PATHOLOGY RESEARCH

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Pathology research addresses the important diseases affecting sugarcane in Louisiana. The overall program goal is to minimize losses to diseases in a cost-effective manner. Projects receiving emphasis during 2007 included: evaluating the feasibility of brown rust management with fungicides, ratoon stunting disease (RSD) management, assessing the threat posed by yellow leaf and control measures, evaluating disease resistance in the variety selection program, and billet planting. Research results on billet planting are reported separately.

BROWN RUST

Results were obtained during 2007 from three field experiments comparing the efficacy of different fungicide treatments for control of brown rust of sugarcane caused by *Puccinia melanocephala.* Experiments were conducted on commercial farms. Multiple triazole and strobilurin fungicides were compared singly and in different combinations in experiment one with treatments initiated at the beginning of the spring epidemic. In experiment two, fungicides from BASF and Bayer chemical companies were compared with treatments initiated at the beginning of the spring epidemic, and three fungicide treatments applied once during June after the brown rust epidemic was in progress were compared in experiment three.

All fungicides were applied using a CO_2 back-pack sprayer with an adjustable height, two-row boom with three nozzles per row on a 36 inch band with a 15 gallon per acre spray volume. The effect of treatments on rust severity was determined by image analysis using detached leaves. Data was then collected to determine the effect of treatments on yield. Yield components compared included harvestable stalk population, stalk weight, stalk sucrose content, cane tonnage, and total sucrose produced.

In experiment one, multiple triazole and strobilurin fungicides were evaluated singly and in combination in naturally infected plantcane of variety Ho 95-988. Fourteen fungicide products were applied in 20 treatments (Table 1) compared to a non-treated control. Two applications were made for each treatment with a 21 day interval between treatments. Application dates were 18 and 19 May for application one and 8 and 9 June for the second application.

Rust symptom severity was assessed twice, once at 19-20 days after the first fungicide application (just prior to the second application) and again at 13-14 days after the second application (Table 1). Disease severity was assessed by collecting six leaves per plot and performing image analysis to determine the percentage of leaf area occupied by rust lesions. The experiment was harvested on 5 December.

In experiment two, the efficacy of fungicides available from BASF and Bayer chemical companies was compared for the control of brown rust in naturally infected plantcane of variety LCP 85-384. Eight fungicides were applied in 12 treatments (Table 2) on two dates with a 17 day application interval. Application dates were 27 April and 14 May. The experiment was harvested on 20 December.

Rust symptom severity was assessed twice, once at 20 days after the first fungicide application (just prior to the second application) and again at 30 days after the second application (Table 2). Disease severity was assessed by collecting six leaves per plot and performing image analysis to determine the percentage of leaf area occupied by rust lesions.

In experiment three, three fungicide treatments, Headline alone, Headline + Caramba, and Stratego were applied once to plantcane of variety LCP 85-384 after brown rust was already well established to determine if a late application would have any benefit. The fungicides were applied on 28 June. No disease assessment was performed. Only yield results were determined. The experiment was harvested on 29 November.

Results and Discussion

Experiment 1. The disease assessment performed following the first fungicide application indicated that most treatments significantly reduced rust symptom severity (Table 1). The triazole fungicides were generally less effective than the triazole + strobilurin combinations. Headline (pyraclostrobin) alone was as effective as when combined with Caramba (metconazole) and Muscle (tebuconazole). At the second disease assessment, rust severity had not increased in the non-treated control, but more rust was evident in the treated plots (Table 1). The same pattern was evident in the treatment comparisons with the strobilurin + triazole combinations providing better rust control than the triazoles alone. The severity of the rust epidemic in this field would be characterized as moderate. The epidemic did not begin until mid-May, and symptom severity visible outside the field was moderate.

No fungicide treatment significantly increased yield compared to the non-treated control (Table 3). Some treatments provided numerical increases that would be economically significant to a farmer. The best treatment for tonnage increase (prothioconazole + trifloxystrobin pre-mix at 12 oz/A) increased yield by 4.1 tons/A (10%), and the best treatment for sucrose per acre increase (Headline at 9 oz/A) increased yield by 818 lbs/A (9%). A comparison of the differences in stalk population, stalk weight and stalk sucrose content suggested that the yield component contributing most to yield differences observed in this experiment was stalk population. Quilt at 14 oz/A was the only treatment that significantly increased stalk population.

Experiment 2. The disease assessment performed after the first application indicated that all of the fungicide treatments reduced brown rust severity (Table 2). The statistical analysis did not distinguish all of the treatments. However, there was a consistent trend for less control with the triazoles than with the triazole + strobilurin combinations and Headline (pyraclostrobin) alone. The second disease assessment was performed after the expected window of protection from the treatments would have passed (Table 2), and disease pressure was continuing in the field. In this assessment, three of the four triazoles could not be distinguished from the non-treated control. The Absolute, Caramba, Headline alone, Proline, and prothioconazole + trifloxystrobin treatments were evaluated for the first time during 2007. These treatments were not superior to the Headline tank mixed with a triazole and Stratego treatments that were the best treatments during 2006. Headline alone was equally effective in suppressing rust compared to Headline mixed with a triazole. The rust epidemic in this test field was severe. It began in April and severe symptoms were visible outside the field through June.

Some fungicide treatments significantly increased yield (Table 4). All treatments produced yields numerically greater than the non-treated control. The three treatments containing Headline alone or Headline tank-mixed with a triazole fungicide significantly increased cane tonnage. Headline + Caramba increased yield by 10.2 tons (a 27% increase). The three Headline treatments and prothioconazole + trifloxystrobin at 12 oz/A significantly increased the yield of sucrose per acre. Headline + Caramba increased sucrose yield by 2,117 lbs/A (a 28% increase). The yield component contributing most to the cane tonnage and sucrose yield increases appeared to be stalk population, although stalk population increases were not significant.

A decision was made in consultation with the farmer to stop after two fungicide applications in this experiment. Brown rust was still active at that time, and the disease eventually became evident in the treated plots. It would have been interesting to compare two applications to three in this experiment. A severe epidemic will last longer than the period of protection provided by two applications. More research in needed to compare the benefits to be obtained from different numbers of applications of effective fungicides under severe epidemic conditions.

Experiment 3. None of the three fungicide treatments improved yield of LCP 85-384 when they were applied during late June after the brown rust was well established (Table 5). The chosen fungicide treatments were ones that had already demonstrated the ability to reduce rust severity and increase yield in previous experiments. The results suggest it is not beneficial to apply fungicide after an epidemic has begun. However, it is also possible that applications will not be beneficial during the summer. The application date, 28 June, was after the time when the heat of summer begins to reduce infection by brown rust. The potential benefit of treatment with an effective fungicide during the spring after an epidemic has already begun still needs to be evaluated.

Conclusions

The 2007 experiment results indicate that fungicide treatments have the potential to provide an economic alternative brown rust control measure in Louisiana. Yield loss experiments conducted from 2004-2006 demonstrated cane tonnage losses of 6-7 tons depending on how early during the spring the epidemic began. In the 2007 experimental field with a severe epidemic beginning in April, a yield increase of up to 10.2 tons of cane per acre was obtained with only two fungicide applications. Under severe epidemic conditions, it is apparent that effective fungicide treatments can greatly reduce rust severity and prevent severe loss from occurring. Using current estimates for chemical and treatment costs, the benefit needed to offset the total treatment costs would be a yield increase of at least one ton of cane per acre for each fungicide application.

In contrast, the results from Experiment 1 conducted under moderate epidemic conditions and the results from the single late June application in Experiment 3 suggest that there are situations when treatment benefits will not offset treatment costs. One confusing factor is that Experiment 1 was the first fungicide efficacy experiment conducted in the sugarcane variety Ho 95-988. Additional experiments are needed to evaluate fungicide efficacy in this and any other varieties that become susceptible to brown rust under severe epidemic conditions and evaluating fungicide treatment effects in later-starting, less severe rust epidemics.

RATOON STUNTING DISEASE

RSD testing was conducted by the Sugarcane Disease Detection Lab for the 10th year during 2006. RSD was monitored on farms, in the LSU AgCenter Variety Selection Program, in the American Sugar Cane League Variety Release Program, and in the Kleentek® and SugarTech® (Helena Chemical Co.) seedcane production systems (Table 6). A total of 1,538 samples were tested. No RSD was detected at any level of Kleentek production or in ASCL Variety Release Program samples. In on-farm RSD testing, 42 fields were sampled on 9 farms. RSD was not detected in any of the tested fields. In addition to RSD testing, nine varieties were processed through the Local Quarantine to provide healthy material to establish Foundation Stock plants that will serve as the source for tissue culture seedcane production.

YELLOW LEAF

The Sugarcane Disease Detection Lab also monitored for *Sugarcane yellow leaf virus* in the LSU AgCenter Variety Selection Program, the ASCL Variety Release Program, and SugarTech® and Kleentek® seedcane sources (Table 7). A total of 10,998 samples were tested. Commercial tissue culture seedcane sources were tested for the third season as part of the Louisiana Department of Agriculture Seedcane Certification Program. No field failed to certify due to virus infection.

A field experiment evaluating the effect of yellow leaf on yield of HoCP 96-540 was in first stubble during 2006 (Table 8). Cane tonnage was 14% lower in virus-infected compared to initially virus-free plots. This is similar to the 13% difference detected in plantcane.

VARIETY SELECTION

Disease resistance levels were evaluated as a routine part of the Variety Selection Program. Inoculated tests were conducted to determine resistance levels in experimental varieties to smut (Table 9) and leaf scald (Table 9). Visual ratings were used to evaluate resistance to brown rust in out-field yield trial plots.

Table 1. Effect of fungicide treatments on sugarcane brown rust severity in Ho 95-988 plantcane determined on 7 June and 22 June in an experiment in St. Mary Parish.

Fungicide treatment	Percent rust on June 7[x]	Percent rust on June 22[y]
Non-treated control	15.8 A	14.7 AB
Absolute (tebuconazole + trifloxystrobin premix), 5 oz/acre	5.3 EF	8.0 CDEFG
Absolute (tebuconazole + trifloxystrobin premix), 10 oz/acre	6.1 DEF	3.7 G
Caramba (metconazole), 9.6 oz/acre	6.8 CDE	10.7 ABCD
Domark (tetraconazole), 5 oz/acre	13.2 AB	12.4 ABC
Folicur (tebuconazole), 6 oz/acre	9.9 BCD	11.9 ABC
Headline (pyraclostrobin), 9 oz/acre	3.7 EF	4.6 FG
Headline (pyraclostrobin), 6 oz + Caramba (metconazole), 8 oz/acre	3.4 EF	4.6 FG
Headline (pyraclostrobin), 6 oz + Muscle (tebuconazole), 4 oz/acre	1.6 F	4.6 FG
Laredo (myclobutanil), 7 oz/acre	11.8 BC	13.3 AB
Laredo (myclobutanil) 7 oz/acre + Headline (pyraclostrobin) 6 oz/acre	4.1 EF	5.1 EFG
Proline (prothioconazole), 5.7 oz/acre	7.8 CDE	9.8 BCDE
Proline (prothioconazole), 8.6 oz/acre	7.3 CDE	9.8 BCDE
Punch (flusilazole), 4 oz/acre	11.0 BC	13.6 AB
Punch (flusilazole), 3 oz/acre + picoxystrobin, 6 oz/acre	6.1 DEF	8.4 CDEF
Quadris (azoxystrobin), 9 oz/acre	7.1 CDE	7.2 DEF
Quilt (azoxystrobin + propiconazole premix), 14 oz/acre	5.7 DEF	7.4 DEF
Stratego (propiconazole + trifloxystrobin premix), 19 oz/acre	3.4 EF	7.2 DEFG
Topguard (flutriafol), 4 oz/acre	13.9 AB	15.1 A
Prothioconazole + trifloxystrobin (premix), 6 oz/acre	5.7 DEF	9.2 BCDE
Prothioconazole + trifloxystrobin (premix), 12 oz/acre	5.8 DEF	6.8 DEFG

[x]Rust leaf infection percentage determined by image analysis on second youngest fully emerged leaf at 19-20 days after first application. Mean values within the column followed by the same letter were not significantly different (P=0.05).

[y]Rust leaf infection percentage determined by image analysis on fourth youngest fully emerged leaf at 13-14 days after second application. Mean values within the column followed by the same letter were not significantly different (P=0.05).

Table 2. Effect of fungicide treatments on sugarcane brown rust severity in LCP 85-384 plantcane determined on 17 May and 13 June in an experiment in Lafourche Parish.

Fungicide treatment	Percent rust on May 17[x]	Percent rust on June 13[y]
Non-treated control	17.5 A	26.5 A
Absolute (tebuconazole + trifloxystrobin premix), 5 oz/acre	4.0 CDEF	19.7 BC
Absolute (tebuconazole + trifloxystrobin premix), 10 oz/acre	3.2 DEF	19.5 BC
Proline (prothioconazole), 5.7 oz/acre	4.9 BCDE	15.7 CDE
Proline (prothioconazole), 8.6 oz/acre	5.6 BCD	16.1 CD
Prothioconazole + trifloxystrobin, 6 oz/acre	5.7 BCD	21.4 ABC
Prothioconazole + trifloxystrobin, 12 oz/acre	2.9 DEF	19.0 BCD
Folicur (tebuconazole), 6 oz/acre	6.6 BC	23.2 AB
Stratego (propiconazole + trifloxystrobin premix), 19 oz/acre	1.9 EF	13.3 DEF
Caramba (metconazole), 9.6 oz/acre	7.7 B	22.7 AB
Headline (pyraclostrobin), 9 oz/acre	1.3 F	9.4 FG
Headline, 6 oz + Caramba, 8 oz/acre	1.7 F	6.6 G
Headline, 6 oz + Muscle (tebuconazole), 4 oz/acre	1.7 F	10.1 EFG

[x]Rust leaf infection percentage determined by image analysis on second youngest fully emerged leaf at 20 days after treatment one and 3 days after treatment two. Mean values within the column followed by the same letter were not significantly different (P=0.05).
[y]Rust leaf infection percentage determined by image analysis on fourth youngest fully emerged leaf at 30 days after treatment two. Mean values within the column followed by the same letter were not significantly different (P=0.05).

Table 3. Effect of two fungicide treatments on sugarcane yield in brown rust affected field of Ho 95-988 plantcane in an experiment in St. Mary Parish during 2007.

Fungicide treatment	Harvestable stalks/acre (x1,000)	Stalk weight (lbs.)	Sucrose /ton cane (lbs.)	Tons of cane/acre	Sucrose/acre (lbs.)
Non-treated control	42.1 BC	1.7ABCD	219.5 AB	40.5ABCDE	8887ABCD
Absolute (tebuconazole + trifloxystrobin premix) 5 oz/acre	42.8 BC	1.8AB	220.9 AB	43.3ABC	9568A
Absolute (tebuconazole + trifloxystrobin premix) 10 oz/acre	43.8 AB	1.7ABCDE	218.2 AB	43.2ABC	9425AB
Caramba (metconazole) 9.6 oz/acre	43.0 BC	1.5CDE	221.4 AB	40.4BCDE	8938ABCD
Domark (tetraconazole) 5 oz/acre	42.9 BC	1.7ABCDE	226.1 AB	41.0ABCDE	9265AB
Folicur (tebuconazole) 6 oz/acre	42.0 BC	1.7ABCDE	197.3 C	37.5DE	7393E
Headline (pyraclostrobin) 9 oz/acre	44.7 AB	1.9A	224.6 AB	43.1ABC	9705A
Headline (pyraclostrobin) 6 oz/acre + Caramba (metconazole) 8 oz/acre	44.3 AB	1.7ABCDE	210.4 BC	41.5ABCDE	8743ABCD
Headline (pyraclostrobin) 6 oz/acre + Muscle (tebuconazole) 4 oz/acre	44.2 AB	1.8AB	218.5 AB	41.1ABCDE	8971ABCD
Laredo (myclobutanil) 7 oz/acre	43.8 AB	1.6ABCDE	218.2 AB	40.7ABCDE	8978ABCD
Laredo (myclobutanil) 5 oz/acre + Headline (pyraclostrobin) 6 oz/acre	43.9 AB	1.7ABCDE	215.0 AB	41.8ABCD	8985ABCD
Proline (prothioconazole) 5.7 oz/acre	44.0 AB	1.6BCDE	216.6 AB	38.4DE	8332BCDE
Proline (prothioconazole) 8.6 oz/acre	42.0 BC	1.5DE	210.7ABC	37.2E	7863DE
Punch (flusilazole) 4 oz/acre	42.8 BC	1.8ABC	216.6 AB	40.5ABCDE	8785ABCD
Punch (flusilazole) 3 oz/acre + picoxystrobin 6 oz/acre	44.3 AB	1.6ABCDE	221.9 AB	40.5ABCDE	8993ABCD
Quadris (azoxystrobin) 9 oz/acre	43.0 BC	1.5E	214.2 AB	37.6DE	8057CDE
Quilt (azoxystrobin + propiconazole premix) 14 oz/acre	45.9 A	1.6ABCDE	217.3 AB	43.8AB	9496AB
Stratetgo (propiconazole + trifloxystrobin premix) 19 oz/acre	42.6 BC	1.6ABCDE	226.5 A	40.7ABCDE	9203ABC
Topguard (flutriafol) 4 oz/acre	43.0 BC	1.7ABCDE	222.2 AB	38.9CDE	8688ABCD
Prothioconazole + trifloxystrobin (premix) 6 oz/acre	40.7 C	1.7ABCDE	216.9 AB	39.4BCDE	8536ABCDE
Prothioconazole + trifloxystrobin (premix) 12 oz/acre	44.8 AB	1.6ABCDE	214.9 AB	45.0A	9673A

Mean values within a column followed by the same letter were not significantly different (P=0.05).

Table 4. Effect of two fungicide treatments on sugarcane yield in brown rust affected field of LCP 85-384 plantcane in an experiment in Lafourche Parish during 2007.

Fungicide treatment	Harvestable stalks/acre (x1000)	Stalk weight (lbs.)	Sucrose/ton cane (lbs.)	Tons of cane/acre	Sucrose/acre (lbs.)
Non-treated control	48.6	1.73	201.6	37.9 A	7,611 C
Absolute (tebuconazole + trifloxystrobin premix) 5 oz/A	52.4	1.42	189.7	43.6 ABC	8,233 BC
Absolute (tebuconazole + trifloxystrobin premix) 10 oz/A	51.7	1.50	201.6	40.6 BC	8,201 BC
Folicur (tebuconazole) 6 oz/A	47.5	1.55	197.3	40.6 BC	7,979 BC
Headline (pyraclostrobin) 9 oz/A	53.5	1.62	195.7	45.3 AB	8,842 AB
Headline (pyraclostrobin) 6 oz/A + Caramba (metconazole) 8 oz/A	52.2	1.66	202.1	48.1 A	9,728 A
Headline (pyraclostrobin) 6 oz/A + Muscle (tebuconazole) 4 oz/A	54.1	1.62	204.2	47.l A	9,602 A
Proline (prothioconazole) 5.7 oz/A	49.9	1.50	202.1	43.3 ABC	8,732 ABC
Proline (prothioconazole) 8.6 oz/A	50.2	1.54	199.3	39.7 BC	7,902 BC
Prothioconazole + trifloxystrobin 6 oz/A	47.8	1.60	199.3	39.8 BC	7,937 BC
Prothioconazole + trifloxystrobin 12 oz/A	50.0	1.62	204.2	43.0 ABC	8,767 AB
Stratego (propiconazole + trifloxystrobin premix) 19 oz/acre	50.6	1.61	201.6	40.6 BC	8,190 BC

Mean values within a column followed by the same letter were not significantly different (P=0.05).

Table 5. Effect of one late fungicide treatment on sugarcane yield in a brown rust affected field of LCP 85-384 plantcane in an experiment in Avoyelles Parish during 2007.

Fungicide treatment	Harvestable stalks/acre (x1000)	Stalk weight (lbs.)	Sucrose/ton cane (lbs.)	Tons of cane/acre	Sucrose/acre (lbs.)
Non-treated control	53.2	1.61	202.2	42.9	8,679
Headline (pyraclostrobin) 9 oz/acre	55.6	1.59	204.7	44.1	9,068
Headline (pyraclostrobin) 6 oz/acre + Caramba (metconazole) 8 oz/acre	55.3	1.52	191.9	41.9	8,061
Stratetgo (propiconazole + trifloxystrobin premix) 19 oz/acre	53.6	1.41	204.9	37.7	7,753

Table 6. Sugarcane Disease Detection Lab - 2007 ratoon stunting disease testing summary.

Source	Location	No. of fields	No. of varieties	No. of stalks
La Growers	Statewide			
LSUAC	St. Gabriel & Iberia	-	0	0
Variety Release Program	1^o & 2^o Stations	-	0	735
SugarTech®	Foundation stock	-	9	46
Kleentek®	Foundation stock	-	9	69
Local Quarantine	LSUAC	-	9	21
Research & Procedure Testing	LSUAC	-	-	667
Totals		0		1,538

Table 7. Sugarcane Disease Detection Lab - 2007 yellow leaf disease testing summary.

Source	Location	No. of fields	No. of varieties	No. of samples
La Growers	Statewide			
LSUAC	St. Gabriel & Iberia	-	1	200
Sugartech®	Foundation stock	-	9	46
Sugartech®	Secondary increase farms	38	0	1477
Kleentek®	Foundation stock	-	17	511
Kleentek®	Secondary increase farms	174	0	6127
Local Quarantine	LSUAC	-	9	52
Research & Procedure Testing	LSUAC	-	-	3440
Totals		212		11,853

Table 8. Effect of *Sugarcane yellow leaf virus* infection on yield of HoCP 96-540 determined in a 3-year field experiment.

Crop year	ScYLV infection status	Stalk no. per acre (x1,000)	Stalk weight (lbs.)	Sucrose per ton of cane (lbs.)	Tons of cane per acre[a]	Sucrose per acre (lbs.)[a]
Plantcane	+	38.9	2.05	211	37.6 B	7,948 B
	-	40.8	2.25	211	43.1 A	9,087 A
First ratoon	+	45.7	1.69	214	38.1 B	8,183
	-	46.9	1.90	209	44.3 A	9,272
Second ratoon	+	49.5	1.57	178	41.6	7,402
	-	49.5	1.70	175	44.1	7,755

[a]Values within a column and crop year followed by a different letter were significantly different (P=0.05).

Table 9. Smut infection level and resistance ratings for experimental varieties determined from an inoculated test during 2007.

Variety	Infection (%)	Rating[x]	Variety	Infection (%)	Rating[x]
1965-357	8	4	2004-814	0	1
1973-351	13	5	2004-821	3	3
1979-1002	30	8	2004-824	0	1
1989-2143	0	1	2004-836	4	3
1995-988	10	4	2004-838	1	2
1996-540	0	1	2004-847	4	3
1997-128	28	7	2004-856	0	1
1999-226	14	5	2005-441	4	3
1999-233	15	5	2005-442	0	1
2000-950	0	1	2005-445	0	1
2000-961	34	8	2005-447	0	1
2001-12	10	4	2005-448	3	3
2001-283	0	1	2005-450	14	5
2001-299	45	9	2005-451	21	6
2002-623	13	5	2005-453	1	2
2003-371	1	2	2005-456	12	4
2003-743	2	2	2005-457	0	1
2004-408	4	3	2005-459	16	5
2004-425	0	1	2005-460	12	4
2004-434	5	3	2005-466	0	1
2004-803	0	1	2005-470	2	2
2004-809	0	1	2005-474	29	7
2004-810	0	1			

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

Table 10. Leaf scald resistance ratings for experimental varieties determined from an inoculated test during 2007.

Variety	Rating[x]	Variety	Rating[x]	Variety	Rating[x]
1965-357	5.5	2003-371	6.0	2005-441	5.5
1973-351	4.7	2003-743	5.5	2005-442	6.1
1979-1002	6.0	2004-408	5.9	2005-445	5.8
1989-2143	5.8	2004-425	5.8	2005-447	5.5
1995-988	5.5	2004-434	5.3	2005-448	6.6
1996-540	6.5	2004-803	6.2	2005-450	5.7
1997-128	5.3	2004-809	6.6	2005-451	5.3
1999-226	5.8	2004-810	5.7	2005-453	5.1
1999-233	5.2	2004-814	5.8	2005-456	6.0
2000-950	7.1	2004-821	6.1	2005-457	5.2
2000-961	6.8	2004-824	6.0	2005-459	5.4
2001-12	4.6	2004-836	5.0	2005-460	5.7
2001-283	5.9	2004-838	5.7	2005-466	6.1
2001-299	5.8	2004-847	6.0	2005-470	4.7
2002-623	5.4	2004-856	6.2	2005-474	5.9

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