RIPENER UPDATE

Al Orgeron[1], Benjamin Legendre[2], Michael Pontif[3], Jim Griffin[4] and Kenneth Gravois[3]
[1]St. James Parish, [2]Audubon Sugar Institute, [3]Sugar Research Station,
[4]School of Plant, Environmental and Soil Sciences

INTRODUCTION

Artificial ripening of sugarcane as a complement to natural maturity has been made possible by the development of glyphosate, a plant growth regulator for use as a chemical ripener that hastens sugarcane maturation and increases sugar yield per ton of cane and per acre. Many may be familiar with glyphosate as the herbicide Roundup (Monsanto Company), a broad spectrum burndown herbicide used in Roundup Ready crops, fallow weed control programs and residential areas. Glyphosate is also one of the most effective chemical ripeners used on a world-wide basis; it apparently influences the way dry matter is partitioned, increasing the ratio of sugar to fiber thus enhancing the sugar level of the juice and cane. However, glyphosate treatment usually decreases cane yield in the crop by slowing cane growth after treatment, thus reducing stalk weight. In Louisiana, the effectiveness of glyphosate for ripening sugarcane is highly dependent upon variety, rate of glyphosate, treatment-harvest interval and growing season.

Glyphosate was first labeled and marketed as the chemical ripener Polado (wettable powder) from Monsanto Company in 1980 and later sold as Polado L [4 lb acid equivalent (ae)/gal] for use as a management tool to increase the yield of sugar per ton of cane and sugar per acre. Polado (or Polado L) was the only glyphosate formulation labeled for commercial use until 2003 when Touchdown IQ (3.0 lb ae/gal) from Syngenta Crop Protection was labeled. In 2007, there were three glyphosate formulations available for use as chemical ripeners for sugarcane in Louisiana: Touchdown Total (4.17 lb ae/gal), which replaced Touchdown IQ, both from Syngenta Crop Protection and Roundup WeatherMAX (4.5 lb ae) and Roundup PowerMAX (5.5 lb ae) from Monsanto Company along with a limited supply of Polado-L. These newer formulations have different concentrations of glyphosate acid per gallon in the diammonium, monopotassium or potassium salt form. These products all contain glyphosate as the active ingredient and act with the same mode of action and, when applied at the equivalent rate of Polado-L, its users can anticipate similar results.

Slow stand development or shoot emergence in spring following the use of glyphosate is commonly observed in sugarcane treated with glyphosate. Research has shown that annual treatments with glyphosate (Polado L) within the same crop cycle will usually increase mean annual sugar yield, but, depending upon the sensitivity of the variety and the treatment-harvest interval, can negatively impact the yield of sugar per acre in the subsequent stubble crop(s). Additional research has shown that regrowth of cane treated with glyphosate can be further impacted by not removing the residue following green cane harvesting with the cane combine. The impact on regrowth is variety dependent with some varieties more sensitive to repeated use of glyphosate within the crop cycle. Polado L and Touchdown Hi-Tech are formulated without added surfactant. However, research has demonstrated that a quality non-ionic surfactant can

improve the efficacy of these products. The remaining three products, Roundup WeatherMAX, Touchdown IQ and Touchdown Total, are formulated with a surfactant and no additional surfactant is recommended.

Currently, glyphosate is used on approximately 250,000 to 300,000 acres in Louisiana each crop year, netting the state's sugarcane growers, processors and landlords an estimated $100 per acre in increased revenue. The average increase in recoverable sugar per ton of cane is approximately 20 lb with a range of 5 to 30 lb depending upon variety, condition of the crop at and following application of the glyphosate and weather conditions between treatment and harvest. Along with the increase in recoverable sugar per ton of cane there is a corresponding decrease in cane tonnage of approximately 2 tons with a range of 1 to 4 tons depending upon variety and date of application. For early harvest (late September), glyphosate must be applied when the cane is still actively growing in August; therefore, a treatment-harvest interval of 28 days is generally recommended. As the harvest season progresses into late October through November when vegetative growth is decreased, the treatment-harvest interval can be increased to 49 days for maximum response in recoverable sugar per acre. The anticipated increase in sugar per acre can range from 350 lb/A early in the harvest season to over 600 lb/A from mid October through mid November. This increase in sugar per acre adds approximately $30 million in increased gross revenues each year for the State's sugarcane industry. With a material and application cost of approximately $4 million annual, the use of glyphosate has a benefit to use ratio of 7.5 to 1. This cost is typically paid for partially or in its entirety by the factories because of the increased recovery of sugar per ton of cane.

For the last three years, research has been conducted on the use of trinexapac-ethyl (Palisade) from Syngenta Crop Protection, as an alternative to the use of glyphosate. Palisade is a plant growth regulator labeled for use on perennial ryegrass. It slows the growth of grass stems when the product is applied at the manufacturer's suggested rate. Research conducted to date has shown that Palisade has increased the yield of recoverable sugar per ton without a dramatic decrease in cane tonnage or impact on the subsequent stubble crop as seen with glyphosate.

No current glyphosate formulations are labeled for use on the plant-cane crop because of the potential for these products to cause significant yield reduction in the subsequent stubble crop, especially when used at the higher rates. Therefore, additional research is ongoing to find alternative ripeners like trinexapac-ethyl that can be used on the plant-cane crop without the loss of yield in the subsequent stubble crop as well as find potential ripeners that have no deleterious impact on the yield of the crop to be harvested. It is also advantageous that ripeners be developed where the crop can be harvested at a reduced treatment-harvest interval.

METHOD

In 2008, the commercial sugarcane varieties, HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, and L 01-283, were planted on August 26, 2008 at St. Gabriel, LA to evaluate their response to the sugarcane ripeners, Touchdown Total (glyphosate) and Palisade (Trinexapac-ethyl). There were four ripener treatments arranged as a complete factorial with five varieties. Treatment plots were 50 ft. long by one row wide (6 ft.), arranged as a randomized complete block design with four replicates.

The objectives of this study were as follows: 1) to compare the effectiveness of the ripeners Touchdown Total and Palisade EC on HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, and L 01-283; and, 2) to evaluate sucrose storage within the top, middle, and bottom section of the stalk following treatment with Touchdown Total and Palisade EC.

Touchdown Total was applied at 5.7 oz/A (0.187 lb/A) and Palisade EC at 0.276 and 0.312 lb/A on August 28, 2009 using a CO_2-pressurized backpack sprayer delivering 140 L/ha at 190 kPa. Nontreated plots of each variety were included as controls. Ripener rates were based on previously published results in the 2004 and 2005 LSU AgCenter's Sugarcane Research Annual Progress Report.

A ten-stalk sample from each plot was hand harvested on September 21, 2009, 28 days after treatment (DAT). Samples were weighed and stalks were processed for brix, apparent sucrose and apparent purity at the Sugar Research Station Sucrose Lab at St. Gabriel, LA using NIR. These data were used to calculate the yield of theoretical recoverable sugar per ton of cane (TRS/TC). Due to excessive lodging cause by thunder storms and continuous rainfall events, sampling at 42 DAT was not conducted. On October 19, 2009, 56 DAT, a fifteen-stalk sample was hand harvested from each plot; plots were then mechanically harvested with a sugarcane combine and loaded into a wagon equipped with load cells to obtain actual plot yield. Hand harvested samples were weighed and the weight added to plot weights. Bundles were separated into a 6- and 9-stalk sub-sample. The 6-stalk sub-sample was processed as whole stalks through a roller mill at the Sugar Research Station to obtain brix by refractometer, apparent sucrose by saccharimeter and apparent purity as the relationship between apparent sucrose and purity. These data were then used to calculate TRS/TC and together with plot weights to calculate the yield of theoretically recoverable sugar per acre (TRS/A).

The 9-stalk sub-sample was measured for stalk length, and then partitioned into equal thirds by using the recorded average bundle length. Partitioned segments were labeled as top, middle, or bottom third of the stalk, and then were weighed and milled. Juice samples were analyzed for brix, apparent sucrose and apparent purity of partitioned segments. Data collected were used to model sucrose storage within stalks.

SAS was used to evaluate the data in a mixed model format for both objectives. Mean separation used least square means probability differences where P=0.05.

RESULTS AND DISCUSSION

All varieties treated with Touchdown Total had statistically more TRS/TC, at 28 DAT, except for L 01-283 when compared to their respective control plots (Table 1). The percentage improvements over the control plots in TRS/TC for varieties treated with Touchdown Total were 57.8, 56.6, 27.4, 27.0 and 12.1% for HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, and L 01-283, respectively, at 28 DAT. HoCP 96-540, L 99-226, HoCP 00-950, and L 01-283 showed a significant improvement over their respective control plots for TRS/TC at 28 DAT when treated with Palisade at rates of 0.276 or 0.312 lbs/A, but L 99-233 only showed a numerical improvement. No statistical differences were detected for mean stalk weight (MSW) and mean

stalk length (MSL) at 28 DAT for all varieties and ripener treatment combinations.

Statistically higher TRS/TC levels at 56 DAT were achieved in all varieties where Touchdown Total was applied at 5.7oz/A compared to their respective control (Table2). TRS/TC levels at 56 DAT for L 99-266, L 99-233, and L 01-283, when treated with Palisade at 0.276 lb/A, were significantly higher than their respective control plots. HoCP 96-540 and L 99-226 plots treated with Palisade at 0.312 lb/A yielded statistically more TRS/TC at 56 DAT than their respective control. Statistical differences were undetected for tons of cane per acre (TC/A) and mean stalk length (MSL) 56 DAT for all varieties and ripener treatment combinations. TRS/A was only statistically improved for the Touchdown Total treatment with L 99-226 and the Palisade treatment applied at 0.276 lb/A with L 01-283 over their respective control plots. MSW was significantly reduced in the HoCP 96-540 and L 99-226 plots treated with Touchdown Total, L 99-226 and L 01-283 plots treated with Palisade at 0.276 lb/A, and L 99-226 and HoCP 00-283 plots treated with Palisade at 0.312 lb/A.

Touchdown Total treated stalk segments for the top, middle, and bottom third of the stalk as an average of all varieties yielded statistically more TRS/TC than respective control (Figure 1). Significantly higher TRS/TC levels over their controls were achieved with Palisade at 0.276 lb/A by top segment and Palisade at 0.312 lb/A by middle segment.

Stand counts taken this spring showed that as an average of all varieties shoot counts in the glyphosate and Palisade treated plots were significantly higher than control plots. This is not unusual as the buds in the chemically-treated plots are delayed and generally germinate later in the season. Buds in the control plots tend to germinate with warmer temperatures and are killed back by subsequent freezes during the winter thus reducing the number of buds available in the spring.

Table 1. Effects of 3 ripener treatments on 6 commercial sugarcane cultivars, on yield of theoretical recoverable sugar per ton cane (TRS/TC), % TRS Increase over control, mean stalk weight (MSW) and mean stalk length (MSL) in plantcane harvested 28 days after treatment.

Variety	Ripener	TRS/TC (lbs)		%TRS Increase	MSW (lbs)	MSL (in)
HoCP 96-540	Control	109			2.22	84.5
	T.D. @ 5.7oz	172	+	57.8	2.19	78.9
	Pal @ 0.276 lb	133	+	22.0	2.41	80.7
	Pal @ 0.312 lb	152	+	39.4	2.17	79.3
L 99-226	Control	106			2.60	85.4
	T.D. @ 5.7oz	166	+	56.6	2.31	75.0
	Pal @ 0.276 lb	133	+	25.5	2.53	81.7
	Pal @ 0.312 lb	141	+	33.0	2.30	80.4
L 99-233	Control	124			1.78	84.1
	T.D. @ 5.7oz	158	+	27.4	1.60	77.0
	Pal @ 0.276 lb	144		16.1	1.67	84.7
	Pal @ 0.312 lb	125		0.8	1.69	85.4
HoCP 00-950	Control	126			2.00	76.2
	T.D. @ 5.7oz	160	+	27.0	1.94	77.2
	Pal @ 0.276 lb	157	+	24.6	1.87	71.3
	Pal @ 0.312 lb	172	+	36.5	1.96	74.0
L 01-283	Control	132			1.85	81.7
	T.D. @ 5.7oz	148		12.1	1.77	78.2
	Pal @ 0.276 lb	155	+	17.4	1.80	76.4
	Pal @ 0.312 lb	160	+	21.2	1.82	75.8

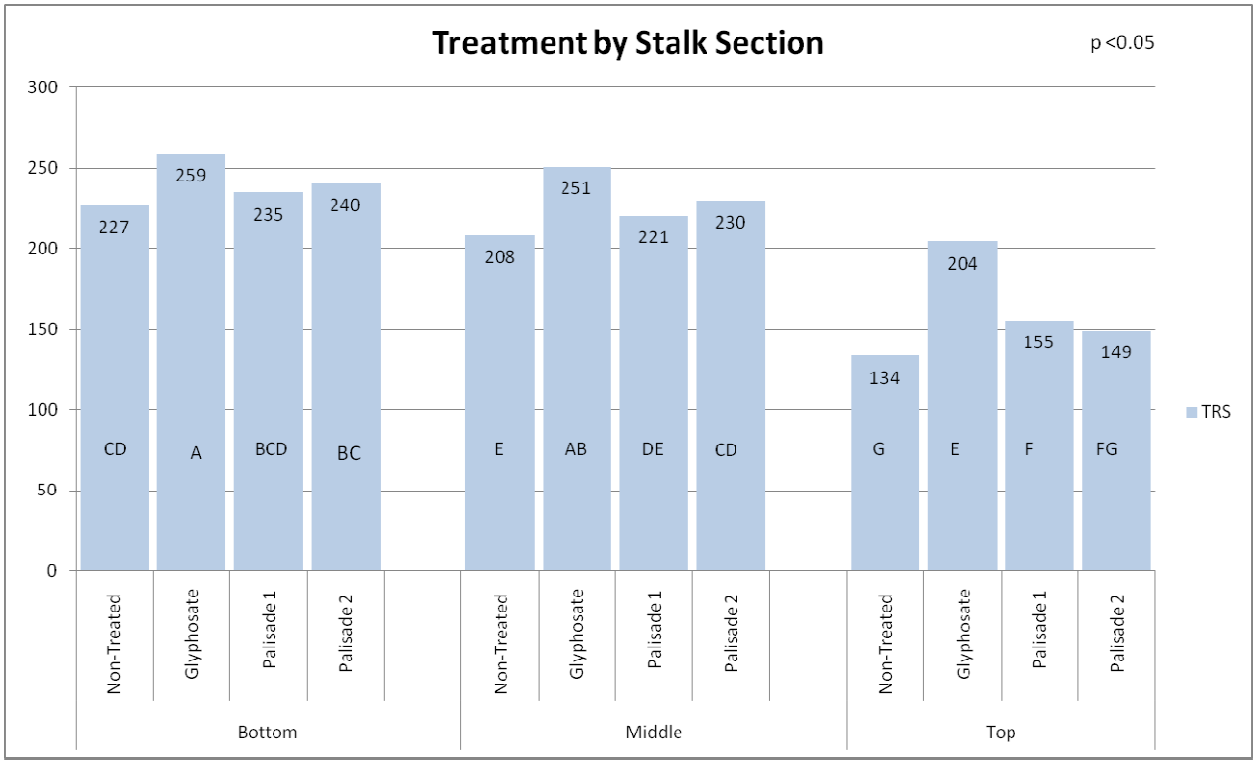
Treatments that are significantly (P=0.05) higher or lower that respective control plots are denoted by a plus (+) or (-), respectively, next to the value for each trait. TD = Touchdown; Pal = Palisade

Table 2. Effects of 3 ripener treatments on 6 commercial sugarcane cultivars, on yield of theoretical recoverable sugar per acre (TRS/A), yield of cane per acre (TC/A), yield of theoretical recoverable sugar per ton cane (TRS/TC), mean stalk weight % TRS Increase over control, (MSW) and mean stalk length (MSL) in plantcane harvested 56 days after treatment.

Variety	Ripener	TRS/A (lbs/A)		TC/A (tons)	TRS/TC (lbs)		%TRS Increase	MSW (lbs)		MSL (in)
HoCP 96-540	Control	9842		50.7	194			2.65		90.6
	T.D. @ 5.7oz	11646		46.6	250	+	28.9	2.19	-	81.1
	Pal @ 0.276 lb	8355		46.8	178		-8.2	2.58		84.7
	Pal @ 0.312 lb	11079		49.9	222	+	14.4	2.57		91.2
L 99-226	Control	9868		51.8	190			3.34		99.6
	T.D. @ 5.7oz	12717	+	48.5	262	+	37.9	2.59	-	79.5
	Pal @ 0.276 lb	11217		49.5	227	+	19.5	3.00	-	88.4
	Pal @ 0.312 lb	10163		47.2	216	+	13.7	2.88	-	89.7
L 99-233	Control	9960		52.2	189			1.91		93.7
	T.D. @ 5.7oz	10454		44.8	236	+	24.9	1.80		85.8
	Pal @ 0.276 lb	9857		45.7	216	+	14.3	1.94		91.9
	Pal @ 0.312 lb	10332		49.5	209		10.6	2.01		89.8
HoCP 00-950	Control	9884		48.2	205			2.67		92.3
	T.D. @ 5.7oz	10633		44.8	237	+	15.6	2.51		88.6
	Pal @ 0.276 lb	9368		44.1	213		3.9	2.49		84.7
	Pal @ 0.312 lb	9991		46.5	215		4.9	2.35	-	83.5
L 01-283	Control	9993		50.6	198			2.22		92.5
	T.D. @ 5.7oz	11008		49.2	224	+	13.1	2.00		81.7
	Pal @ 0.276 lb	12752	+	56.8	225	+	13.6	1.87	-	81.1
	Pal @ 0.312 lb	8680		41.7	208		5.1	1.96	-	80.7

Treatments that are significantly (P=0.05) higher or lower that respective control plots are denoted by a plus (+) or (-), respectively, next to the value for each trait. TD = Touchdown; Pal = Palisade

Figure 1. Effect of chemical treatments on yield of theoretical recoverable sugar per ton of cane (TRS) for the bottom third, middle third and top third of the stalk[1].



1/ Touchdown applied at 5.7oz/ac; Palisade 1 applied at 0.276 lb/ac; Palisade 2 applied at 0.312 lb/ac

ACKNOWLEDGEMENTS

We would like to express appreciation to the American Sugar Cane League and Syngenta Crop Protection for their support of this research project.