BILLET PLANTING RESEARCH

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Research continued to develop methods to maximize the chances of success with billet (stalk section) planting. During 2021, results were obtained from field experiments conducted at the Sugar Research Station at St. Gabriel and from one commercial farm evaluating the potential for seed-treatment pesticides to improve stand establishment and yield in billet plantings. In addition, a greenhouse experiment was conducted to evaluate the effect of pesticide treatments showing promise in the field on disease symptom severity and an experiment was conducted to compare gene expression in sugarcane plants inoculated with the red rot pathogen, *Colletotrichum falcatum*, and treated with the insecticide, thiamethoxam with and without inoculation.

Seed-Treatment Pesticide Experiments at the Sugar Research Station

Billet pesticide treatments continued to be evaluated in small field experiments to determine whether they can increase yields obtained from billet plantings in Louisiana. Results were obtained from on-going and newly established experiments comparing treatments and application methods. In all experiments, billets 20-22 inches in length were cut with a mechanical harvester and run through a mechanical drum planter to provide planting material similar to what would be planted on commercial farms.

In one field experiment at the Sugar Research Station in first ratoon during 2021, multiple seed-treatment pesticides applied as a dip treatment to billets at planting were compared to non-treated billets and whole stalks. The treatments were: Topguard Terra fungicide (flutriafol 42%, FMC) at 7 oz/acre, Topguard Terra + Prevathon insecticide (chlorantraniliprole 5%, FMC) at 20 oz/acre, Topguard Terra + Prevathon at 28 oz/acre, Topguard Terra + Platinum insecticide (thiamethoxam 75% granular, Syngenta) at 5.7 oz/acre, Quilt Xcel fungicide (azoxystrobin 13.6% and propiconazole 11.7%, Syngenta) at 20 oz/acre + Platinum 75 SG, and ET-F fungicide (copper sulfate 19.8%, Earth Sciences Laboratories) at 20 oz/acre. The yield differences detected in plant cane were no longer evident in first ratoon, and there were no differences among treatments for tons of cane and total sucrose yield (Table 1).

A plant cane experiment was conducted comparing HoCP 96-540 non-treated billets and whole stalks to billets dip-treated with the following treatments: Topguard Terra fungicide at 7 oz/acre, Topguard Terra + Platinum 75 SG insecticide at 5.7 oz/acre, Priaxor Xemium fungicide (fluxapyroxad 14.33%, pyraclostrobin 28.58%, BASF) 7.5 oz/acre, Priaxor + Platinum, Quilt Xcel fungicide at 20 oz/acre + Platinum, Trivapro fungicide (benzovindiflupyr 2.9%, azoxystrobin 10.5%, propiconazole 11.9%, Syngenta) 13.7 oz/acre + Platinum, Trivapro 20 oz/acre + Platinum, Revytek fungicide (mefentrifluconazole 11.61%, pyraclostrobin 15.49%, fluxapyroxad 7.74%, BASF) 15 oz/acre, Revytek + Plantinum, Veltyma fungicide (mefentrifluconazole 17.56% and pyraclostrobin 17.56 %, BASF) 10 oz/acre, and Veltyma + Platinum. The experiment was planted 9/09/2020 and harvested 12/09/2021.

Table 1. Comparison of 2020 plant cane and 2021 first ratoon cane and total sugar yields obtained from plantings of non-treated billets and whole stalks and billets dip-treated with seed-treatment pesticides in a field experiment conducted at the Sugar Research Station

Treatment	Plant cane[1]		First ratoon[1]	
	Cane (tons/acre)	Sugar (lbs/acre)	Cane (tons/acre)	Sugar (lbs/acre)
Non-treated billets	41.2 ab	8,318 ab	29.7	6,691
Whole stalks	37.0 b	7,734 b	28.7	6,447
Topguard Terra 7 oz	38.5 ab	8,103 ab	24.8	5,584
Topguard Terra + Prevathon 20 oz	39.5 ab	8,432 ab	26.4	5,919
Topguard Terra + Prevathon 28 oz	44.8 a	9,388 a	29.5	6,710
Topguard Terra + Platinum 5.7 oz	44.8 a	8,621 ab	30.0	6,809
Quilt Xcel + Platinum	42.2 ab	9,564 a	31.2	7,036
ET-F 20 oz	36.7 b	7,856 b	30.4	6,764

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).

Stand establishment following planting was improved by three treatments as indicated by higher primary shoot counts for Quilt Xcel + Platinum, Priaxor + Platinum, and Revytek + Platinum compared to non-treated billets (Table 2). The millable stalk population was higher for the same three treatments and for the Veltyma + Platinum treatment compared to non-treated billets (Table 2). The initial stand and millable stalk population were not significantly different for non-treated billets and the whole stalk planting.

Effects of treatments were variable among the different plant cane yield components. The Revytek + Platinum treatment that had the highest stalk population had a lower stalk weight than Topguard 7 oz and Veltyma applied alone (Table 3). No treatment had a higher stalk weight than non-treated billets. No differences were detected among treatments for stalk sugar content/commercially recoverable sugar (CRS) (Table 3). Tons of cane was higher for Topguard + Platinum compared to four treatments, Priaxor, Topguard 7 oz, Veltyma, and Trivapro 20 oz + Platinum, but no pesticide treatment had more tons of cane than non-treated billets (Table 3). Total sugar per acre yield was higher for whole stalks, Platinum alone, Revytek + Platinum, and Topguard + Platinum compared to Priaxor and Topguard 7 oz, but again, no pesticide treatment had higher yield than non-treated billets (Table 3). The results were similar to previous experiments in which beneficial effects from fungicide and insecticide treatments alone have been erratic with the most consistent benefits being obtained from fungicide + Platinum treatments.

Table 2. Primary and millable stalk populations in plant cane for non-treated billets and whole stalks compared to billets dip-treated with seed-treatment pesticides in a field experiment conducted at the Sugar Research Station during 2021

Treatment	Primary shoots per acre[1]	Millable stalks per acre[1]
Non-treated billets	6,570 cd	21,556 de
Whole stalks	7,735 abcd	25,602 bcde
Topguard Terra 7 oz	8,092 abc	24,825 bcde
Topguard Terra 7 oz + Platinum 5.7 oz	8,092 abc	27,252 abcd
Quilt Xcel + Platinum	8,901 ab	39,295 ab
Priaxor 7.5 oz	6,150 d	18,417 e
Priaxor + Platinum	8,609 ab	29,032 abc
Trivapro 13.7 oz + Platinum	7,994 abc	26,540 abcd
Trivapro 20 oz + Platinum	7,833 abcd	25,925 abcd
Platinum	7,282 bcd	24,760 bcde
Revytek 15 oz	6,829 cd	22,430 cde
Revytek + Platinum	9,321 a	33,143 a
Veltyma 10 oz	7,444 bcd	23,983 bcde
Veltyma + Platinum	8,221 abc	29,291 abc

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).

Table 3. Plant cane yield components for HoCP 96-540 billets planted non-treated or treated with different combinations of seed-treatment pesticides applied as a dip and non-treated whole stalks in a field experiment at the Sugar Research Station during 2021

Treatment	Stalk weight (lbs) [1]	CRS (lbs) [1]	Tons cane per acre[1]	Sugar per acre (lbs) [1]
Non-treated billets	2.36 ab	221	36.4 abcd	8,060 abc
Whole stalks	2.36 ab	221	41.9 ab	9,279 a
Platinum 5.7 oz	2.30 ab	221	41.5 ab	9,165 a
Priaxor 7.5 oz	2.30 ab	216	32.8 cd	7,064 bc
Priaxor + Platinum	2.25 ab	220	39.8 abc	8,728 abc
Quilt Xcel 21 oz + Platinum	2.49 ab	220	39.5 abcd	8,698 abc
Revytek 15 oz	2.53 ab	217	37.1 abcd	8,093 abc
Revytek + Platinum	2.13 b	221	42.1 ab	9,334 a
Topguard 7 oz	2.60 a	217	32.0 d	6,958 c
Topguard + Platinum	2.55 ab	215	43.4 a	9,348 a
Trivapro 13.7 oz + Platinum	2.29 ab	223	39.6 abc	8,833 ab
Trivapro 20 oz + Platinum	2.30 ab	226	35.3 bcd	7,977 abc
Veltyma 10 oz	2.60 a	218	35.6 bcd	7,777 abc
Veltyma + Platinum	2.38 ab	220	39.4 abcd	8,671 abc

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).

Seed-Treatment Pesticide Experiment on a Commercial Farm

One experiment was conducted on a commercial farm in Avoyelles Parish to evaluate the ability of seed-treatment pesticides to improve billet planting stand establishment and yield. Platinum insecticide (5.7 oz/acre) applied singly and in combination with Quilt Excel fungicide (20 oz/acre) was compared to non-treated billets. Quilt Xcel was applied with a Traube mechanical planter that has a bath in the front of the planter at the base of the elevator, and Platinum was applied by spraying on top of the billets in the planting furrow just prior to covering. The variety planted in the test was L 01-299. The experiment was planted with three, 3-entire-row replicates on 10/05/2020 and harvested on 12/12/2021.

Platinum applied alone and in combination with Quilt Xcel both increased the number of primary shoots emerging after planting and millable stalk counts (Table 4). At harvest, cane yield was 4.3 tons higher in the insecticide/fungicide combination and pounds of sugar per acre was 790 lbs higher than for non-treated billets, but these increases were not significant (Table 5). Platinum applied alone did not increase cane and sugar yields, and theoretically recoverable sugar (TRS) was similar for all three treatments (Table 5).

Table 4. Effect of Platinum + Quilt Xcel and Platinum alone treatments on primary shoot population following planting and millable stalk population in an on-farm test in Avoyelles Parish during 2021

Treatment	Primary shoot population/acre[1]	Millable stalk population/acre[1]
Non-treated billets	24,643 b	47,065 b
Platinum (5.7 oz) + Quilt Xcel (20 oz)	31,000 a	51,777 a
Platinum (5.7 oz)	29,500 a	52,079 a

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).

Table 5. Effects of Platinum + Quilt Xcel and Platinum treatment on plant cane yield of L 01-299 billets planted in on-farm test in Avoyelles Parish during 2021.

Treatment	TRS (lbs)	Tons cane/acre	Sugar/acre (lbs)
Non-treated billets	192	39.4	7,430
Platinum (5.7 oz) + Quilt Xcel (20 oz)	190	43.7	8,220
Platinum (5.7 oz)	186	40.3	7,599

Results from the seed-treatment pesticide field experiments with billets continue to be promising. New chemicals continue to be evaluated. The results continue to suggest that applications of single pesticides have erratic effects on billet planting performance, whereas a combination of any one of multiple fungicides and insecticide have the most beneficial effect. Most of the results from small plot experiments conducted at the Sugar Research Station have been obtained with dip application of the chemicals. In experiments comparing dip application to a spray application over the top of billets before covering, spray application does not provide the benefit obtained from dip application. Dip application may be more difficult to achieve on a commercial basis. The positive on-farm test results from a third season with a different type of mechanical billet planter suggest that applications made using commercial planters can achieve the complete, thorough coverage needed to obtain the yield potential protection potentially provided by the fungicide/insecticide combination.

The improvements in stand establishment and yield obtained from treatment have been greater in seasons when billet plantings have been exposed to environmental stress after planting. Planted billets suffer more than whole stalks when any type of problem occurs, and this fact has made shifting from whole stalk to billet planting difficult in Louisiana, even though multiple factors are pushing the industry to change to billet planting. The small plot experiment results raise the question of whether the treatment will only be an insurance policy that will be of benefit only in seasons when problems are encountered. The results from the Avoyelles Parish on-farm experiment were encouraging because the planter/coverage tool combination treatment provided a positive economic return on investment when no severe environmental stress occurred following planting. This is the third consecutive season that the combination treatment has increased yield in an on-farm test.

Experiments to Evaluate Pesticide Treatment Effects on Stalk Rot Symptom Severity and Plant Gene Expression

A greenhouse experiment was repeated during 2021 with three-node billets of HoCP 96-540 to determine the effects of dip application of Quilt Xcel fungicide (20 oz/acre rate), Platinum insecticide (5.7 oz/acre rate), or a combination of fungicide and insecticide compared to no treatment on bud germination, plant growth, and stalk rot symptom development. Billets receiving the different treatments were planted in non-sterile sugarcane field soil with natural inoculum; billets were planted in steamed soil following removal of leaf sheaths, surface sterilization with bleach, and inoculation with the red rot pathogen; and surface sterilized billets were planted in steamed soil. The inoculated billets were surface sterilized by dipping in 10% commercial bleach for 5 minutes. All billets had a hole drilled in one internode and then some were inoculated by introducing spores of the pathogen. Billets were planted in trays with three per tray, placed in the greenhouse and allowed to germinate and grow for 6 weeks. Billets were then washed free of soil, plant root and shoot growth were measured, the billets were split, and red rot symptoms were assessed. Disease severity was assessed as whether stalk rot symptoms passed across the node, whether nodes exhibited rot, and the amount of internode tissue exhibiting rot symptoms in the drilled/inoculated internode and the second adjacent internode.

Differences were detected among treatments applied to surface sterilized billets planted in steamed soil with and without inoculation with *C. falcatum* (Table 6). Stalk rot symptoms were not detected for any chemical treatment applied to non-inoculated billets, except insecticide treated billets had a slight amount of internode discoloration. For inoculated billets, the non-treated and insecticide treated billets had more extensive rotting of the inoculated internode, the fungicide treated billets had less, and billets receiving the combination treatment had the least. For the adjacent internode, the combination treatment had less rot than all three other treatments of inoculated billets. The number of nodes passed by disease symptoms was lower for the combination treatment compared to the others (Table 6). The number of nodes rotted was reduced by all three chemical treatments and the number rotted was further reduced in the combination treatment compared to the insecticide treatment to a level that was similar to non-inoculated billets.

Table 6. Effects of billet pesticide treatments on stalk rot symptoms in steamed soil with and without inoculation with *Colletotrichum falcatum*.[1]

Inoculation[2]	Treatment[3]	Node passed[4]	Nodes rotted[4]	Inoculated internode rating[4]	Non-inoculated internode rating[4]
-	None	0.00 c	0.00 d	0.73 de	0.00 b
-	Insecticide	0.07 c	0.13 cd	1.00 d	0.07 b
-	Fungicides	0.00 c	0.07 d	0.13 e	0.00 b
-	Combination	0.00 c	0.00 d	0.60 de	0.00 b
+	None	0.80 a	1.40 a	5.60 a	1.13 a
+	Insecticide	0.73 a	0.73 b	5.20 a	1.00 a
+	Fungicides	0.67 a	0.47 bc	3.87 b	1.20 a
+	Combination	0.13 b	0.13 cd	2.06 c	0.13 b

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).
[2]Billets were inoculated by placing spores of the pathogen into a hole drilled in one of two internodes. Non-inoculated billets had a hole drilled in one of two internodes with no spores added.
[3]Treatments included a non-inoculated control and billets dipped in solutions containing insecticide (thiamethoxam), two fungicides (azoxystrobin and propiconazole), or a combination of insecticide and fungicides.
[4]Disease traits assessed included whether rot symptoms passed across the node from the inoculated internode into the adjacent internode, whether any of the three nodes exhibited rotting, and the extent of rotting of internode tissue in the inoculated and adjacent internodes using a 1-6 rating scale in which 1 ≤ 10%, 2 = 11 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, 5 = 76 to 90%, and 6 = greater than 90%.

Shoot number and weight were not affected by any chemical treatment applied to non-inoculated billets in steamed soil (Table 7). Shoot number was higher for all three chemical treatments of inoculated billets compared to non-treated, inoculated billets, and shoot weight was lower for the non-treated compared to the fungicide treatment. However, shoot height was lower for the non-treated, non-inoculated billets treated with fungicide and the fungicide/insecticide combination and for all treatments of inoculated billets compared to the non-treated, non-inoculated control. In contrast, root weight was higher for the fungicide treated compared to insecticide treated non-inoculated billets, while the insecticide treatment of inoculated billets had higher root weight than the non-treated, inoculated treatment.

Table 7. Effects of billet pesticide treatments on plant growth in steamed soil with and without inoculation with *Colletotrichum falcatum*.[1]

Inoculation[2]	Treatment[3]	Shoot height (cm)	Shoot no.	Shoot weight (g)	Root weight (g)
-	None	8.2 a	2.7 a	6.6 a	3.6 bc
-	Insecticide	8.0 ab	2.6 a	6.5 a	3.4 c
-	Fungicides	7.2 bc	2.9 a	6.8 a	4.9 ab
-	Combination	7.0 cd	2.9 a	7.1 a	4.2 abc
+	None	6.0 d	2.1 b	5.1 b	3.4 c
+	Insecticide	6.5 cd	2.9 a	6.0 ab	5.2 a
+	Fungicides	7.0 cd	2.9 a	7.1 a	4.7 abc
+	Combination	6.9 cd	2.8 a	6.4 ab	4.2 abc

[1]Mean values within a column followed by the same letter were not significantly different ($P>0.05$).
[2]Billets were inoculated by placing spores of the pathogen into a hole drilled in one of two internodes. Non-inoculated billets had a hole drilled in one of two internodes with no spores added.
[3]Treatments included a non-inoculated control and billets dipped in solutions containing insecticide (thiamethoxam), two fungicides (azoxystrobin and propiconazole), or a combination of insecticide and fungicides.

Differences were detected among treatments applied to billets planted in non-sterile soil with natural inoculum (Table 8). Rot symptoms in the wounded internode were greatest in the insecticide treatment followed by the non-treated billets and were least in the fungicide and combination treatments. The adjacent internode exhibited more rot symptoms in the insecticide treatment and correspondingly had the most passage of rot across the node. The fungicide and combination treated billets had reduced node rot compared to non-treated billets and the insecticide treatment. As for the inoculated billets, the fungicide and combination treatments reduced disease severity measured as multiple traits while the insecticide applied alone did not. However, the effects of fungicides and the combination with insecticide were similar in non-sterile soil, whereas the combination treatment had the lowest disease severity with inoculated billets.

Overall, the results suggest that the effects of pesticide treatments on plant growth were minor and mostly not significant at 6 weeks after planting in the greenhouse. When stalk rot was developing, shoot number was increased by the fungicide and combination treatments similar to what is observed in the field. Treatment effects on disease symptom severity were evident. The fungicide and fungicide/insecticide combination treatments reduced stalk rot symptom severity while treatment with insecticide alone did not. Treatment with the combination resulted in greater reductions in symptom severity than fungicide treatment alone in inoculated billets.

Table 8. Effects of billet pesticide treatments on stalk rot symptoms in steamed soil and non-sterile sugarcane field soil.[1]

Soil type[2]	Treatment[3]	Node passed[4]	Nodes rotted[4]	Wounded internode rating[4]	Not wounded internode rating[4]
Steamed	None	0.00 b	0.00 b	0.73 cd	0.00 b
Steamed	Insecticide	0.07 b	0.13 b	1.00 c	0.07 b
Steamed	Fungicides	0.00 b	0.07 b	0.13 d	0.00 b
Steamed	Combination	0.00 b	0.00 b	0.60 cd	0.00 b
Non-sterile	None	0.13 ab	0.60 a	3.13 b	0.20 b
Non-sterile	Insecticide	0.27 a	0.80 a	5.73 a	0.87 a
Non-sterile	Fungicides	0.00 b	0.00 b	1.00 c	0.00 b
Non-sterile	Combination	0.00 b	0.00 b	0.87 cd	0.00 b

[1]Mean values within a column followed by the same letter were not significantly different (P>0.05).
[2]Soil type included steamed and nonsterile sugarcane field soil.
[3]Treatments included a non-inoculated control and billets dipped in solutions containing insecticide (thiamethoxam), two fungicides (azoxystrobin and propiconazole), or a combination of insecticide and fungicides.
[4]Disease traits assessed included whether rot symptoms passed across the node from the wounded internode into the adjacent internode, whether any of the three nodes exhibited rotting, and the extent of rotting of internode tissue in the wounded and adjacent internodes using a 1-6 rating scale in which 1 ≤ 10%, 2 = 11 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, 5 = 76 to 90%, and 6 = greater than 90%.

Shoot height and root weight were not affected by any pesticide treatment for billets in non-sterile soil with natural inoculum (Table 9). Shoot weight was lower for insecticide treated billets compared to the fungicide and combination treatments. Shoot number that would affect stand establishment in the field was improved by the fungicide and combination treatments.

An experiment is in progress to evaluate the effects of *C. falcatum* infection and treatment with the systemic insecticide, thiamethoxam (Platinum), on gene expression in plants of a red rot susceptible variety, HoCP 96-540, to determine if this insecticide induces systemic resistance and affects the plant response to infection. The experiment will determine the responses of sugarcane plants to three treatments: response to infection of the stalk tissues by the pathogen and response to treatment with the systemic insecticide with and without inoculation with the pathogen. All plants (two-node stalk cuttings) had a hole drilled into the internode, and some were inoculated by placing conidia of the pathogen inside. Plant tissue samples, consisting of internode tissue and bud/shoot and root tissue once developed, were collected from non-inoculated, non-treated plants; inoculated, non-treated plants; and inoculated, treated plants. Samples were collected before planting, 1 week after planting, and 4 weeks after planting. Total RNA was extracted, and RNA sequence analysis was performed, and sequence data was obtained. The sequence data is being analyzed to determine and compare gene expression in the different treatments to determine if thiamethoxam induces systemic resistance responses. This research is being conducted in cooperation with Dr. Jon Richards.

Table 9. Effects of billet pesticide treatments on plant growth in steamed soil and non-sterile sugarcane field soil.[1]

Soil type[2]	Treatment[3]	Shoot height (cm)	Shoot no.	Shoot weight (g)	Root weight (g)
Steamed	None	8.2 a	2.7 ab	6.6 a	3.6 b
Steamed	Insecticide	8.1 a	2.6 abc	6.5 a	3.4 b
Steamed	Fungicides	7.2 b	2.9 a	6.8 a	4.9 a
Steamed	Combination	7.0 b	2.9 a	7.1 a	3.8 b
Non-sterile	None	5.7 c	2.3 c	2.9 bc	1.7 c
Non-sterile	Insecticide	5.2 c	2.4 bc	2.4 c	1.6 c
Non-sterile	Fungicides	5.0 c	2.9 a	3.4 b	2.0 c
Non-sterile	Combination	5.4 c	2.7 ab	3.4 b	2.0 c

[1]Mean values within a column followed by the same letter were not significantly different ($P>0.05$).

[2]Soil type included steamed and non-sterile sugarcane field soil.

[3]Treatments included a non-inoculated control and billets dipped in solutions containing insecticide (thiamethoxam), two fungicides (azoxystrobin and propiconazole), or a combination of insecticide and fungicides.