A LOOK AT AN ALTERNATIVE CHEMISTRY TO GLYPHOSATE FOR USE AS A SUGARCANE RIPENER

Albert Orgeron[1], Benjamin Legendre[2], Jim Griffin[3], Kenneth Gravois[4], and Michael Pontif[5]
[1]St. James Parish, [2]Audubon Sugar Institute, [3]School of Plant, Environmental and Soil Sciences, [4]LCES, [5]Sugar Research Station

INTRODUCTION

Louisiana's climate limits physiological growth of sugarcane to a maximum time span of 9 months before processing of the sugarcane crop. Today there are 11 sugar factories remaining to crush over 12,000,000 tons of sugarcane annually. Since 1969, 33 processers have closed sugar factory operations. Louisiana growers in 2009-2010 produced 7.9 million tons more than was produced in the 1969-1970 crop. In spite of increases in daily processing capacities of the 11 remaining sugar factories, the total number of days required to process the State's crop has increased. Mill managers have shifted the harvest period to begin processing cane earlier in the year to handle the increase in cane tonnage and to avoid the threat of freezing conditions which often occur in late December and/or early January.

Shifting of the harvest period into late September or early October has led to greater proportion of immature cane being processed. Recoverable sugar per ton of cane generally increases in most Louisiana sugarcane varieties as the harvest season advances until the first freeze occurs. Extended periods of high incident sun light and cool night temperatures promote sugar accumulation in immature cane, which is also termed natural ripening.

In Louisiana, glyphosate has been used as a ripener since 1980. Glyphosate has had great success in improving early season recoverable sugar per ton of cane in Louisiana. However, in recent years farmers have been more reluctant to use glyphosate as a ripener due to less than desirable stubble regrowth in treated fields.

Researchers have been on a quest to find an alternative ripener to glyphosate that displays potential to increase the yield of theoretical recoverable sugar per ton of cane (TRS) and overall sugar yield per acre as well as a ripener with little or no impact on subsequent stubble crop(s) ratooning ability.

One such product, Palisade® (trinexapac-ethyl), manufactured by Syngenta Crop Protection, is used in Brazil and other Latin American countries as a sugarcane ripener. Palisade® differs from glyphosate in that it is classified as a plant growth regulator, unlike the herbicide glyphosate.

2011 EXPERIMENTS

Variety by Ripener Study

In 2008, the commercial sugarcane cultivars, HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, and L 01-283, were planted on August 26 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 objective of this study was 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. Touchdown Total® was applied at 5.7 oz/A and Palisade® at 16.8 and 19.0 oz/A on August 15, 2011 using a CO_2-pressurized backpack sprayer delivering 13.9 gal/A at 27.6 psi. 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 fifteen-stalk sample from each plot was hand harvested on October 10, 2011, 56 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). Plots were then mechanically harvested with a sugarcane combine and loaded into a wagon equipped with load cells to obtain actual plot yield. These data were then used to calculate yield of tons of cane per acre (TCA) and together with TRS to calculate the yield of theoretically recoverable sugar per acre (SPA). SAS was used to evaluate the data in a mixed model format. Mean separation used least square means probability differences where P=0.05.

Results

A variety by ripener treatment interaction was observed for the parameters of TRS and MSL. Statistical differences for these two parameters were evaluated against each variety's respective nontreated control. TRS was statistically increased for HoCP 96-540 and L 99-226 treated with Touchdown Total® (Table 1). Increases in TRS was also observed for L 99-226 when treated with 16.8 oz. of Palisade® per acre and for L01-283 treated with 19.0 oz of Palisade® per acre. All ripener treatments negatively affected MSL of both L 99-226 and L 01-283. Regardless of rate, HoCP 00-950 MSL was decreased when treated with Palisade®.

The main effect of ripener treatment was significant for TCA, MSTWT and Fiber. Averaged across all varieties the nontreated control yielded 28.9 TCA (Table 2). A statistical decease in tonnage was observed for both Touchdown Total® and Palisade® 19 oz/A treatments of 3.6 and 3.4 TCA, respectively. MSTWT was significantly higher for the nontreated control compared to all ripener treatment, averaging 1.64 lbs/stalk. Fiber was decreased by 0.5 for Touchdown Total® treated cane compared the nontreated control which averaged 10.8%. No statistical differences were detected for SPA.

Table 1. Effects of 3 ripener treatments on 5 commercial sugarcane cultivars, on yield of theoretical recoverable sugar per ton cane (TRS) and mean stalk length (MSL) in second stubble cane harvested 56 days after treatment.

Variety	Treatment	TRS (lbs)	MSL (in)
HoCP 96-540	Control	216	201
"	T.D. @ 5.7 oz.[1]	251 +[2]	200
"	Pal @ 16.8 oz.	224	194
"	Pal @ 19.0 oz.	207	208
L 99-226	Control	212	225
"	T.D. @ 5.7 oz.	253 +	176 -
"	Pal @ 16.8 oz.	234 +	188 -
"	Pal @ 19.0 oz.	225	186 -
L 99-233	Control	204	210
"	T.D. @ 5.7 oz.	223	200
"	Pal @ 16.8 oz.	205	197
"	Pal @ 19.0 oz.	223	195
HoCP 00-950	Control	238	200
"	T.D. @ 5.7 oz.	256	189
"	Pal @ 16.8 oz.	246	182 -
"	Pal @ 19.0 oz.	259	168 -
L 01-283	Control	220	212
"	T.D. @ 5.7 oz.	235	189 -
"	Pal @ 16.8 oz.	232	191 -
"	Pal @ 19.0 oz.	250 +	183 -

[1] Treated August 11, 2011; T.D. = Touchdown Total® and Pal = Palisade®.

[2] 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.

Table 2. Ripener treatment means averaged across five varieties for the second stubble-cane crop conducted in St. Gabriel, Louisiana in 2011.[1]

Treatment	TCA (tons/A)	MSTWT (lbs)	Fiber (%)
Control	28.9	1.64	10.8
T.D. @ 5.7 oz.[2]	25.3 -[3]	1.40 -	10.3 -
Pal @ 16.8 oz.	26.9	1.44 -	10.4
Pal @ 19.0 oz.	25.5 -	1.40 -	10.8

[1] Varieties = HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, L 01-283.
[2] Treated August 11, 2011; T.D. = Touchdown Total® and Pal = Palisade®.
[3] Treatments that are significantly (P=0.05) higher or lower than respective control plots are denoted by a plus (+) or (-), respectively, next to the value for each trait.

Effect of Nitrogen Rate on Ripeners Study

In late April 2011, a plant-cane crop of HoCP 96-540 was fertilized with UAN at rates of 60, 100, and 140 units per acre. Touchdown Total® or Palisade® was applied to plots on August 24, 2011, to investigate the response of sugarcane to ripeners with differing nitrogen levels. Touchdown Total® and Palisade® were applied at 5.7 and 19.0 oz/acre, respectively, using a CO^2-pressurized backpack sprayer delivering 13.9 gal/A at 27.6 psi. The experiment was arranged as a split block with 3 replications. A ten-stalk sample from each plot was hand harvested on October 5, 2011. 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). Plots were then mechanically harvested with a sugarcane combine and loaded into a wagon equipped with load cells to obtain actual plot yield. These data were then used to calculate yield of tons of cane per acre (TCA) and together with TRS to calculate the yield of theoretically recoverable sugar per acre (SPA). SAS was used to evaluate the data in a mixed model format. Mean separation used least square means probability differences where P=0.05.

Results

No significant differences were observed for the ripener by nitrogen rate interaction. Averaged across nitrogen rates, Touchdown Total® treated cane yielded 24 more lbs of TRS than the nontreated control (Table 3). The MSTWT for the nontreated control averaged 2.36 lbs/stalk, but Touchdown Total® treated cane decreased MSTWT by 0.26 lbs. Percent fiber was decreased for both Touchdown Total® and Palisade® treatments by 0.5 and 0.6%, respectively compared to the nontreated control.

Table 3. Ripener treatment means average across three nitrogen rates for plant cane HoCP 96-540, conducted in St. Gabriel, Louisiana in 2011.[1]

Treatment[2]	TCA (tons/A)	TRS (lbs/ton)	SPA (lbs/A)	MSTWT (lbs)	Fiber (%)
Control	38.7	226	8732	2.36	10.8
T.D. @ 5.7 oz.	33.1	250 +[3]	8267	2.10 -	10.3 -
Pal @ 19.0 oz.	35.6	218	7682	2.20	10.2 -

[1] Nitrogen Rates = 60, 120, 180 units/A; Nitrogen source UAN.
[2] Ripener treatments applied 8/24/11; T.D. = Touchdown Total® and Pal = Palisade®.
[3] Treatments that are significantly (P=0.05) higher or lower than respective control plots are denoted by a plus (+) or (-), respectively, next to the value for each trait.

Surfactants and Spray Volumes Study

On August 24, 2011 a field of plant cane HoCP 96-540 was used to evaluate the value of additional surfactant with loaded glyphosate products as well as application spray volumes. Plots were arranged in a randomized complete block design with 4 replications. Sugarcane ripeners included Touchdown Total® applied at 5.7 oz/acre and Palisade® at 19.0 oz/acre using a boom broadcast sprayer. Spray volumes included 8 and 16 gal/acre. Addition of the non-ionic surfactant Induce® to the spray mixture at rates of 0 and 0.25% volume/volume was also evaluated. A ten-stalk sample from each plot was hand harvested on October 5, 2011. 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). Plots were then mechanically harvested with a sugarcane combine and loaded into a wagon equipped with load cells to obtain actual plot yield. These data were then used to calculate yield of tons of cane per acre (TCA) and together with TRS to calculate the yield of theoretically recoverable sugar per acre (SPA).

Results

No significant differences were observed for all combinations of interactions, but main ripener effects were observed for several parameters. TCA for Palisade® treated cane was statistically greater, yielding 42.0 tons compared to 37.3 for Touchdown Total® treated cane (Table 4). Touchdown Total® treated cane produced 235 lbs. of TRS, which out yielded the Palisade® treatment cane by 19 lbs. of TRS. Palisade® had a significantly higher percent fiber than Touchdown Total®-treated cane. No differences were observed for SPA or MSTWT.

Table 4. Ripener treatment means averaged across spray volumes and surfactant treatments for plant cane HoCP 96-540 conducted in St. Gabriel, Louisiana in 2011.[12]

Ripener	TCA (tons/A)	TRS (lbs/ton)	SPA (lbs/A)	MSTWT (lbs)	Fiber (%)
T.D.@ 5.7 oz/A	37.3	235	8784	2.18	9.9
Pal @ 19.0 oz/A	42.0 +[3]	216 -	9094	2.20	10.4 +

[1] Sugarcane harvested October 5, 2011.
[2] Ripener treatments were applied August 24, 2011 using a broadcast boom sprayer delivering 8 gal/A and 16 gal/A at 32 psi; T.D. = Touchdown Total® and Pal = Palisade®. Surfactant treatments 0 and 0.25% v/v.
[3] Treatments that are significantly (P=0.05) higher or lower than glyphosate standard plots are denoted by a plus (+) or (-), respectively, next to the value for each trait.

Harvest Interval Study

Many of the previous techniques used by researchers to evaluate potential ripeners were based on results observed for glyphosate. Palisade®, unlike glyphosate, is not a herbicide; hence protocols previously used may have been biased in favor of glyphosate. Both glyphosate (Touchdown Total®) and Palisade® were applied to HoCP 96-540 plots on August 24, 2011 at 5.7 and 19.0 oz/acre, respectively. The experiment was arranged as a randomized complete block with 3 replications. Ripener treatments were applied August 24, 2011 using a CO2-pressurized backpack sprayer delivering 13.9 gal/A at 27.6 psi. Sugarcane was hand harvested at 6, 8, 10, and 12 weeks post-treatment. A ten-stalk sample from each plot was for each harvest interval. 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).

Results

No significant differences were observed for the ripener by harvest interval interaction; however, a significant difference was observed for ripener main effect. TRS was significantly greater for Touchdown Total® and Palisade® treated cane over the nontreated control (Table 5). Fiber was significantly decreased for Touchdown Total® treated cane.

Table 5. Ripener treatment means averaged across four harvest intervals for plant cane HoCP 96-540, conducted in St. Gabriel, Louisiana in 2011.[1]

	TRS (lbs/ton)	MSTWT (lbs)	Fiber (%)
Control	228	2.34	10.7
T.D.@ 5.7 oz/A[2]	254 +[3]	2.27	9.8 -
Pal @ 19.0 oz/A	246 +	2.35	10.8

[1] Harvest Intervals = 6, 8, 10, 12 weeks after treatment.
[2] Ripener treatments applied 8/24/11; T.D. = Touchdown Total® and Pal = Palisade®.
[3] Treatments that are significantly (P=0.05) higher or lower than respective control plots are denoted by a plus (+) or (-), respectively, next to the value for each trait.

Conclusions

Beginning in the 1970's a great deal of attention has been given to the use of chemicals to increase sucrose levels in the early portion of the harvest season. Since 1980, glyphosate has been the primary ripener used in the Louisiana Sugarcane Industry. Trinexapac-ethyl (Palisade®) has been used to ripen sugarcane in Brazil since 2000. Past research conducted in Brazil, indicated an average increase in sugar content of 10% for the 25 most important varieties.

In 2011, Touchdown Total® (glyphosate) treated cane had a more consistent response than Palisade® treated cane, significantly increasing TRS in most experiments, in the range of 10-12% above the non-treated control. Response in terms of TRS for Palisade® treated cane was more variable than Touchdown Total® treated cane. It also had a lower magnitude of TRS gain compared to Touchdown Total®. Percent fiber was reduced by at least 0.5 points for Touchdown treated cane. Both ripeners showed a tendency to reduce cane tonnage in 2011; however, the decreases in tonnage for 2011 glyphosate treated cane was minimal compared to 2010 experiments.

Multiple years of data suggest that glyphosate appears to provide a more consistent increase in TRS than trinexpac-ethyl for Louisiana sugarcane cultivars. Future research will continue to strive to find alternative chemistries to improve early season cane sucrose that minimizes impact on cane yield.