality. The primary purpose of this project was to evaluate the effect of post-harvest residue (mulch cover) on the field with respect to surface water quality. This project evaluated three management strategies with primary focus on mulch residue and its effect on soil erosion, surface water quality, and crop yields. The treatments include (1) burning the mulch after harvest and cultivating in the spring; (2) sweeping the mulch off of the top of the row after harvest and cultivating in the spring; and (3) leaving the mulch on the field after harvest and cultivating in the spring. Treatment 1 is the common method by which sugarcane mulch is managed in Louisiana. Treatments 2 and 3 are proposed sugarcane residue management practices for use by Louisiana sugarcane farmers. Sugarcane plant population, yields, and quality of surface runoff water were measured for each treatment.

MATERIALS AND METHODS

The experimental site was at the Louisiana Agricultural Experiments Station's St. Gabriel Research Station located 20 km south of Baton Rouge. Six leveed plots 0.25 ha in size (nine rows spaced 1.8 m apart and 140 m long) and sloped 0.1% were located on a Commerce silt loam soil (Aeric Fluvaquent, fine-silty, mixed, non-acid, thermic) (Camp 1976 and Rogers et al. 1985). The sugarcane cultivar HoCP91-555 was planted on September 19, 2001.

To measure and sample surface runoff, a sump was installed on the low side of each plot. 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. An automatic water sampler at each sump was used to collect runoff samples. Runoff samples were analyzed by the Department of Agricultural

Chemistry for total solids, nitrogen, phosphorus, and potassium. Nitrogen was determined by an automated colorimetric procedure developed by Wall and Gehrke (1979). Phosphorus and potassium were determined by an EPA Method 200.2. (Martin et al., 1991). These analyses determined the total concentration in both solution and 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.

RESULTS AND DISCUSSION

The sugarcane was planted in September 19, 2001, and was harvested December 9, 2002, and October 28, 2003. Table 1 shows the sugarcane (biomass) yields for each treatment for 2002 and 2003. The biomass yields for 2002 were 74,180 kg/ha for all treatments. The yields for 2003 were 76,600; 72650; and 69630 kg/ha for the burned, mulch, and swept treatments, respectively. The yields increased 3.3% for the burned treatment and decreased 2.0% and 6.1% for the mulch and swept treatments, respectively. Table 2 shows the sugar yields for each treatment for 2002 and 2003. The amount of sugar produced during 2002 was 8400 kg/ha for all treatments. The yields for 2003 were 9273, 8070, and 7885 kg/ha for the burned, mulch, and swept treatments, respectively. The amount of sugar increased from 2002 to 2003, 10.4% for the burned treatment and decreased 4.0% and 6.2% for the mulch and swept treatments, respectively. During 2003, the burned treatment increased yields while the mulch and swept treatments decreased yields.

Table 1. Annual sugarcane (biomass) yields (kg/ha).

Treatment	Year 2002	Year 2003	% Difference
Burned	74180	76600	+3.3
Mulch	74180	72650	-2.0
Swept	74180	69630	-6.1

Table 2. Annual sugar yields (kg/ha).

Treatment	Year 2002	Year 2003	% Difference
Burned	8400	9273	+10.4
Mulch	8400	8070	-4.0
Swept	8400	7885	-6.1

During the period from September 1, 2001, to December 31, 2002, the rainfall was 2016 mm (102% normal) (Table 3) and the runoff was 653 mm. During the period January 1 to December 31, 2003, the rainfall was 1306 mm (87% normal) (Table 4). The runoff was 444 mm, 472 mm, and 456 mm for the burned, mulch, and swept treatments, respectively. There was not a significant difference among the runoff values.

Table 3. Rainfall and runoff for 2001-2002 at St. Gabriel, Louisiana.

Month	Rain (mm)	Runoff (mm)
Sep 2001	107	47
Oct 2001	121	34
Nov 2001	26	0
Dec 2001	65	10
Jan 2002	129	48
Feb 2002	38	6
Mar 2002	166	42
Apr 2002	107	34
May 2002	31	0
Jun 2002	148	19
Jul 2002	164	5
Aug 2002	50	4
Sep 2002	320	82
Oct 2002	259	149
Nov 2002	107	46
Dec 2002	178	127
Total	2016	653

Rain 102% Normal

The average annual soil losses for September 1, 2001, to December 31, 2002, were 29,292 kg/ha (Table 5). A large portion of the soil erosion occurs during the first year of the sugarcane cycle. During this period, the rows are bare and the soil is loose following the fallow period. Winter rains that fell soon after planting in the amount of 486 mm (24% of the total) caused 19,408 kg/ha of soil losses (665 of the total). Soil erosion during the second crop year was 64% smaller. This was because the rows were covered with vegetation and the soil has consolidated. During the period January 1 to December 31, 2003, the soil losses were 3465, 4295, and 4182 kg/ha (Table 6) for the burned, mulch, and swept treatments, respectively. The burned results were 19% smaller than for the mulch.

Table 4. Rainfall and runoff for 2003 at St. Gabriel, Louisiana.

Month	Rain (mm)	Runoff (mm)		
		Mulch	Swept	Burned
Jan	22	0	0	0
Feb	135	88	81	81
Mar	97	62	60	58
Apr	141	90	90	90
May	6	0	0	0
Jun	165	17	14	11
Jul	142	27	24	21
Aug	175	26	24	24
Sep	117	29	30	29
Oct	84	31	38	30
Nov	150	70	74	70
Dec	72	32	21	30
Total	1306	472	456	444

Rain 87% Normal

The average annual nitrogen losses for September 1, 2001, to December 31, 2002, were 12.80 kg/ha (Table 5). During the period January 1 to December 31, 2003, the nitrogen losses were 8.18, 11.33, and 8.67 kg/ha (Table 7) for the burned, mulch, and swept treatments, respectively. The burned results were 28% smaller than for the mulch. There was not a reduction of nitrogen losses during the second year.

The average annual phosphorus losses for September 1, 2001, to December 31, 2002, were 17.43 kg/ha (Table 5). During the period January 1 to December 31, 2003, the phosphorus losses were 7.65, 9.07, and 9.51 kg/ha (Table 8) for the burned, mulch, and swept treatments, respectively. The burned results were 16% smaller than for the mulch. Phosphorus losses were 28% smaller during the second year.

The average annual potassium losses for September 1, 2001, to December 31, 2002, were 137.91 kg/ha (Table 5). During the period January 1 to December 31, 2003, the potassium losses were 55.42, 57.31, and 56.42 kg/ha (Table 9) for the burned, mulch, and swept treatments, respectively. The burned results were 3% smaller than for the mulch. The potassium losses were 47% smaller during the second year.

Table 5. Soil, nitrogen, phosphorus, and potassium losses for 2001-2002 at St. Gabriel, Louisiana.

Month	Soil (kg/ha)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Sep 2001	2057	2.36	1.90	11.40
Oct 2001	14182	2.08	2.52	16.65
Nov 2001	0	0.00	0.00	0.00
Dec 2001	1152	0.21	0.48	2.46
Jan 2002	1858	0.47	1.02	8.56
Feb 2002	159	0.07	0.04	0.37
Mar 2002	1967	0.69	0.97	8.70
Apr 2002	2514	0.74	2.09	13.42
May 2002	0	0.00	0.00	0.00
Jun 2002	872	0.45	1.58	8.55
Jul 2002	72	0.07	0.04	0.47
Aug 2002	62	0.06	0.02	0.38
Sep 2002	570	1.13	0.76	10.18
Oct 2002	1379	2.42	3.45	26.03
Nov 2002	322	0.74	1.28	9.84
Dec 2002	2126	1.31	1.28	20.90
Total	29292	12.80	17.43	137.91

CONCLUSIONS

The burned treatment increased biomass yields by 3.3% and sugar yields by 10.4%. There was a reduction in biomass and sugar yields from the swept and mulch treatments. There was 29,292 kg/ha soil erosion from the plots during the first year. The soil erosion for the second year was 64% smaller. The soil erosion from the burned treatment was 19% smaller than for the mulch. There was not a difference in nitrogen losses between the first and second years. During the second year, the burned results were 28% smaller than for the mulch. Phosphorus losses were 28% smaller during the second year. The burned results were 16% smaller than for the mulch. The potassium losses were 47% smaller during the second year. The burned results were 3% smaller than for the mulch.

Table 6. Soil losses for 2003 at St. Gabriel, Louisiana.

Month	Soil Losses (kg\ha)		
	Mulch	Swept	Burned
Jan	0	0	0
Feb	551	500	827
Mar	350	417	363
Apr	1176	1363	602
May	0	0	0
Jun	325	246	98
Jul	304	265	225
Aug	333	280	291
Sep	219	205	202
Oct	263	218	209
Nov	568	521	508
Dec	206	167	140
Total	4295	4182	3465

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Table 7. Nitrogen losses for 2003 at St. Gabriel, Louisiana.

Month	Nitrogen Losses (kg\ha)		
	Mulch	Swept	Burned
Jan	0.00	0.00	0.00
Feb	2.52	1.63	1.38
Mar	0.46	0.74	0.78
Apr	3.41	2.08	1.45
May	0.00	0.00	0.00
Jun	1.09	0.82	1.42
Jul	1.46	1.61	1.19
Aug	0.70	0.63	0.65
Sep	0.44	0.46	0.48
Oct	0.79	0.42	0.32
Nov	0.14	0.15	0.14
Dec	0.32	0.13	0.37
Total	11.33	8.67	8.18

Table 8. Phosphorus losses for 2003 at St. Gabriel, Louisiana.

Month	Phosphorus Losses (kg\ha)		
	Mulch	Swept	Burned
Jan	0.00	0.00	0.00
Feb	1.74	1.34	0.96
Mar	1.02	1.74	1.64
Apr	2.24	3.43	1.65
May	0.00	0.00	0.00
Jun	0.24	0.19	0.11
Jul	0.25	0.21	0.17
Aug	0.30	0.27	0.37
Sep	0.27	0.27	0.24
Oct	0.36	0.31	0.26
Nov	2.07	1.52	1.62
Dec	0.58	0.23	0.63
Total	9.07	9.51	7.65

Table 9. Potassium losses for 2003 at St. Gabriel, Louisiana.

Month	Potassium Losses (kg\ha)		
	Mulch	Swept	Burned
Jan	0.00	0.00	0.00
Feb	7.90	7.84	4.34
Mar	2.54	3.61	4.39
Apr	6.00	6.01	5.16
May	0.00	0.00	0.00
Jun	1.55	1.45	0.91
Jul	2.26	1.90	1.64
Aug	3.18	2.80	3.93
Sep	4.08	4.22	3.73
Oct	3.84	4.70	3.45
Nov	20.00	20.40	21.40
Dec	5.96	3.49	6.47
Total	57.31	56.42	55.42