VARIETAL RESISTANCE TO THE SUGARCANE BORER IN FIRST RATOON CANE

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The sugarcane borer (SCB), *Diatraea saccharalis*, is the most destructive insect attacking the Louisiana sugarcane crop. Cultivar resistance to the SCB, is categorized as a combination of physical and chemical characteristics that impede larval feeding and stalk entry. The most common method used to assess sugarcane cultivar resistance in the practice is the counting of bored internodes. However, this practice does not incorporate the larvae that survived until adulthood inside of the stalk. Measuring the emergence per stalk allows for assessment of potential moth production. These two measures to evaluate resistance were merged in one single relative resistance ratio that incorporates both values.

Nine advanced experimental sugarcane cultivars of the L, HoCP, and Ho series, program and seven commercial varieties (L 01-299, HoCP 85-845, HoCP 96-540 and HoCP 00-950, HoCP 04-838, L 01-283, and HoCP 09-804) were evaluated for susceptibility to SCB during 2019 in first ratoon cane. All varieties were planted on October 28, 2017, at the LSU AgCenter Sugar Research Station in St. Gabriel, in a randomized block design with five replications. In order to increase the SCB population in the experimental plots, rows of corn were planted in between two-row plots and were inoculated with laboratory-reared SCB larvae early in the season. A 12-stalk sample was cut from each plot on October 23, 2019. The number of bored internodes, total internodes, and moth emergence holes from each sample was recorded. Relative survival was calculated as the ratio of emergence holes over the number of bored internodes. The relative resistance ratio is calculated based on rankings within replications for percentage bored internodes and relative survival. Ratios approaching 1 indicate a high degree of susceptibility relative to other cultivars evaluated. All data were analyzed with generalized linear mixed models (SAS, PROC GLIMMIX). The Kenward–Rogers method was used to estimate degrees of freedom and the Tukey's HSD (α=0.05) was used for mean separations. Models included "Cultivar" as a fixed effect and "Rep" as a random effect.

Differences in the percentage of bored internodes, emergence per stalk and relative resistance ratio among the varieties were detected, with HoCP 00-950 (27.56% bored internodes) being the most susceptible cultivar with the highest value of emergence per stalk (2.73 adults per stalk). The cultivar Ho 11-573 had the highest survival ratio (0.72 adults per bored internode). The use of the relative resistance ratio classified cultivars in one highly resistant cultivar (HoCP 85-845) in one resistant cultivar (HoCP 04-838), in seven intermediate resistant cultivars (L 01-299, L 01-283, HoCP 09-804, Ho 12-615, HoCP 96-540, Ho 13-739 and Ho 11-573) and seven susceptible cultivars (L 12-201, HoCP 13-740, L 13-251, Ho 13-708, HoCP 13-758, L 11-183 and HoCP 00-950). Results from this study will be included in considerations of cultivar releases and cultivar specific SCB management tactics.

Table 1. Sugarcane borer cultivar resistance among commercial and experimental sugarcane cultivars first ratoon cane, St. Gabriel, LA, 2019

Cultivar	% Bored Internodes	Emergence/ Stalk	Relative Survival	Relative Resistance Ratio	Classification
HoCP 85-845	4.5 e	0.32 d	0.41 a	0.19 c	Highly Resistant
HoCP 04-838	5.7 e	0.55 cd	0.47 a	0.29 bc	Resistant
L 01-299	8.4 ed	0.80 bcd	0.59 a	0.41 abc	Intermediate
L 01-283	8.0 ed	0.77 bcd	0.61 a	0.43 abc	Intermediate
HoCP 09-804	13.0 bcde	1.12 bcd	0.51 a	0.44 abc	Intermediate
Ho 12-615	9.0 ed	1.00 bcd	0.66 a	0.46 abc	Intermediate
HoCP 96-540	15.7 bcd	1.40 bcd	0.53 a	0.51 abc	Intermediate
Ho 13-739	10.2 cde	1.02 bcd	0.58 a	0.51 abc	Intermediate
Ho 11-573	9.7 cde	1.22 bcd	0.72 a	0.56 ab	Intermediate
HoCP 13-740	19.3 abc	1.80 abc	0.55 a	0.61 ab	Susceptible
L 12-201	17.1 bcd	1.88 ab	0.60 a	0.61 a	Susceptible
L 13-251	16.8 bcd	1.78 abc	0.61 a	0.63 a	Susceptible
Ho 13-708	17.6 bcd	1.78 abc	0.56 a	0.64 a	Susceptible
L 11-183	20.0 ab	2.02 ab	0.62 a	0.72 a	Susceptible
HoCP 13-758	16.3 bcd	1.83 ab	0.68 a	0.72 a	Susceptible
HoCP 00-950	27.6 a	2.73 a	0.6 a	0.74 a	Susceptible
P =	<0.0001	<0.0001	0.0706	<0.0001	
df =	15,60	15,60	15,60	15,60	
F =	10.06	6.61	1.72	4.51	

Means which share a letter are not significantly different (Tukey's HSD, α=0.05).

EVALUATION OF THE IMPACT OF SUGARCANE BORER INJURY IN SEED CANE ON PLANT CANE ESTABLISHMENT

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The impact of sugarcane borer, *Diatraea saccharalis*, injury on sugar yields has been well documented. The impact of injury in seed cane, however, is not well understood. A field trial was conducted at the USDA ARS Research Farm in Terrebonne Parish, LA that investigated the impact of borer injury on plant cane establishment.

Fifteen stalk samples were collected from insecticide-protected and unprotected plots of L 01-299 and HoCP 96-540 and weighed. The total number of internodes, number of bored internodes was recorded for each sample. Samples were then planted to three row, 15-ft plots (0.006 acres) on 19 Sept 2019. Each factorial treatment (cultivar × insecticide) was randomized to plots in four blocks (replications). The number of tillers per plot was recorded on 20 Nov 2019 and 12 Mar 2020. Data were analyzed with two-way ANOVAs (SAS, Proc Mixed) with cultivar, insecticide treatment and the interaction as fixed effects.

Percentage of bored internodes was influenced by cultivar, treatment and the interaction. Insecticidal protection reduced borer injury to negligible levels. Injury in unprotected plots of HoCP 96-540 was >2-fold greater than L 01-299. Stalk weights and number of internodes were greater in protected plots of HoCP 96-540 than in unprotected plots, but did not differ between treatments in L 01-299. Fall stalk populations were greatest in treated plots of HoCP 96-540. Differences in spring plant populations were not detected.

Results suggest that high levels of borer injury can reduce fall plant cane establishment. Plant populations may recover for these reductions during the spring. Impacts of borer injury to seed cane on plant cane yields will be assessed during harvest of 2020.

		Seed Cane Quality			Plant cane establishment (stalks per acre)	
Cultivar	Insecticidal protection	% bored internodes	Stalk weight (lbs)	Internodes per plot	20 Nov 2019	12 Mar 2020
HoCP 96-540	Protected	0.4 C	1.7 A	206 A	6150 A	15300
	Unprotected	21.9 A	1.3 B	184 B	4250 B	18650
L 01-299	Protected	0.0 C	1.6 A	206 A	4500 B	19950
	Unprotected	10.1 B	1.6 A	210 A	5400 AB	18400
	Cultivar x treatment	$F_{1,12} = 7.72$ $P = 0.021$	$F_{1,12} = 3.51$ $P = 0.085$	$F_{1,12} = 4.79$ $P = 0.049$	$F_{1,12} = 6.31$ $P = 0.016$	$F_{1,12} = 1.86$ $P = 0.170$

Means in the same column that share a letter are not significantly different ($P > 0.10$)

EVALUATION OF INSECTICIDES, APPLICATION TIMING, AND WATER VOLUME FOR CONTROL OF SUGARCANE BORER

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The sugarcane borer (SCB), *Diatraea saccharalis* (F.), is an economically important insect pest of sugarcane in Louisiana. This pest also attacks other crops such as rice, corn, and sorghum as well as non-crop hosts. Currently, several insecticides are available to control this pest but the effective window for insecticide application is narrow. Thus, it is important to evaluate various facets to continually improve the efficiency of these insecticides. This study assessed (1) the efficacy of available insecticides, (2) the effects of application timing and residual activity, and (3) the effects of water volume on control of sugarcane borer infestation.

Three field experiments were conducted at Sugar Research Station in St. Gabriel, LA in 2019. In order to increase sugarcane borer population in the experimental plots, rows of corn were planted in between two-row plots and were inoculated with laboratory-reared sugarcane borer larvae early in the season. All experiments were conducted in plots of two 20-ft rows (0.0055 acres) of HoCP 00-950 plant cane with randomized complete block designs with four replications. In all experiments, insecticide applications were made with a two-row boom equipped with eight TeeJet TP11001VS nozzles spaced 18 inches approximately two ft above the canopy. In the product efficacy screening and application timing experiment, all treatments were applied at 15 gallons per acre. Applications were made 26 July 2018 (early application) and 13 August 2018 (all other treatments). Sugarcane infestations were assessed at the end of the growing season (19–28 Nov 2018) from 12 stalks per plot. The number and position of bored internodes, the number of total internodes, and the number of adult emergence holes per stalk were recorded. Percent bored internodes and emergence data were analyzed separately using generalized linear mixed models (PROC GLIMMIX). Means were separated using Tukey's HSD test ($\alpha = 0.05$).

Product efficacy screening

Two rates of Intrepid Edge® (methoxyfenozide and spinetoram), a high labeled rate of the industry standard Prevathon® (chlorantraniliprole), and an untreated check were evaluated in a randomized block design with six replications. Percentage bored internodes was calculated for each plot sample prior to analysis. Percentage of bored internodes was also calculated for the bottom (internodes 1–5), middle (internodes 6–10), and top (internodes >11) of stalks to approximate the point during the growing season when injury occurred. Data were analyzed with generalized linear mixed models (SAS Proc Glimmix) and means were separated with Tukey's HSD. All insecticide treatments reduced the percentage of bored internodes (whole stalk) and adult emergence relative to untreated check, but differences were not detected among treatments (Table 1). All treatments also reduced injury to the middle internodes corresponding to infestations occurring in late July to mid-August as well as injury to top internodes likely sustained in late August and September. Intrepid Edge® applied at 9.6 fl oz provided longer residual control as evidence by more than 80% reductions in SCB injury to top internodes. Failure of insecticide treatments to reduce injury in bottom internodes indicates some injury was present prior to the application or that the product failed to cause mortality of older larvae nearing stalk entry. Results suggest Intrepid Edge® can provide effective control of SCB infestations, but applications may need to be well timed to target young larvae.

Table 1. Sugarcane borer injury and adult emergence as affected by insecticide treatments, Sugar Research Station, St. Gabriel, LA, 2019

Treatment/Formulation	Rate (fl oz/acre)	Percent Bored: Whole stalk	Percent Bored: Bottom	Percent Bored: Middle	Percent Bored: Top	Emergence per Stalk
Untreated check	NA	18.9a	13.3	24.7a	18.4a	1.2a
Intrepid Edge	4.8	8.0b	8.6	6.9b	8.9b	0.3b
Intrepid Edge	9.6	7.6b	11.9	8.3b	3.0b	0.6b
Prevathon 0.43SC	20	2.9b	4.4	2.2b	2.0b	0.1b
F =		17.3	3.0	20.3	12.3	9.6
P =		<0.001	0.064	<0.001	<0.001	0.001

Means within columns followed by the same letter are not different (P>0.05, Tukey's HSD)

Application timing and residual activity

In this experiment, three insecticides (Diamond 0.83EC, Confirm 2F, and Prevathon 0.43SC) were applied at early (approximately 3 weeks prior to infestation of sugarcane plots) and at threshold (>5% stalks with larvae feeding on plant surfaces). In this experiment plots were randomized within a six row block of sugarcane with a row of corn on either side. Pest pressure was sustained in all plots with active infestations occurring through September.

A reduction in percentage bored internodes was observed in both early and threshold Prevathon-treated plots compared to non-treated controls (Table 2). Prevathon provided comparable control when sprayed early and at threshold suggesting that this product maintained activity several weeks after initial spray. Diamond and Confirm reduced injury relative to nontreated controls, but did not provide satisfactory control with a single application regardless of timing. Results from this study indicate the superior control achieved by Prevathon relative to Diamond and Confirm likely results from increased residual activity.

Table 2. Sugarcane borer injury and adult emergence as affected by insecticide treatments and application timing, Sugar Research Station, St. Gabriel, LA, 2019

Treatment/formulation	Rate (fl oz/a)	Application time	% Bored internodes (LS means ± [1.6]SE)
Nontreated	-	-	28.3a
Diamond 0.83EC	12	Early	17.0bc
Diamond 0.83EC	9	Threshold	12.4cd
Confirm 2F	8	Early	19.3b
Confirm 2F	6	Threshold	12.0de
Prevathon 0.43SC	20	Early	7.7de
Prevathon 0.43SC	14	Threshold	4.0e
		F value	3.65
		P value	0.01

Means within columns followed by the same letter are not different (P>0.05, Tukey's HSD)

Effects of insecticides and water volume against sugarcane borer

In this experiment, two insecticides (Confirm 2F and Prevathon 0.43SC) were applied at 5 and 20 gallons per acre (GPA). All treatments reduced the percentage bored internodes relative to non-treated controls (Table 3). Prevathon at 20 GPA provided improved control over Confirm at 5 GPA. However, for each insecticide, application at 20 GPA did not provide better control that at 5 GPA. Emergence per stalk did not differ among treatments. These results suggest increasing water volume to 20 gallons per acre would have only minimal improvements to application efficacy. Future studies should include treatments applied at 2 GPA, a common practice among aerial applicators in commercial sugarcane.

Table 3. Sugarcane borer injury and adult emergence as affected by insecticide treatments and water volume in sugarcane, Sugar Research Station, St. Gabriel, LA, 2019

Treatment/formulation	GPA	% Bored internodes
Nontreated	-	24.3a
Confirm 2F	2	17.6b
(6 fl oz/acre)	5	14.2bc
	20	10.9c
Prevathon 0.43SC	2	5.9d
(14 fl oz/acre)	5	6.1d
	20	4.3d
F value		40.90
P value		<0.001

Means within columns followed by the same letter are not different (P>0.05, Tukey's HSD)