PATHOLOGY RESEARCH

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Pathology research addresses the important diseases affecting sugarcane in Louisiana. The overall program goal is to provide farmers with practices to minimize losses to diseases in a cost-effective manner. Projects receiving emphasis during 2012 included: improving control methods for brown rust, surveys to determine the distribution of orange rust, support of healthy seedcane programs to manage ratoon stunting disease (RSD) and other systemic diseases, improving the evaluation of resistance to leaf scald, identifying potential parents with resistance to smut, evaluating disease resistance in the variety selection program, and billet planting. Research results on billet planting are reported separately.

BROWN RUST

Warm winter and spring conditions resulted in a severe brown rust epidemic during 2012. This provided a research opportunity to evaluate the efficacy of fungicides and minor elements for brown rust control. Field experiments were conducted at the Sugar Research Station at St. Gabriel with BASF, Syngenta Crop Protection, and FMC Corporation fungicides. The potential of Ni and Cu for brown rust suppression was evaluated in an experiment at the Sugar Research Station and a field experiment on a commercial farm. Large scale strip trials were conducted on commercial farms to determine the cost effectiveness of Headline® (pyraclostrobin) fungicide for rust control.

A field experiment comparing five Syngenta and two BASF fungicide treatments was conducted in plant cane of a brown rust susceptible variety, HoCP 96-540, at the Sugar Research Station at St. Gabriel. Fungicides were applied on a 36 inch band with a two-row CO_2 backpack sprayer. Treatments were applied to two-rows, 30 ft. in length with two non-treated rows as buffer between treatments and a 5 ft. non-treated section of row along rows between treatments. Each treatment was replicated four times in a randomized complete block design. Fungicide application dates were April 1 and 29. Brown rust symptom severity was assessed on the youngest fully emerged leaf by image analysis once 8 days after the second application. Yield components, including stalk population, stalk weight, sucrose per ton of cane, cane tonnage, and total sucrose, were determined and compared.

All fungicide treatments reduced rust severity compared to the non-treated control, and differences in ability to suppress rust severity were detected among fungicide treatments (Table 1). The Headline + Caramba treatment reduced rust symptoms more than the Quadris + Tilt and Quilt Xcel treatments. Sucrose yield per ton of cane (commercially recoverable sugar) was greater for five treatments compared to the non-treated control, and total sucrose yield was higher for the X4604, Quilt Xcel, and Headline + Caramba treatments (Table 2).

Table 1. Reductions in brown rust symptom severity provided by different fungicide treatments in HoCP 96-540 plant cane in Sugar Research Station experiment comparing Syngenta and BASF fungicides during 2012.

Treatment[1]	Brown rust severity (%)[2]
Non-treated control	21.9 a
Quadris SC 12 oz/acre + Tilt EC 6 oz/acre	14.0 b
Quadris Xtra SC 7 oz/acre	11.3 bcd
Quilt Xcel SE 21 oz/acre	12.9 bc
X4601 10.3 oz/acre	9.1 cd
X4604 13.7 oz/acre	10.3 bcd
Headline SC 9 oz/acre	10.0 bcd
Headline SC 12 oz/acre + Caramba SL 12 oz/acre	7.8 d

[1]All fungicides applied on 4/1/12 and 4/29/12 with 0.125% non-ionic surfactant.
[2]Rust leaf infection percentage determined by image analysis on youngest fully emerged leaf on 5/7/2012 at 8 days after second fungicide application. Percentage means followed by different letters were significantly different (P=0.05).

Table 2. Effects of fungicides on yield components of HoCP 96-540 plant cane in Sugar Research Station experiment comparing Syngenta and BASF fungicides during 2012.

Treatment[1]	Stalks/acre	Stalk weight (lbs.)	Sugar/ton (lbs.)[2]	Tons cane/acre	Sugar/acre (lbs.)[2]
Non-treated control	46219	2.43	244 b	44.7	10928 c
Quadris SC 12 oz/acre + Tilt EC 6 oz/acre	47729	2.43	257 a	45.7	11728 abc
Quadris Xtra SC 7 oz/acre	47004	2.34	251 ab	44.9	11247 bc
Quilt Xcel SE 21 oz/acre	48213	2.48	257 a	48.6	12457 ab
X4601 10.3 oz/acre	49784	2.32	255 a	48.5	12356 abc
X4604 13.7 oz/acre	47669	2.35	254 a	50.3	12740 a
Headline SC 9 oz/acre	46763	2.42	253 a	45.7	11571 abc
Headline SC 12 oz/acre + Caramba SL 12 oz/acre	46884	2.39	251 ab	49.9	12538 ab

[1]All fungicides applied on 4/1/12 and 4/29/12 with 0.125% non-ionic surfactant.
[2]Means within a column followed by different letters were significantly different (*P*=0.05).

A field experiment comparing eight BASF fungicide treatments, two Manniplex Ni (Brandt Consolidated, Inc.) treatments, and one fungicide plus Ni treatment was conducted in plant cane of HoCP 96-540 at the Sugar Research Station at St. Gabriel as described above. Fungicide application dates were April 1 and 26. Brown rust symptom severity was assessed on the youngest fully emerged leaf by image analysis once 11 days after the second application.

All fungicide treatments and Ni applied at the high rate reduced rust severity compared to the non-treated control, and differences in ability to suppress rust severity were detected among fungicide treatments (Table 3). Stalk weight was greater for the Headline 12 oz rate, Headline Amp, Priaxor 5 oz rate, and Ni high rate treatments compared to the non-treated control (Table 4). Sucrose per ton of cane was lower in the Sercadis 5.7 oz rate and low Ni treatments. Cane tonnage was greater for the Headline Amp, Priaxor 5 oz, Priaxor 7.5 oz, and Priaxor plus Caramba treatments, and total sucrose yield was higher for the Headline Amp, Priaxor 7.5 oz, and Priaxor plus Caramba treatments.

Table 3. Reductions in brown rust symptom severity provided by different fungicide and Ni treatments in HoCP 96-540 plant cane in Sugar Research Station experiment comparing BASF fungicides and Manniplex Ni during 2012.

Treatment[1]	Brown rust severity (%)[2]
Non-treated control	17.4 a
Sercadis 4.5 oz/acre	9.9 cd
Sercadis 5.7 oz/acre	12.7 bc
Priaxor 5 oz/acre	5.8 e
Priaxor 7.5 oz/acre	5.6 e
Priaxor 5 oz/acre + Caramba SL 14 oz/acre	6.4 de
Headline Amp 12 oz/acre	7.5 de
Headline 12 oz/acre	4.5 e
Headline SC 9 oz/acre	3.7 e
Headline SC 9 oz/acre + Manniplex Ni 1 pt/acre	6.9 de
Manniplex Ni 1 pt/acre	16.2 ab
Manniplex Ni 2 pt/acre	12.6 bc

[1]All fungicides applied on 4/1/12 and 4/26/12 with 0.125% non-ionic surfactant.
[2]Rust leaf infection percentage determined by image analysis on youngest fully emerged leaf on 5/7/2012 at 11 days after second fungicide application. Percentage means followed by different letters were significantly different (*P*=0.05).

Table 4. Effects of fungicides and Ni on yield components of HoCP 96-540 plant cane in Sugar Research Station experiment comparing BASF fungicides and Manniplex Ni during 2012.

Treatment	Stalks/acre (x1000)	Stalk weight (lbs.)[2]	Sugar/ton (lbs.)[2]	Tons cane/acre[2]	Sugar/acre (lbs.)[2]
Non-treated control	45917 ab	1.96 d	254 a	34.8 c	8855 bc
Sercadis 4.5 oz/acre	46763 a	2.35 abcd	252 abc	39.4 abc	9930 ab
Sercadis 5.7 oz/acre	45917 ab	2.12 abcd	245 c	38.6 abc	9434 abc
Priaxor 5 oz/acre	44588 ab	2.36 abc	249 abc	40.3 ab	10049 ab
Priaxor 7.5 oz/acre	45554 ab	2.07 bcd	253 ab	42.0 a	10643 a
Priaxor 5 oz/acre + Caramba SL 14 oz/acre	46944 a	2.27 abcd	252 abc	41.6 a	10495 a
Headline Amp 12 oz/acre	44708 ab	2.36 abc	253 ab	41.4 a	10480 a
Headline 12 oz/acre	46823 a	2.49 a	250 abc	39.7 abc	9929 ab
Headline SC 9 oz/acre	46763 a	2.25 abcd	248 abc	38.5 abc	9537 abc
Headline SC 9 oz/acre + Manniplex Ni 1 pt/acre	46279 ab	2.08 bcd	252 abc	38.5 abc	9965 abc
Manniplex Ni 1 pt/acre	44588 ab	1.99 cd	246 bc	35.0 c	8617 c
Manniplex Ni 2 pt/acre	43379 b	2.44 ab	248 abc	36.0 bc	8910 bc

[1]All fungicides applied on 4/1/12 and 4/26/12 with 0.125% non-ionic surfactant.
[2]Means within a column followed by different letters were significantly different (*P*=0.05).

A field experiment comparing two FMC, one BASF, and one FMC + BASF fungicide treatments was conducted in plant cane of HoCP 96-540 at the Sugar Research Station at St. Gabriel as described above. Fungicide application dates were April 19 and May 10. Brown rust symptom severity was assessed on the youngest fully emerged leaf by image analysis once before the second application.

Only the fungicide treatments with Headline fungicide reduced brown rust severity (Table 5). Headline treatment increased stalk population and total sucrose yield (Table 6). Headline applied with Regalia Maxx increased cane tonnage.

Table 5. Reductions in brown rust symptom severity provided by different fungicide treatments in HoCP 96-540 plant cane in Sugar Research Station experiment comparing FMC and BASF fungicides during 2012.

Treatment[1]	Brown rust severity (%)[2]
Non-treated control	10.3 ab
ProBlad Plus 2.1 45.7 oz/acre	10.0 b
Regalia Maxx 20 8 oz/acre	12.8 a
Regalia Maxx 20 8 oz/acre + Headline SC 9 oz/acre	2.2 c
Headline SC 9 oz/acre	2.7 c

[1]All fungicides applied on 4/19/12 and 5/10/12 with 0.125% non-ionic surfactant.
[2]Rust leaf infection percentage determined by image analysis on youngest fully emerged leaf on 5/10/2012. Percentage means followed by different letters were significantly different (*P*=0.05).

Table 6. Effects of fungicides on yield components of HoCP 96-540 plant cane in Sugar Research Station experiment comparing FMC and BASF fungicides during 2012.

Treatment	Stalks/acre[2]	Stalk weight (lbs.)	Sugar/ton (lbs.)	Tons cane/acre[2]	Sugar/acre (lbs.)[2]
Non-treated control	39875 b	2.27	240	42.0 b	10076 b
ProBlad Plus 2.1 45.7 oz/acre	39935 b	2.49	248	42.7 ab	10617 ab
Regalia Maxx 20 8 oz/acre	42654 ab	2.33	246	45.7 ab	11232 ab
Regalia Maxx 20 8 oz/acre + Headline SC 9 oz/acre	42413 ab	2.45	229	48.4 a	11128 ab
Headline SC 9 oz/acre	44225 a	2.62	248	48.2 a	11960 a

[1]All fungicides applied on 4/19/12 and 5/10/12 with 0.125% non-ionic surfactant.
[2]Means within a column followed by different letters were significantly different (*P*=0.05).

Four field experiments in which Headline fungicide was applied once or twice to multiple, complete 6-10 row strips of HoCP 96-540 plant cane were conducted to evaluate the impact of brown rust on cane tonnage yield of HoCP 96-540 and to provide a cost/benefit analysis of fungicide application. Brown rust severity and yield were determined and compared in treated and non-treated sets of rows. There were three sets of treated rows for an Assumption Parish experiment and four sets of treated rows for the other three experiments. Fungicide was first applied in late March. A second application was made during the third week of April for three experiments but not until May 9th for the Assumption experiment. Yields were determined by tracking truck weights at the mill.

As expected, fungicide reduced rust severity. In the Pointe Coupee experiment, rust severity was 20% on the youngest fully emerged leaf compared to 3% on leaves receiving two fungicide applications. In St. Mary experiment 1, brown rust severity was 16% compared to 3% for leaves without fungicide application and with two applications, respectively. Two applications of Headline increased cane tonnage in all experiments compared to rows with no fungicide application (Table 7). Fungicides applied to control disease are actually preserving yield or minimizing loss, but it is easier to think about a yield increase resulting from treatment. A similar yield increase ranging from 3.5-3.9 tons was detected in three experiments, and a 1.9 ton increase was recorded for the Assumption Parish experiment. The Assumption experiment had only three treatment replications and a lengthy interval between the two applications; the first application was probably a little too early (March 19) and the second application too late (May 9) with 51 days between applications. The Assumption trial results indicate the importance of fungicide application timing.

Table 7. Effects of Headline fungicide on cane tonnage yield of HoCP 96-540 plant cane in four strip trials conducted during 2012.

Parish for experiment	Treatment	Application dates	Tons of cane per acre	Difference[1]
Assumption	No application	-	52.6	
	One application	3/19	51.0	-1.6
	Two applications	3/19 & 5/9	54.5	+1.9
Pointe Coupee	No application	-	56.8	
	Two applications	3/27 & 4/20	60.2	+3.4
St. Mary 1	No application	-	44.5	
	No application with shredding	-	41.4	-3.1
	Two applications	3/30 & 4/26	48.4	+3.9
St. Mary 2	No application	-	51.7	
	One application	Last week of March	52.2	+0.5
	Two applications	Mid-April	55.6	+3.9

[1]Difference in tons of cane per acre between Headline application treatment and the no application control.

Even including the lower yield increase from the Assumption experiment, the average yield increase resulting from two fungicide applications was 3.3 tons per acre. Determining the economic return from spraying requires a comparison of fungicide treatment cost and the expected value of a ton of cane to the grower. The cost of a broadcast fungicide application and the value of a ton of cane at a sugar price of 27 cents per pound were both approximately $30 during 2012. This meant that two fungicide broadcast applications needed to increase yield by at least 2 tons to break even financially. A 3.3 ton increase provided a $39 per acre return on investment with this scenario.

The yield increases detected in the experiments were very likely an underestimate of the benefit of fungicide application. The spore pressure on the treated sets of rows and resulting level of disease were greater than they would be when fungicide is applied to a whole field. Also, fungicide drift from treated row sets onto adjacent non-treated rows resulted in lower disease severity that there would be in a non-treated whole field. Therefore, one can conclude with confidence that making two fungicide applications to control a severe brown rust epidemic was economically beneficial in HoCP 96-540. Some good news is that HoCP 96-540 may not be set back by brown rust as much as LCP 85-384. However, even with a variety not as badly impacted by brown rust, it was still profitable to apply fungicide.

In two of the experiments, Assumption and St. Mary Experiment 2 (Table 7), there was a treatment consisting of only one early fungicide application. A single, early application alone did not provide a positive economic return. With a rust epidemic extending over more than 2 months, more than one fungicide application is needed. A fungicide application in late March will reduce rust symptom severity for several weeks after treatment, but the cane plants are not growing rapidly during this period with cooler temperatures and prior to fertilization. A treatment with no early spray (only a single delayed application) was not included in the experiments, but allowing severe disease to develop for a month before treating would probably not be advisable. During a season with a brown rust epidemic occurring over several months, multiple fungicide applications are going to be needed to protect yield potential.

St. Mary Experiment 1 had well established rust prior to fungicide application. It also included a treatment with no fungicide application but instead a shredding or mechanical removal of the rusted leaves. During 2012, many growers had a strong impulse to cut off the rusted leaves. The results of the experiment indicate that shredding after the crop is actively growing should not be considered as a rust control measure. The yield of the shredded treatment was 3.1 tons less than doing nothing and 7 tons less than two fungicide sprays.

Experiments were conducted under controlled conditions and in the field to evaluate the effects of foliar applications of nickel, copper, and Headline fungicide on brown rust severity in sugarcane. The controlled conditions experiments utilized plants of cultivar HoCP 96-540 grown in the greenhouse from single-node cuttings. Leaves were inoculated with brown rust spores, the plants were placed in a mist chamber overnight at 23 C, the plants were placed on lighted shelves at 23 C, symptoms were allowed to develop for 2 weeks, and disease severity was determined and compared by image analysis. A field experiment was conducted on a commercial farm in the plant cane crop of HoCP 96-540 (in cooperation with Dr. R. Johnson, USDA-ARS Sugarcane Research Unit). Disease severity was determined with image analysis. Nutrient uptake was determined for the controlled conditions experiment and the commercial farm experiment. Yield components were determined and compared for the field experiment.

In the controlled conditions experiment, $NiSO_4$ applied at the highest of two rates was the only treatment that reduced brown rust severity (Table 8). The high rate of $CuSO_4$ caused slight plant injury that affected the image analysis results. Manniplex Ni foliar application resulted in greater Ni uptake than $NiSO_4$ but did not reduce rust severity (Table 9). The phytotoxic rate of $CuSO_4$ was the only treatment that increased Cu uptake (Table 10).

In the commercial farm experiment, only Headline fungicide reduced brown rust severity (Table 11). However, Manniplex applied at 1 pt/acre increased cane tonnage and total sucrose yield (Table 12). The two nickel products increased Ni uptake (Table 13).

Table 8. Percentage of HoCP 96-540 leaf area occupied by brown rust lesions in controlled conditions experiment.

Treatment[1]	Leaf area with brown rust lesions (%)
Control	0.65 bcd
$NiSO_4$ (100 mg/ha)	0.15 de
$NiSO_4$ (200 mg/ha)	0.07 e
$NiSO_4$ (200 mg/ha) + $CuSO_4$ (50 g/ha)	0.02 e
Ni Manniplex (5.2 L/ha)	0.85 bc
Ni Manniplex (10.4 L/ha)	0.36 cde
$CuSO_4$ (50 g/ha)	0.93 ab
$CuSO_4$ (200 g/ha)	1.45 a

[1]All treatments were applied three times (weekly) with a CO_2 sprayer at 15 gal/acre and included a silicon surfactant and 50% urea.

Table 9. HoCP 96-540 leaf uptake of Ni in controlled conditions experiment.

Treatment	Ni uptake (ppm)
$NiSO_4$ (100 mg/ha)	16.0 d
$NiSO_4$ (200 mg/ha)	32.1 c
$NiSO_4$ (200 mg/ha) + $CuSO_4$ (50 g/ha)	43.4 b
Ni Manniplex (5.2 L/ha)	40.2 b
Ni Manniplex (10.4 L/ha)	62.1 a
$CuSO_4$ (50 g/ha)	3.1 e
$CuSO_4$ (200 g/ha)	1.6 e
Control	2.6 e
Reference	3.4 e

Table 10. HoCP 96-540 leaf uptake of Cu in controlled conditions experiment.

Treatment	Cu uptake (ppm)
$CuSO_4$ (200 g/ha)	37.8 a
$CuSO_4$ (50 g/ha)	17.1 bc
$CuSO_4$ (50 g/ha) + $NiSO_4$ (200 mg/ha)	19.5 b
$NiSO_4$ (100 mg/ha)	13.9 cd
$NiSO_4$ (200 mg/ha)	14.6 cd
Ni Manniplex (5.2 L/ha)	14.5 cd
Ni Manniplex (10.4 L/ha)	12.9 d
Control	14.5 cd
Reference	5.2 e

Table 11. Effects of copper, nickel, and Headline fungicide foliar applications on percentage of HoCP 96-540 leaf area occupied by brown rust lesions in West Baton Rouge Parish field experiment during 2012.

Treatment[1]	Brown rust severity (%)
Control	5.7 ab
Cu (1 qt/acre)	6.3 ab
Cu (1.5 qt/acre)	7.0 a
Manniplex Ni (1 pt/acre)	5.0 b
Nickel product (0.125 lb/acre)	5.2 b
Headline (9 oz/acre)	1.2 c

[1]Nutrients and Headline were applied twice with nonionic surfactant with a CO_2 sprayer at 15 gal/acre.

Table 12. Effects of copper, nickel, and Headline fungicide foliar applications on yield components of HoCP 96-540 plant cane in West Baton Rouge Parish field experiment during 2012.

Treatment	Stalks/acre[1]	Stalk height (cm) [1]	Sugar/ton (lbs)	Tons cane/acre[1]	Sugar/acre (lbs) [1]
Control	50849 ab	258 ab	250	44.9 b	11205 b
Cu (1 qt/acre)	50559 ab	255 b	253	48.2 ab	12217 ab
Cu (1.5 qt/acre)	48774 b	256 b	246	46.8 ab	11574 ab
Manniplex Ni (1 pt/acre)	49064 ab	260 ab	252	50.3 a	12677 a
Nickel product (0.125 lb/acre)	52219 ab	257 ab	254	47.6 ab	12095 ab
Headline (9 oz/acre)	52634 a	262 a	253	46.9 ab	11868 ab

[1]Means within a column followed by different letters were significantly different (P=0.05).

Table 13. Effects of copper, nickel, and Headline fungicide foliar applications on nickel and copper leaf uptake by HoCP 96-540 plant cane in West Baton Rouge Parish field experiment during 2012.

Treatment	Ni uptake (ppm)	Cu uptake (ppm)
Control	1.2 b	26.5
Cu (1 qt/acre)	1.5 b	32.1
Cu (1.5 qt/acre)	1.2 b	32.2
Manniplex Ni (1 pt/acre)	3.0 a	23.2
Nickel product (0.125 lb/acre)	3.0 a	34.0
Headline (9 oz/acre)	0.8 b	24.0

Spores of the brown rust pathogen, *Puccinia melanocephala*, were collected and used to evaluate the potential of inoculation under controlled conditions to determine and compare resistance levels in parent and seedling populations. Plants grown in the greenhouse were inoculated with brown rust spores, placed in a chamber with mist generators overnight, and placed on shelves under artificial light for 1-2 weeks at room temperature for symptoms to develop. Differences in susceptibility were detected among parental clones; however, variability occurred in infection severity for some clones. Additional research is being conducted to evaluate the effects of varietal spore source and mixtures of spores from different varieties on resistance ratings. Inoculation of seedlings with variable concentrations of rust spores under favorable conditions for infection was continued. Inoculation with a 10^5/ml spore concentration with disease severity ratings assigned at 2 weeks resulted in segregation of resistant and susceptible seedlings closest to what would be expected from the cross type. However, inoculum concentration strongly affected disease severity and the frequency of seedlings rated resistant in crosses. Brown rust resistance is a moderately heritable trait. However, it was possible to overwhelm resistance in seedling populations with inoculation, and cross type was not a consistent predictor of progeny distribution across resistance categories even under optimized conditions. These results suggest that seedling inoculation under controlled conditions is not suitable for cross appraisal of brown rust resistance.

Shifts in disease response from resistant to susceptible have been repeatedly observed for sugarcane cultivars; however, information is limited concerning pathogen variability related to differential host reactions in this pathosystem. To evaluate variability in the pathogen population and resistance responses in different host genotypes, seven varieties, LCP 85-384, Ho 95-988, HoCP 96-540, L 99-226, L 99-233, L 01-283, and L 01-299, were inoculated with a total of four spore collections from three varieties, Ho 95-988 (two collections), HoCP 96-540, and L 99-226 in two experiments. Greenhouse grown plants were inoculated under controlled conditions favorable for infection. After 2 weeks, disease severity calculated as leaf area occupied by rust lesion, lesion density, and individual lesion size, was determined by image analysis. Three varieties that experienced a shift from resistance to high susceptibility over time, LCP 85-384, Ho 95-988, and HoCP 96-540, exhibited differential disease severity when inoculated with spore collections from Ho 95-988 and HoCP 96-540 (Tables 14-19). Three other cultivars, L 99-226, L 99-233, and L 01-283, exhibited consistent moderate to high levels of quantitative resistance against all spore collections, and the only commercial cultivar with the *Bru*1 major resistance gene, L 01-299, was highly resistant to all spore collections. The results demonstrated pathogenic variability related to host genotype in the pathogen. In addition, quantitative resistance was detected that could be very useful in on-going resistance research to ultimately improve breeding and selection for effective, durable resistance to brown rust.

ORANGE RUST INCURSION DURING 2012

Orange rust caused by the fungus, *Puccinia kuehnii*, was found for the first time in Louisiana during 2012 in the newly released variety Ho 05-961 by USDA-ARS Sugarcane Research Unit personnel. Increase plots of this variety on the secondary increase stations for the American Sugar Cane League Variety Release Program were surveyed by LSU AgCenter, USDA-ARS, ASCL, and LDAF personnel to determine the distribution and severity of the disease. In addition, adjacent fields of different varieties were surveyed to determine what varieties were being affected. Orange rust symptoms and characteristic spores were detected in 17 of 38 (45%) of surveyed fields. Distribution was limited to the southern portion of the Louisiana sugarcane production area. Within fields, disease incidence and severity remained low during the summer then began to increase during the fall with the onset of milder temperatures. No orange rust was detected in any other variety. The decision was made to discontinue cultivation of Ho 05-961.

Table 14. Comparison of infection severity assessed as leaf area occupied by lesions in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 1.

Cultivar inoculated	Lesion leaf area (%) for four urediniospore collections[y] Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	0.49 b	1.49 b	9.40 a	2.36 ab	3.43 a
Ho95-988	8.68 a	8.38 a	0.70 cd	0.24 c	4.50 a
HoCP96-540	0.64 b	0.84 b	3.14 b	2.75 a	1.84 b
L99-226	1.12 b	1.22 b	2.47 bc	1.20 bc	1.50 bc
L99-233	1.43 b	0.56 b	0.16 d	0.13 c	0.49 bc
L01-283	0.51 b	0.07 b	0.41 cd	0.07 c	0.27 c
L01-299	0.17 b	0.07 b	0.21 d	0.05 c	0.12 c
Mean	1.89 AB	1.80 AB	2.35 A	0.97 B	

[y]Percentage of leaf area (6 replications) occupied by brown rust lesions following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different ($P = 0.05$). Spore collection lesion area means followed by different upper case letters were significantly different ($P = 0.05$).

Table 15. Comparison of infection severity assessed as leaf area occupied by lesions in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 2.

	Lesion leaf area (%) for four urediniospore collections[y]				
Cultivar inoculated	Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	0.35 bc	0.21 bc	0.85 bcd	0.33 a	0.43 bc
Ho95-988	1.19 a	4.11 a	1.86 ab	0.13 bc	1.82 a
HoCP96-540	1.27 a	1.26 b	2.91 a	0.12 bc	1.39 a
L99-226	0.66 b	1.24 b	1.16 bc	0.23 ab	0.82 b
L99-233	0.18 c	0.38 bc	0.82 bcd	0.07 c	0.36 bc
L01-283	0.04 c	0.06 c	0.17 cd	0.03 c	0.08 c
L01-299	0.05 c	0.04 c	0.06 d	0.06 c	0.05 c
Mean	0.54 B	1.04 A	1.12 A	0.14 B	

[y]Percentage of leaf area (6 replications) occupied by brown rust lesions following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different ($P = 0.05$). Spore collection lesion area means followed by different upper case letters were significantly different ($P = 0.05$).

Table 16. Comparison of infection severity assessed as lesion density in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 1.

Cultivar inoculated	Lesion density for four urediniospore collections[y] Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	1.3 de	2.1 b	7.8 a	4.6 a	4.0 a
Ho95-988	7.2 a	6.0 a	1.5 c	0.7 c	3.8 ab
HoCP96-540	1.6 cd	1.8 b	4.6 b	3.1 b	2.8 b
L99-226	2.5 bc	2.7 b	3.9 b	2.2 b	2.8 b
L99-233	2.8 b	1.4 bc	0.4 c	0.4 c	1.1 c
L01-283	1.5 de	0.1 c	1.1 c	0.1 c	0.7 c
L01-299	0.5 e	0.1 c	0.5 c	0.1 c	0.3 c
Mean	2.5 AB	2.0 AB	2.8 A	1.6 B	

[y]Number of lesions per cm^2 of leaf (6 replications) following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different (P = 0.05). Spore collection lesion density means followed by different upper case letters were significantly different (P = 0.05).

Table 17. Comparison of infection severity assessed as lesion density in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 2.

Cultivar inoculated	Lesion density for four urediniospore collections[y] Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	3.6 b	1.7 c	4.5 bcd	1.0 a	2.7 cd
Ho95-988	6.8 a	9.5 a	10.8 a	1.1 a	7.0 a
HoCP96-540	7.1 a	5.8 b	7.5 ab	0.4 b	5.2 ab
L99-226	3.5 b	7.0 b	6.5 abc	1.0 a	4.5 bc
L99-233	1.6 bc	2.5 c	4.8 bcd	0.1 b	2.2 de
L01-283	0.5 c	0.6 c	2.2 cd	0.3 b	0.9 de
L01-299	0.4 c	0.2 c	0.9 d	0.1 b	0.4 d
Mean	3.3 B	3.9 AB	5.3 A	0.6 C	

[y]Number of lesions per cm^2 of leaf (6 replications) following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different (P = 0.05). Spore collection lesion density means followed by different upper case letters were significantly different (P = 0.05).

Table 18. Comparison of infection severity assessed as individual lesion area in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 1.

Cultivar inoculated	Lesion area for four urediniospore collections[y]				
	Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	0.5 b	0.7 bc	1.2 a	0.5	0.7 ab
Ho95-988	1.2 a	1.3 a	0.4 b	0.4	0.8 a
HoCP96-540	0.4 b	0.4 c	0.6 ab	0.8	0.6 ab
L99-226	0.4 b	0.5 bc	0.6 ab	0.5	0.5 b
L99-233	0.5 b	0.4 c	0.5 b	0.8	0.5 b
L01-283	0.4 b	0.5 bc	0.5 b	0.8	0.5 b
L01-299	0.4 b	1.0 ab	0.7 ab	0.5	0.7 ab
Mean	0.5	0.7	0.7	0.6	

[y]Individual lesion area (mm^2) (6 replications) following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different (P = 0.05). Spore collection lesion area means were not significantly different (P = 0.05).

Table 19. Comparison of infection severity assessed as individual lesion area in seven sugarcane cultivars resulting from inoculation under controlled conditions with *Puccinia melanocephala* urediniospore collections from three cultivars from experiment 2.

Cultivar inoculated	Lesion area for four urediniospore collections[y]				
	Collection 1 (Ho95-988-1)	Collection 2 (Ho95-988-2)	Collection 3 (HoCP96-540)	Collection 4 (L99-226)	Mean
LCP85-384	0.9 c	0.8	0.2 bc	0.4 b	0.4 a
Ho95-988	1.7 a	0.4	0.2 bc	0.1 b	0.2 ab
HoCP96-540	1.7 a	0.2	0.4 a	0.3 b	0.3 ab
L99-226	1.9 a	0.2	0.3 b	0.2 b	0.2 ab
L99-233	1.0 bc	0.1	0.2 bc	1.4 a	0.5 a
L01-283	1.2 bc	0.1	0.1 c	0.1 b	0.1 b
L01-299	1.5 ab	0.2	0.2 bc	0.4 b	0.2 ab
Mean	0.1 B	0.3 AB	0.2 B	0.4 A	

[y]Individual lesion area (mm^2) (6 replications) following inoculation with each of four urediniospore collections. The cultivar from which spores were collected is shown in parentheses; there were two different spore collections from cultivar Ho95-988. Cultivar means within a column followed by different lower case letters were significantly different (P = 0.05). Spore collection lesion area means followed by different upper case letters were significantly different (P = 0.05).

HEALTHY SEEDCANE PROGRAM SUPPORT

Disease testing was conducted by the Sugarcane Disease Detection Lab for the 17^{th} year during 2012. Kleentek and SugarTech seedcane production was monitored for RSD, and no disease was detected. A total of 1,483 stalk samples from research farms, variety increase plots, and grower fields were tested for RSD with no positives detected (Table 20). Limited testing was conducted on commercial farms. A total of 15 fields were tested, and no RSD was detected (Table 20). A total of 8,738 leaf samples were tested for yellow leaf (Table 21). Commercial tissue-culture seedcane sources were tested as part of the LDAF seedcane certification program. No field failed to certify due to virus infection. The Local Quarantine supplied healthy plant material of promising experimental varieties to the two seedcane companies.

Table 20. RSD testing summary for 2012.

Source	Location	No. of fields	No. of varieties	No. of samples
Louisiana growers	State-wide	15	5	320
Variety Release Program	1° & 2° stations	-	9	501
Helena SugarTech®	Foundation stock	-	7	70
Kleentek®	Foundation stock	-	-	45
Kleentek®	Other than foundation	-	-	513
Local Quarantine	LSUAC	-	11	34
Research	LSUAC	-	-	-

Table 21. Sugarcane yellow leaf virus testing summary for 2012.

Source	Location	No. of fields	No. of varieties	No. of samples
LDAF	Seed Certification	221	-	6867
Helena SugarTech®	Foundation stock	-	7	74
Kleentek®	Foundation stock	-	-	-
Kleentek®	Other than foundation	-	-	450
Local Quarantine	LSUAC	-	11	34
Research	LSUAC	-	-	1313

RESISTANCE TO LEAF SCALD

The primary control measure for leaf scald is host plant resistance. The current system of resistance evaluation using visual rating of disease severity can be uncertain due to erratic symptom expression. A quantitative polymerase chain reaction (qPCR) assay was developed previously with demonstrated potential for resistance screening; however, only four cultivars were compared. Therefore, Xa populations were compared in multiple tissues of 30 clones at different times after inoculation during 2011 and 2012. Correlations within and between qPCR and visual ratings were determined. Differences in populations of the pathogen, *Xanthomonas albilineans*, among clones varying in resistance were greater in young, emerging, systemically infected leaves compared to apical meristem and stalk tissues at 8 weeks after inoculation (wai). The highest correlation between qPCR and visual ratings occurred at 8 wai (0.62, $P<0.0001$). The intermediate correlation between the methods was due in part to the erratic symptomatology. Consistency was determined by the correlation among data obtained with the same method at different times. The qPCR was more consistent among different inoculations (0.81, $P<0.0001$) compared with the visual rating system (0.54, $P=0.002$) at 8 wai. The high sensitivity, specificity, and consistency suggest that qPCR can provide an improved method to evaluate resistance to leaf scald in sugarcane.

SMUT RESISTANT PARENT DEVELOPMENT

Multiple varieties with low to moderate smut susceptibility were released to provide alternatives to replace LCP 85-384. Susceptibility to smut has been a recurrent problem for the breeding program. Therefore, an attempt to select more resistant parents through resistance screening of clones earlier in the selection program was initiated during 2012. Single stalks were collected from clones in the second line trial, dip-inoculated in a suspension of $5x10^6$ smut teliospores, cut in half, and planted in un-replicated plots along with the parents from each cross. No infection was observed in 98/128 clones (77%). The no-infection clones will be re-inoculated to confirm the resistance rating.

VARIETY SELECTION

Disease susceptibility in experimental varieties in the Variety Selection Program was determined. Resistance ratings for smut and leaf scald were determined for experimental varieties in the selection program in annual inoculated tests. Smut infection resulting from dip-inoculation ranged from 0-66% for the susceptible check variety, CP 73-351 (Table 22). An experiment was conducted within the inoculated test to compare smut infection in L 01-299 stalks with four treatments: leaf sheath removal and dip-inoculation, leaf sheath removal and natural infection (non-inoculated), no leaf sheath removal and dip-inoculation, and no leaf sheath removal and natural infection (Table 23). Dip-inoculation resulted in severe infection and a smut rating of 9 whether the leaf sheath was removed or not. Plants growing from non-inoculated stalks developed lower infection levels, and the lowest infection and rating occurred when the leaf sheath was not removed. Leaf scald resistance ratings ranged from 1-8 for commercial and experimental varieties in the inoculated test (Table 24).

The severe rust epidemic during 2012 provided an opportunity to rate natural infection severity in parent clones for the breeding program. Rust severity resulting from natural infection was determined for parent clones in three nurseries. Resistance ratings were assigned on a 1-9 scale in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible. A range of ratings were assigned to 178 clones.

Table 22. Smut resistance ratings determined in an inoculated test for commercial and experimental sugarcane varieties during 2012.

Variety	Smut rating	Variety	Smut rating
CP 73-351	9	HoCP 09-810	1
L 99-226	6	HoCP 09-814	4
L 99-233	8	Ho 09-832	1
L 01-299	9	Ho 09-840	2
L 03-371	2	Ho 09-846	1
HoCP 04-838	3	L 10-132	4
Ho 05-961	1	L 10-133	1
L 08-088	4	L 10-138	1
L 08-090	1	L 10-141	1
L 08-092	1	L 10-142	1
Ho 08-709	1	L 10-144	2
Ho 08-711	1	L 10-145	1
Ho 08-717	1	L 10-146	5
L 09-099	7	L 10-147	2
L 09-112	1	L 10-148	2
L 09-117	1	L 10-150	2
L 09-125	3	L 10-151	1
L 09-131	1	L 10-156	6
HoCP 09-800	1	L 10-163	2
HoCP 09-804	2		

[x]Resistance ratings assigned on a 1-9 scale in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible.

Table 23. Smut resistance ratings determined for variety L 01-299 in an experiment comparing stalks with and without leaf sheath removal then dip-inoculated or exposed to natural infection during 2012.

L 01-299 treatment	Smut infection (%)[1]	Smut rating[2]
Leaf sheath removed; dip-inoculated	56.0	9
Leaf sheath removed; non-inoculated	19.4	6
Leaf sheath not removed; dip-inoculated	46.7	9
Leaf sheath not removed; non-inoculated	11.2	4

[1]Percentage of shoots developing smut whip.

[2]Resistance ratings assigned on a 1-9 scale in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible.

Table 24. Leaf scald resistance ratings determined in an inoculated test for commercial and experimental sugarcane varieties during 2012.

Variety	Leaf scald rating[1]	Variety	Leaf scald rating[1]
CP 65-357	4	L 08-088	2
CP 70-321	3	L 08-090	5
CP 73-351	5	L 08-092	3
LCP 82-89	3	Ho 08-706	3
LCP 85-384	1	Ho 08-709	3
HoCP 85-845	6	Ho 08-711	3
CP 89-2143	5	Ho 08-717	3
HoCP 89-846	8	HoL 08-723	3
Ho 95-988	3	HoCP 08-726	2
HoCP 96-540	2	L 09-099	2
L 97-128	2	L 09-112	1
L 99-226	3	L 09-117	1
L 99-233	5	L 09-131	5
HoCP 00-950	5	HoCP 09-800	1
L 01-283	3	HoCP 09-804	2
L 01-299	4	HoCP 09-810	1
L 03-371	4	HoCP 09-814	2
HoCP 04-838	5	Ho 09-832	4
Ho 05-961	4	Ho 09-840	2
L 07-057	2	Ho 09-846	3
L 08-075	2		

[1]Resistance ratings assigned on a 1-9 scale in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible.

NEW HERBICIDE RESEARCH

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Sugarcane injury was evaluated for Zidua (pyroxasulfone), Sharpen (saflufenacil), and Velpar (hexazinone) applied postemergence in March. Zidua and Sharpen are BASF products labeled in corn and soybean. Zidua has provided very good control of both annual grass and broadleaf weeds. Velpar is currently labeled in sugarcane but there is some concern regarding injury. At 16 days after treatment (April 11), 'HoCP 96-540' sugarcane was injured 9% with Velpar at 2 pt plus Sencor (metribuzin) at 2 lb/A, 11% with Sharpen at 2 oz/A, and 18% with Zidua at 2 oz plus Sharpen at 1 oz/A (Table 1). Injury consisted of chlorosis, reddening of foliage, and/or height reduction. Injury was no more than 3% for Zidua alone at 2 and 3 oz/A, Sencor at 2 lb/A, and Prowl (pendimethalin) at 3 qt plus atrazine at 1 qt/A. At 45 days after treatment (May 10), injury was no more than 9% for any of the herbicide treatments. Sugarcane yield, TRS, and sugar yield were each equivalent regardless of herbicide treatment.

Table 1. Sugarcane response to herbicides applied on March 26, 2012.

Herbicide treatment	Sugarcane injury					
	April 11	April 24	May 10	Sugarcane yield	TRS	Sugar yield
	---------------%----------------			ton/A	lb/ton	lb/A
Sharpen 1 oz/A	5 bc [a]	4 ab	0 a	32 a	267 a	8,580 a
Sharpen 2 oz/A	11 b	4 ab	4 a	26 a	271 a	7,350 a
Zidua 2 oz/A	0 c	0 b	0 a	26 a	278 a	7,180 a
Zidua 3 oz/A	3 c	5 ab	5 a	29 a	266 a	7,570 a
Zidua 2 oz + Sharpen 1 oz/A	18 a	5 ab	4 a	30 a	268 a	7,910 a
Velpar 2 pt + Sencor 2 lb/A	9 bc	13 a	9 a	24 a	273 a	6,500 a
Sencor 2 lb/A	0 c	0 b	0 a	28 a	272 a	7,520 a
Prowl 3 qt + Atrazine 1 qt/A	0 c	0 b	0 a	26 a	267 a	6,960 a
No herbicide	1 c	0 b	0 a	27 a	270 a	7,250 a

[a] Treatment means within a column followed by the same letter are not significantly different ($P \leq 0.05$).

SPRING WEED CONTROL PROGRAMS FOR BERMUDAGRASS

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Herbicide treatments including Sencor (metribuzin) at 3 lb/A, Command (clomazone) plus Direx (diuron) at 3 pt + 2.5 qt/A, Prowl (pendimethalin) plus Sencor at 2 qt + 3 lb/A, and Command plus Sencor at 3 pt + 1 lb/A were applied February 22, March 7, and March 27. In contrast to previous years, the mild winter resulted in earlier than normal emergence of both bermudagrass and sugarcane. For the February application, bermudagrass ground cover was around 50% and runners were 3 to 8 inches in length. ‘HoCP 96-540’ sugarcane was 12 to 14 inches tall. For the March applications, bermudagrass ground cover was around 60% and some runners were 12 inches in length. Sugarcane was 12 to 15 inches tall in early March and 25 to 30 inches tall in late March.

Four weeks after the February application, bermudagrass control was 40% for Sencor, 68% for Command plus Direx, 48% for Prowl plus Sencor, and 45% for Command plus Sencor (Table 1); six weeks after treatment control was 30 to 55% (data not shown). For the early March application, bermudagrass control four weeks after treatment was 40% for Sencor, 50% for Command plus Direx, 38% for Prowl plus Sencor, and 43% for Command plus Sencor; six weeks after treatment control was 35 to 50%. For the late March application, bermudagrass control four weeks after treatment was 48% for Sencor, 40% for Command plus Direx, 35% for Prowl plus Sencor, and 43% for Command plus Sencor; six weeks after treatment control was 45 to 65%. Sugarcane injury (whitening/bleaching and height reduction) was observed for Command plus Direx and Command plus Sencor at all application dates. After layby, differences in bermudagrass population could not be distinguished among the herbicide treatments applied in February or March. Sugarcane was used for seed and yield could not be obtained.

In a second experiment, herbicide treatments were applied March 2 when bermudagrass ground cover was 30 to 60% and runners were 3 to 4 inches in length. Sugarcane was 8 to 12 inches tall. Four weeks after the March application, bermudagrass control was 43% for Sencor, 65% for Command plus Direx, 44% for Prowl plus Sencor, 63% for Command plus Sencor, 49% for Velpar plus Sencor, and 23% for Prowl alone; at eight weeks after treatment control for all treatments except Prowl alone was 46 to 55% (Table 2). Sugarcane injury for Command plus Direx and Command plus Sencor was as high as 19% 4 weeks after application. Injury with Velpar plus Sencor was less than for Command plus Direx and equal to that for Sencor applied alone.

Table 1. Bermudagrass control and sugarcane injury four weeks following herbicides applied on February 22, March 7, and March 27, 2012.

	Herbicide application date					
	February 22		March 7		March 27	
Herbicide treatment	Bermudagrass control	Sugarcane injury	Bermudagrass control	Sugarcane injury	Bermudagrass control	Sugarcane injury
	------%------					
Sencor 3 lb/A	40 a [a]	0 c	40 a	0 c	48 a	5 a
Command 3 pt + Direx 2.5 qt/A	68 a	25 a	50 a	13 ab	40 a	18 a
Prowl at 2 qt + Sencor at 3 lb/A	48 a	5 c	38 a	0 b	35 a	8 a
Command 3 pt + Sencor 1 lb/A	45 a	20 b	43 a	8 c	43 a	15 a

[a] Treatment means within each column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 2. Bermudagrass control and sugarcane injury following herbicides applied on March 2, 2012.

	April 3		April 16		April 30	
Herbicide treatment	Bermudagrass control	Sugarcane injury	Bermudagrass control	Sugarcane injury	Bermudagrass control	Sugarcane injury
	------%------					
Sencor 3 lb/A	43 b [a]	0 c	49 ab	0 c	46 ab	1 b
Command 3 pt + Direx 2.5 qt/A	65 a	19 a	54 ab	15 a	49 ab	14 a
Prowl at 1.7 qt + Sencor at 3 lb/A	44 b	10 b	53 ab	0 c	51 ab	0 b
Command 3 pt + Sencor 1 lb/A	63 a	16 a	59 a	9 b	55 a	4 b
Velpar 2 pt + Sencor 1.5 lb/A	49 b	6 b	45 b	5 c	46 ab	4 b
Prowl 2.6/A	23 c	10 b	29 c	0 c	39 b	0 b

[a] Treatment means within within each column followed by the same letter are not significantly different ($P \leq 0.05$).

BERMUDAGRASS COMPETITION WITH SUGARCANE AT PLANTING

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Research was conducted to evaluate response of sugarcane when grown in competition with bermudagrass. Two experiments were conducted, a density experiment where a single cultivar was planted with bermudagrass at four densities (none, 1, 2, or 4 plants per pot) and a cultivar experiment where six sugarcane cultivars were planted with bermudagrass at two densities (none or 2 plants per pot). Single node stolon segments of bermudagrass and single node cuttings of sugarcane were pre-sprouted for 10 days and transplanted into 26.5 L pots with a surface area of 0.093m^2 (approximately 1 square foot). Sugarcane and bermudagrass were allowed to compete in pots for 56 days.

In the density experiment, ‘HoCP 96-540’ leaf growth was reduced an average of 12% when co-planted with 4 bermudagrass plants; sugarcane dewlap height was not affected by bermudagrass competition (Table 1). Sugarcane shoot number was reduced at least 48% when in competition with bermudagrass and sugarcane shoot weight was reduced at least 51% (Table 2). Sugarcane root weight was not affected when grown with 1 bermudagrass plant, but 2 and 4 bermudagrass plants reduced sugarcane root weight 36 and 41%, respectively.

In the cultivar experiment, bermudagrass competition (2 plants per pot) did not reduce sugarcane shoot population 56 days after planting for the cultivars ‘HoCP 96-540’,‘L 97-128’, ‘L 99-226’, ‘HoCP 00-950’, ‘L 01-283’, and ‘L 03-371’ (Table 3). Averaged across bermudagrass densities, shoot population for L 97-128, L 99-226, and L 03-371was almost twice that for HoCP 00-950 and L 01-283. Bermudagrass competition did not reduce sugarcane shoot or root weight for any of the cultivars (Table 4). Averaged across bermudagrass densities, shoot weight for L 97-128 and L 99-226 was equivalent and averaged 2.8 times that for HoCP 96-540 and L 01-283 (Table 4). Sugarcane root weight for L 97-128 and L 99-226 was equivalent and averaged 1.9 times that for HoCP 96-540, HoCP 00-950, L 01-283, and L 03-371.

Table 1. Sugarcane leaf length and dewlap height when a single node segment of 'HoCP 96-540' sugarcane was co-planted with bermudagrass at four planting densities.[a]

Bermudagrass plants/pot	Sugarcane leaf length 42 DAP	56 DAP	Density average	Sugarcane dewlap height 42 DAP	56 DAP	Density average
	--------------------cm---------------------			---------------------cm---------------------		
0	115	122	118 a	26.9	30.3	28.6
1	109	113	111 ab	25.0	27.4	26.2
2	107	113	110 ab	23.4	26.4	24.9
4	102	105	104 b	22.8	24.3	23.6

[a] Treatment means within a column (density average) followed by the same letter are not significantly different ($P \leq 0.05$).

Table 2. Sugarcane shoot population and shoot and root weight when a single node segment of 'HoCP 96-540' sugarcane was co-planted with bermudagrass at four planting densities.[a]

Bermudagrass plants/pot	Sugarcane shoot population	Sugarcane shoot weight	Sugarcane root weight
	no./pot	g/pot	g/pot
0	8.9 a[b]	38.9 a	25.6 a
1	4.4 b	19.1 b	19.1 ab
2	4.6 b	17.4 b	16.3 b
4	4.3 b	13.0 b	15.2 b

[a] Treatment means within each column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 3. Sugarcane shoot population when a single node segment of six cultivars was co-planted with bermudagrass at two plant densities (-BG = none and +BG = 2 plants per pot).[a]

Cultivar	Sugarcane shoot population 56 DAP - BG	+ BG	Cultivar average
	--------------------------------------no./pot-------------------------------------		
HoCP 96-540	5.3	4.3	4.8 aba[a]
L 97-128	5.4	5.6	5.5 a
L 99-226	6.1	5.4	5.8 a
HoCP 00-950	3.3	2.9	3.1 b
L 01-283	3.9	2.9	3.4 b
L 03-371	5.3	5.8	5.5 a
Density average	4.9	4.5	--

[a] Treatment means within a column (cultivar average) followed by the same letter are not significantly different ($P \leq 0.05$).

Table 4. Sugarcane shoot and root weight when a single node segment of six cultivars was co-planted with bermudagrass at two plant densities (-BG = none and +BG = 2 plants per pot).[a]

Cultivar	Shoot weight			Root weight		
	- BG	+ BG	Cultivar average	- BG	+ BG	Cultivar average
	-------------------g/pot-------------------			---------------------g/pot------------------		
HoCP 96-540	26.7	26.2	26.4 d[a]	17.9	16.6	17.3 b
L 97-128	72.9	70.3	71.6 a	40.3	31.0	35.7 a
L 99-226	76.0	59.7	67.8 ab	35.3	37.9	36.6 a
HoCP 00-950	57.3	44.3	50.8 bc	20.3	17.3	18.8 b
L 01-283	26.9	20.3	23.6 d	22.4	17.8	20.1 b
L 03-371	47.8	34.8	41.3 cd	23.0	15.8	19.4 b
Density average	51.3 a[c]	42.6 b	--	26.5 a[c]	22.7 b	--

[a] Treatment means within a column (cultivar average) or row (density average) followed by the same letter are not significantly different ($P \leq 0.05$).

COMPARISON OF BERMUDAGRASS BIOTYPES

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Bermudagrass was collected at 13 outfield locations used by the LSU AgCenter Sugar Research Station for sugarcane variety field trials, at four sites from sugarcane farms of interest, and from three LSU AgCenter Research Stations (Table 1). Plants were potted and used to establish plants for various experiments. For the field study, two to three inch sections of stolons from the “mother plants” were planted into 2-inch pots in the greenhouse. Plants were transplanted in the field at the Central Station, Ben Hur Research Farm, Baton Rouge, LA, in plots 5 x 5 feet. Two plants were planted in the center of each plot 2 feet from one another. To prevent bermudagrass encroachment from adjoining plots, alleys between plots (5 feet wide) were sprayed with glyphosate using a hooded sprayer.

At 84 days after planting (DAP) bermudagrass ground cover was less than 40% for biotypes J, N, and T, but greater than 80% for biotypes A, C, D, F, Q, and R (Tables 1 and 2). Bermudagrass biotypes with the greatest plant height were A, B, E, Q, R, and S (8.1 to 12.8 inches); plant height for Biotype I was 3.7 inches. Internode length ranged from 1.1 inches for Biotype F to 3.1 inches for Biotype Q. Leaf width ranged from 0.11 inch for Biotypes G, L, and M to 0.17 inch for Biotype S.

In both 2011 and 2012 the most aggressive biotypes, based on ability to produce the highest yield, were A and Q (Tables 1 and 3). Total dry weight for the two years was greatest for Biotype A (657 g/plot) and Biotype Q (623 g/plot), which corresponds to a dry matter yield of around 3.5 tons/A. Lowest dry matter yield was observed for Biotypes J and T (around 1.2 tons/A). Biotypes also differed in time of emergence following the winter dormant period and in seed head production. In 2011 bermudagrass seedhead emergence was greatest for Biotypes A, B, P, Q, and S and lowest for Biotypes E, F, N, R, and T (Tables 1 and 4). In April of 2012, seedhead emergence was greatest for Biotypes G, H, I, and P and lowest for Biotypes A, C, E, N, R, and T. Differences observed among the bermudagrass biotypes in morphology and growth characteristics may help explain variability in control and competitiveness observed in sugarcane fields in Louisiana.

Table 1. Bermudagrass biotypes evaluated in 2011 and 2012.

Biotype	Grower	Farm	Location	Parish
	--------------------------------------Outfield Sites (12)---			
A	Lawrence Levert	St. John	St. Martinville	St. Martin
B	Ronald Hebert	Ronald Hebert	Jeanerette	Iberia
C	Brett Allain	Allain	Baldwin	St. Mary
D	Wilson Judice	Frank Martin	Centerville/Calumet	St. Mary
E	Pete Lanaux	Lanaux	Lucy	St. John the Baptist
F	Brian Graugnard	Bon Secour	Vacherie	St. James
G	Joel Landry	Glenwood	Napoleonville	Assumption
H	Howard Robichaux	Mary	Raceland	Lafourche
I	Danny Naquin	Magnolia	Schriever	Terrebonne
J	Joe Beard III	Brunswick	Samuels	Pointe Coupee
K	Todd Andre	Alma	Allon	Pointe Coupee
L	Al Landry	Landry Farm	Plaquemine	Iberville
	--------------------------------Off-Station Nursery Site (1)--			
M	Blake Newton	Bunkie	Bunkie	Avoyelles
	--Other Sites (7)---			
N	Ronnie Gonsulan	Airport Road	New Iberia	Iberia
P	Mike Cremaldi	Cremaldi Farms	Patterson	St. Mary
Q	Kerny Gros	Barrowza Plantation	Port Allen	West Baton Rouge
R	LSU AgCenter	Sugar Res. Station	St. Gabriel	Iberville
S	LSU AgCenter	Dean Lee Res. Station	Alexandria	Rapides
T	LSU Agcenter	Northeast Res. Station	St. Joseph	Tensas

Table 2. Growth comparisons of bermudagrass biotypes in 2011 and 2012.

Biotype	Bermudagrass ground cover 54 DAP	64 DAP	74 DAP	84 DAP	Biotype avg.	Plant height	Internode length	Leaf width
	%					mm		
A	54	68	86	93	75 abc[a]	234 abc	50 bcdef	3.6 ab
B	13	31	48	65	39 abc	206 abcd	51 bcde	3.2 bc
C	18	24	49	83	43 abc	148 bcd	56 abc	3.1 bc
D	19	27	53	83	45 abc	141 cd	38 cdef	3.0 bc
E	15	27	47	73	40 abc	236 abc	55 abcd	3.0 bc
F	8	21	46	85	40 abc	125 cd	29 ef	3.1 bc
G	14	25	41	74	38 abc	120 cd	39 cdef	2.8 c
H	13	21	45	68	37 abc	125 cd	41 cdef	3.1 bc
I	9	14	39	64	31 abc	95 d	33 cdef	3.1 bc
J	5	6	16	32	15 c	105 cd	39 cdef	3.5 b
K	10	14	33	58	29 abc	161 bcd	43 cdef	3.5 ab
L	14	22	44	67	37 abc	120 cd	37 cdef	2.8 c
M	11	21	42	68	35 abc	141 cd	31 def	2.8 c
N	5	9	19	39	18 bc	144 cd	49 bcdef	3.1 bc
P	13	22	36	74	36 abc	118 cd	50 bcde	2.9 bc
Q	46	75	96	99	79 ab	325 a	78 a	3.6 ab
R	56	79	100	100	84 a	285 ab	47 bcdef	3.2 bc
S	11	18	42	75	36 abc	208 abcd	68 ab	4.2 a
T	5	7	13	22	12 c	77 d	26 f	2.9 bc

[a] Treatment means within a column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 3. Biomass production for bermudagrass biotypes in 2011 and 2012.

Biotype	Dry weight		
	August 25, 2011	April 25, 2012	Total
	---------------------------------------g/plot---------------------------------------		
A	219 a[a]	438 a	657
B	111 bcd	407 ab	518
C	98 cd	171 d	269
D	76 cd	200 bcd	276
E	141 abc	286 abcd	427
F	108 cd	241 abcd	349
G	73 cd	299 abcd	372
H	47 cd	349 abcd	396
I	44 cd	261 abcd	305
J	31 d	179 cd	210
K	75 cd	338 abcd	413
L	59 cd	265 abcd	324
M	97 cd	239 abcd	336
N	35 cd	259 abcd	294
P	55 cd	295 abcd	350
Q	223 a	400 abc	623
R	216 ab	286 abcd	512
S	141 abc	407 ab	548
T	18 d	196 bcd	214

[a] Treatment means within a column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 4. Seedhead emergence for bermudagrass biotypes in 2011 and 2012.

	Seed head emergence rating (1=low,2=medium,3=high)	
Biotype	11/7/11	4/25/12
A	2.8 ab[a]	1.0 d[1]
B	2.8 ab	2.0 abcd
C	1.8 abcd	1.3 cd
D	1.5 bcd	1.5 bcd
E	1.0 d	1.3 cd
F	1.0 d	1.8 bcd
G	1.8 abcd	2.5 ab
H	1.8 abcd	3.0 a
I	2.3 abcd	3.0 a
J	1.8 abcd	1.5 bcd
K	2.3 abcd	2.0 abcd
L	1.5 bcd	2.3 abc
M	2.3 abcd	2.0 abcd
N	1.3 cd	1.3 cd
P	3.0 a	3.0 a
Q	2.5 abc	2.3 abc
R	1.0 d	1.0 d
S	3.0 a	2.0 abcd
T	1.3 cd	1.0 d

[a] Treatment means within a column followed by the same letter are not significantly different ($P \leq 0.05$).

ITALIAN RYEGRASS CONTROL AS AFFECTED BY SUGARCANE HARVEST RESIDUE AND HERBICIDE TREATMENTS

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Following harvest of HoCP 96-540 sugarcane on October 30, 2012, crop residue was removed from plots. Italian ryegrass was seeded at a rate of 10 lb/A. Collected crop residue was weighed and redistributed evenly over each row to represent residue levels of none, 4, 8, and 12 tons fresh weight per acre. Superimposed on each residue level were the herbicide treatments atrazine at 2 qt/A, Prowl (pendimethalin) at 2.5 qt/A, Sencor (metribuzin) at 1.5 lb/A, Command (clomazone) at 2.5 pt + Direx (diuron) at 2.5 qt/A, Velpar (hexazinone) at 1.0 qt + Direx at 1.8 qt/A, and no herbicide. Herbicides were applied on November 2 and around 1 inch of rain was received within 7 days after application. The experimental design was a randomized complete block with a factorial treatment arrangement (4 levels of residue and 6 herbicide treatments). Data were analyzed using ANOVA and treatment means were separated using Least Significant Difference (LSD).

Visual evaluation of ryegrass ground cover (0 to 100%) was initiated on December 17, 2012 (45 days after herbicide application) and continued every four weeks until April 19, 2013 (168 days after treatment). Sugarcane was off-barred on March 15 leaving a 20 inch uncultivated band on the row tops. On April 19, percent ground cover of sugarcane residue (0 to 100%), depth of the residue cover, and sugarcane shoot population were determined.

On December 17, ryegrass ground cover was 36% for the no herbicide and no sugarcane residue control; ryegrass ground cover was 28 and 22% when sugarcane residue was 4 and 8 tons per acre, respectively (Table 1). With no sugarcane residue ryegrass ground cover was 39% for atrazine and was equal to that when herbicide was not applied. Ryegrass ground cover when residue was not present was no more than 4% for Prowl, Sencor, Command plus Direx, and Velpar plus Direx. With sugarcane residue of 12 tons per acre, ryegrass ground cover was 8% when no herbicide was applied compared with 1 to 14% for atrazine, Prowl, Sencor, Command plus Direx, and Velpar plus Direx.

On April 19, ryegrass ground cover when sugarcane residue was not present and when atrazine or no herbicide was applied was around 80% (Table 2), nearly twice that observed on December 17 (Table 1). When herbicide was not applied and sugarcane residue was 4 and 8 tons per acre, ryegrass ground cover was 60 and 34%, respectively. Ryegrass ground cover was 16% for 12 tons per acre of sugarcane residue. Ryegrass ground cover with atrazine decreased as sugarcane residue increased and for 12 tons per acre, ryegrass ground cover was 29%. For Prowl, ryegrass ground cover was greater with residue of 4 tons per acre compared with no residue (49 vs. 17% ground cover). When residue was not present, ryegrass ground cover was 13% for Sencor but no more than 2% for Command plus Direx and Velpar plus Direx. For these herbicide treatments in most cases, increasing residue level did not affect ryegrass control.

Ground cover of sugarcane residue on April 19 averaged across herbicide treatments was 43% for the initial residue level of 4 tons per acre and 74% for 12 tons per acre (Table 3). Averaged across sugarcane residue levels, ground cover of crop residue was 41% for no herbicide, 39% for atrazine, and 45 to 58% for the other herbicide treatments. Depth of sugarcane residue on April 19 averaged 0.8, 1.9, and 2.2 inches for the initial residue levels of 4, 8, and 12 tons per acre (Table 4). Averaged across residue levels, residue depth was equivalent regardless of herbicide treatment (1.2 to 1.4 inches). Sugarcane shoot population averaged across herbicide treatments was equivalent regardless of sugarcane residue level (Table 5). Averaged across residue levels, sugarcane shoot population was 39 per row for Command plus Direx and 35 per row for Velpar plus Direx. Where no herbicide was applied sugarcane shoot population averaged 17 per row, which was around 50% less than for Command or Velpar plus Direx. For atrazine, Prowl, and Sencor shoot population was equivalent to when no herbicide was applied.

Results show that when herbicide was not applied, sugarcane residue at 12 tons per acre significantly reduced ryegrass seedling emergence (16% ryegrass ground cover vs. 78% for the no residue control 168 days after crop harvest). Ryegrass control with atrazine was increased as sugarcane residue level increased from none to 12 tons per acre (80 vs. 29% ryegrass ground cover). For Prowl, however, ryegrass control tended to decrease as sugarcane residue level increased from none to 12 tons per acre (17 vs. 26% ryegrass ground cover) suggesting that herbicide may have been adsorbed by the residue and therefore unavailable to provide weed control. Ryegrass control with Sencor, Command plus Direx, and Velpar plus Direx was generally not affected by increasing sugarcane residue levels. With no sugarcane residue, ryegrass ground cover 168 days after crop harvest was 13% for Sencor, 1% for Command plus Direx, and 2% for Velpar plus Direx.

For all herbicide treatments, sugarcane shoot population was not negatively affected by sugarcane residue level even though residue ground cover averaged as much as 74% and residue depth was as much as 2.2 inches. Consequently, the major factor affecting sugarcane shoot population in this study was ryegrass control. Sugarcane shoot population was greatest for Command plus Direx and Velpar plus Direx and on the average shoot population for these treatments was around 2.2 times that of the nontreated, 1.7 times that for atrazine and Prowl, and 1.5 times that for Sencor. Apparently ryegrass present in sugarcane in the spring affected drying and warming of beds which in turn affected sugarcane emergence and growth.

Table 1. Ryegrass ground cover on December 17, 2012, as influenced by sugarcane harvest residue level and preemergence herbicides applied on November 2, 2012.

Sugarcane residue level tons/A	Herbicide						Average
	None	Atrazine	Prowl	Sencor	Command + Direx	Velpar + Direx	
	--------------------------------------Ryegrass ground cover (%)-------------------------------------						
0	36 a[a]	39 a	4 h-k	2 ijk	0 k	1 jk	14
4	28 b	28 b	18 cd	5 g-k	7 g-j	4 h-k	15
8	22 bc	16 cde	11 efg	5 g-k	5 g-k	5 g-k	11
12	8 f-i	14 def	10 e-h	6 g-k	6 g-k	1 jk	8
Average	24	24	11	5	4	3	

[a] Treatment means within column and rows followed by the same letter are not significantly different using LSD ($P \leq 0.05$).

Table 2. Ryegrass ground cover on April 19, 2013, as influenced by sugarcane harvest residue level and preemergence herbicides applied on November 2, 2012.

Sugarcane residue level tons/A	Herbicide						Average
	None	Atrazine	Prowl	Sencor	Comand + Direx	Velpar + Direx	
	--Ryegrass ground cover --						
0	78 a[a]	80 a	17 fgh	13 ghi	1 j	2 ij	32
4	60 bc	61 b	49 c	18 efg	13 ghi	11 g-j	35
8	34 d	30 d	26 def	11 g-j	7 g-j	6 hij	19
12	16 fgh	29 de	26 def	10 g-j	13 ghi	3 ij	16
Average	47	50	29	13	8	5	

[a] Treatment means within columns and rows followed by the same letter are not significantly different using LSD ($P \leq 0.05$).

Table 3. Sugarcane residue ground cover on April 19, 2013 as influenced by sugarcane harvest residue level and preemergence herbicides applied on November 2, 2012.

Sugarcane residue level tons/A	Herbicide						Average
	None	Atrazine	Prowl	Sencor	Command + Direx	Velpar + Direx	
	--Residue ground cover --						
0	4	2	5	5	5	6	4 c[a]
4	30	34	41	46	50	59	43 b
8	57	58	65	66	83	79	68 a
12	74	63	68	80	71	87	74 a
Average	41 cd[b]	39 d	45 bcd	49 bc	52 ab	58 a	

[a] Treatment means for sugarcane residue levels (averaged across herbicide treatments) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).
[b] Treatment means for herbicide treatments (averaged across sugarcane residue levels) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).

Table 4. Depth of sugarcane residue on April 19, 2013, as influenced by sugarcane harvest residue level and preemergence herbicides applied on November 2, 2012.

Sugarcane residue level tons/A	Herbicide						
	None	Atrazine	Prowl	Sencor	Command + Direx	Velpar + Direx	Average
	inches						
0	0	0	0	0	0	0	0 d[a]
4	0.8	1.3	0.9	0.5	0.8	0.6	0.8 c
8	1.8	2.2	2.2	1.6	2.0	1.8	1.9 b
12	2.2	1.8	2.4	2.6	2.4	2.2	2.2 a
Average	1.2 a[b]	1.3 a	1.4 a	1.2 a	1.3 a	1.2 a	

[a] Treatment means for sugarcane residue levels (averaged across herbicide treatments) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).
[b] Treatment means for herbicide treatments (averaged across sugarcane residue levels) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).

Table 5. Sugarcane shoot population on April 19, 2013, as influenced by sugarcane harvest residue level and preemergence herbicides applied on November 2, 2012.

Sugarcane residue level tons/A	Herbicide						
	None	Atrazine	Prowl	Sencor	Command + Direx	Velpar + Direx	Average
	no./10 feet						
0	18	20	26	27	38	30	26 a[a]
4	9	27	16	26	33	33	24 a
8	15	17	18	17	50	41	26 a
12	29	19	28	25	33	38	29 a
Average	17 c[b]	21 c	22 c	24 bc	39 a	35 ab	

[a] Treatment means for sugarcane residue levels (averaged across herbicide treatments) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).
[b] Treatment means for herbicide treatments (averaged across sugarcane residue levels) followed by the same letter are not significantly different using LSD ($P \leq 0.05$).