EFFECTS OF VERTICILLIUM WILT AND BACTERIAL BLIGHT ON COMMERCIAL VARIETIES

Terry A. Wheeler
Jane Dever
Texas A&M AgriLife Research
Lubbock, TX

Abstract

Bacterial blight severity continues to decline in U.S. upland cotton acres because producers are planting more blight resistant varieties. DP 1646B2XF, which has partial resistance to bacterial blight is the most widely planted variety for upland cotton in the U.S. In our 2019 bacterial blight testing program, all new tested varieties or advanced lines from Phytogen were resistant to bacterial blight, 79% of Deltapine entries were resistant, 70% of BASF entries were resistant, 64% of Americot (NexGen) entries were resistant, and 50% of Winfield United (Croplan) entries were resistant to bacterial blight. Verticillium wilt was not a problem in 2019, due to the high temperatures in August and September. However, new varieties that developed higher wilt incidence and/or defoliation relative to resistant check varieties included: Croplan (CP) 9068B3XF, CP 9178B3XF, DP 1835B3XF, DP 1845B3XF, DP 1851B3XF, DP 1909XF, DP 1908B3XF, DP 1916B3XF, DP 1948B3XF, NG 2982B3XF and NG 3994B3XF. If these varieties are highly susceptible to Verticillium wilt, it will need to be confirmed in a year where Verticillium wilt causes yield reduction.

Introduction

Cotton is the most widely planted crop in the Southern High Plains of Texas. The climate is semi-arid, with an average of 18 inches of rain annually. Rain events, though sporadic can be violent with hail and strong winds in the spring and summer. This type of weather is ideal for spreading the bacterial blight pathogen (*Xanthomonas citri* subsp. *malvacearum*) across fields. The dry winter climate facilitates survival of this bacteria in plant debris. Losses to bacterial blight in cotton >400 lbs. of lint/acre have been found. Blight resistant varieties are the most effective method of reducing losses to bacterial blight of cotton. Fortunately, most cotton seed companies consider this trait important to include in their newer varieties. An inoculated blight screening program was initiated in 2000 and has been continued every year since then in Lubbock.

Verticillium wilt is another disease of cotton that can be very important to the Southern High Plains of Texas. This disease can cause significant yield losses in those years where the air temperature decreases, and rainfall increases in August and early September. Early season weather does not appear to have much impact on subsequent wilt incidence or severity. The fungus, *Verticillium dahliae*, is distributed widely across the region, and is particularly damaging in fields with adequate irrigation, or when weather is highly conducive for the disease. The most popular methods of limiting yield loss is to plant varieties that are tolerant or possibly partially resistant to Verticillium wilt. Small plot variety trials have been planted annually since 2005 in Verticillium wilt fields to provide cotton producers with information on this disease.

Materials and Methods

Bacterial blight

There were two inoculated trials. In trial 1, plots were two-rows wide, 36 feet long, and contained 40 entries, arranged in a randomized complete block design (RCBD) with four replications. In trial 2, plots were one row wide, 36 feet long, with 21 entries arranged in a RCBD and three replications. The bacteria isolates (numbers 388 and 465) were put in trypticase soy broth and shaken at room temperature (approximately 78°F) for 1½ days. Then 1800 ml of this solution was mixed into a 50-gallons of water that also included the product Silwet L-77 (0.2% v/v) and applied to the trial at 50 gallons/acre. Trial 1 was treated on 16 August and rated on 2 September, while trial 2 was treated on 17 July and rated on 1 August. Rating consisted of taking 15 paces through the plot and rating plants at each pace, and then calculating the incidence of bacterial blight symptoms.

Verticillium wilt

Test sites were in Floyd, Hale, and Hockley counties, in fields with a history of Verticillium wilt. Plots were 2-rows wide, 36 feet long, on 40-inch centers. Seeds were planted at a rate of 4 seed/ft row. The entries consisted of commercial varieties or advanced breeding lines from Croplan, Deltapine, Dynagro, Fibermax, NexGen, Phytogen,

and Stoneville brands. There were 36, 40, and 40 entries at the Floyd, Hale, and Hockley county sites, respectively, arranged in a randomized complete block design with four replications. Data collected included plant stand in both rows, incidence of plants with Verticillium wilt symptoms during the last week of August, defoliation percent during the middle of September, and in the case of Floyd county, defoliation percent during early October. Plots were harvested with a 2-row John Deere cotton stripper, and 1000 g samples were taken from harvested plots, and ginned to determine lint turnout. Lint was HVI tested at the Texas Tech Fiber and Biopolymer Center and loan values were calculated for each variety.

Results and Discussion

Bacterial blight

Disease was adequate in 2019. Air temperature was hot, and no rain occurred, so once leaves expressed symptoms, they defoliated, and no new leaves developed symptoms. Blight resistant varieties from Deltapine were DP 2012B3XF, DP 2020B3XF, DP 2022B3XF, DP 2044B3XF (Table 1). Blight resistant varieties from Americot included NG 2982B3XF, NG 3930B3XF, NG 3956B3XF, NG 4777B2XF, NG 4792XF, and NG 4098B3XF. Blight resistant varieties from Phytogen included PHY 210W3FE, PHY 250W3FE, PHY 320W3FE, PHY 350W3FE, PHY 400W3FE, PHY 500W3FE, and PHY 580W3FE. Blight resistant varieties from BASF included FM 1621GL, FM 2202GL, FM 2398GLTP, FM 2498GLT, FM 2574GLT, and ST 5707B2XF. Blight resistant varieties from Croplan included CP9598B3XF, CP 9210B3XF, and CP 9830B3XF.

Verticillium wilt

There was insufficient disease in 2019 to have much impact on yield. The high temperatures in August and through the middle of September suppressed wilt development. So, it was not possible to identify Verticillium wilt resistant cultivars, but it was possible to identify some of the more susceptible cultivars through wilt incidence and/or defoliation symptoms. At the Floyd county site there was little disease development at the normal times for rating disease. However, a later defoliation rating was performed (9 October), which did identify some susceptible cultivars. Varieties with high defoliation ratings included CP 9178B3XF (80%), DP 1612B2XF (69%), DP 1909XF (66%), DP 1835B3XF (65%), and DP 1916B3XF (62%) (Table 2). The resistant check, FM 2334GLT, had 13% defoliation. At the Hale county site, varieties with the highest wilt incidence included DP 1908B3XF (14%), DP 1909XF (13%), and CP 9608B3XF (11%) (Table 3). The check variety averaged 1% wilt incidence at this site. At the Hockley county site, defoliation was most severe on DP 1612B2XF (23%), DP 1916B3XF (20%). NG 2982B3XF (20%), NG 3994B3XF (20%), ST 4550GLTP (17%), DP 1851B3XF (15%), and DP 1835B3XF (15%) (Table 4). The resistant check averaged 5% defoliation. It will be important to screen these new varieties in a year with more Verticillium wilt symptom development, and when the yield is affected by the disease. However, for now, the more susceptible varieties are not recommended in Verticillium wilt fields.

Table 1. Bacterial blight ratings for cultivars in 2019.

Variety (Test 1)[1]	% Blight	Variety (Test 2)	%Blight
BX 2005	0 h[2]	CP 9830B3XF	0 c
DP 2012B3XF	0 h	CP 9210B3XF	0 c
DP 2020B3XF	0 h	PX5E28W3FE	0 c
DP 2044B3XF	0 h	PX5E34W3FE	0 c
NG 2982B3XF	0 h	DP 1908B3XF	0 c
NG 3930B3XF	0 h	PX5C05W3FE	0 c
NG 4777B2XF	0 h	DP 1909XF	0 c
PHY 210W3FE	0 h	CP 9598B3XF	0 c
PX2C14W3FE	0 h	DP 1845B3XF	0 c
PX3D32W3FE	0 h	PHY 580W3FE	0 c
NG 4098B3XF	1 gh	PHY 500W3FE	0 c
BX 2037GLT	1 gh	DP 1948B3XF	0 c
DP 2022B3XF	1 gh	DP 1851B3XF	0 c
FM2398GLTP	1 gh	DP 1840B3XF	0 c
FM 2498GLT	1 gh	PX5C45W3FE	7 c
PHY 320W3FE	1 gh	CP 9608B3XF	83 b
AMX1818B3XF	3 f-h	DP 1835B3XF	97 a
18R628NRB3XF	3 f-h	CP 9178B3XF	97 a
NG 4792XF	3 f-h	DP 1916B3XF	100 a
FM 1621GL	5 f-h	DP 1823NRB2XF	100 a
PHY 250W3FE	5 f-h	WFUB9B3XF	100 a
PHY 400W3FE	5 f-h		
FM 2202GL	6 f-h		
PX2B14W3FE	6 f-h		
FM 2574GLT	8 f-h		
PHY 350W3FE	8 f-h		
PX3D43W3FE	8 f-h		
SSG UA 222	11 fg		
ST 5707B2XF	11 fg		
DP 1646B2XF	13 f		
AMX 1828B3XF	45 e		
DP 1612B2XF	45 e		
BX2076GLTP	68 d		
NG 4936B3XF	78 cd		
ST 5600B2XF	85 bc		
AMX1816B3XF	94 ab		
NG 3994B3XF	95 ab		
DP 1522B2XF	98 a		
AMX19005B3XF	100 a		

[1]18R is an experimental line for DP (Bayer CropSciences), AMX is an experimental line for Americot, BX is an experimental line for BASF, CP is Croplan, DP is Deltapine, FM is Fibermax, NG is NexGen, PHY is Phytogen, PX is an experimental line for Phytogen, ST is Stoneville, and WFU is an experimental line for Winfield United.

[2]Means with the same letter are not significantly different at P=0.05.

Table 2. Verticillium wilt results for Floyd County in 2019.

Variety[1]	Lint Yield (lbs./a)	Turn out	Loan x Yield ($/acre)	%Wilt on 8/30	Defoliation 9/18	Defoliation 10/9	Loan (¢/lb.)	Plants /ft row
CP 9210B3XF	1,445	0.323	825	0.0	1.9	50.1 f-i[2]	57.10	3.06
FM 1621GL	1,400	0.330	777	0.5	0.4	33.8 k-o	55.53	2.69
FM 2334GLT	1,368	0.331	782	0.5	0.0	13.0 rs	57.13	3.15
FM 2498GLT	1,353	0.310	772	0.3	2.3	29.2 m-p	57.05	3.55
NG 3500XF	1,335	0.290	730	0.7	0.8	20.1 p-s	54.68	2.61
NG 4098B3XF	1,328	0.292	755	0.0	0.0	27.5 n-p	56.85	2.71
PX3D43W3FE	1,327	0.285	760	0.9	0.8	30.7 l-p	57.28	2.97
DP 1820B3XF	1,326	0.317	761	0.0	0.4	26.3 n-q	57.38	2.09
FM 2322GL	1,322	0.314	755	1.0	3.1	21.1 p-s	57.10	2.17
DP 1612B2XF	1,299	0.294	740	1.3	0.2	68.9 ab	56.98	3.30
FM 2398GLTP	1,295	0.302	743	0.9	0.0	29.8 m-p	57.38	2.57
FM 2202GL	1,293	0.322	736	0.6	0.2	9.3 s	56.90	2.03
DP 1822XF	1,290	0.279	740	0.0	0.2	40.2 i-m	57.33	2.60
PX2B14W3FE	1,286	0.258	672	0.2	0.0	10.7 s	52.23	3.83
FM 1830GLT	1,283	0.316	736	0.5	1.9	36.9 j-n	57.35	2.43
PX3D32W3FE	1,264	0.284	721	0.3	1.3	19.1 p-s	57.08	3.25
FM 1320GL	1,248	0.301	700	1.0	1.7	26.5 n-p	56.05	2.75
CP 9598B3XF	1,245	0.325	714	0.5	0.2	25.6 n-q	57.35	2.05
DGX19015B3XF	1,242	0.304	711	0.3	1.5	35.9 j-o	57.30	2.13
CP 9830B3XF	1,226	0.326	701	0.3	1.5	43.9 g-k	57.20	2.38
FM 1911GLT	1,210	0.300	684	0.1	0.4	14.5 q-s	56.53	3.11
DGX19019B3XF	1,208	0.293	688	0.7	3.5	59.4 b-f	56.95	3.14
BX2037GLT	1,205	0.337	690	0.0	3.1	11.0 s	57.30	1.76
CP 9178B3XF	1,203	0.331	688	0.6	8.7	80.2 a	57.20	2.38
NG 3930B3XF	1,202	0.297	686	0.4	1.2	24.4 o-r	57.08	2.98
DP 1835B3XF	1,192	0.339	682	2.1	2.5	65.8 bc	57.20	2.40
PHY 210W3FE	1,147	0.293	656	0.2	0.0	12.8 rs	57.20	3.11
NG 2982B3XF	1,147	0.277	627	1.5	0.9	42.4 h-l	54.65	3.27
PHY 250W3FE	1,144	0.276	655	1.3	8.3	55.3 c-g	57.28	2.75
DP 1909XF	1,119	0.294	641	3.6	3.5	66.2 bc	57.30	2.32
DP 1916B3XF	1,087	0.315	619	2.2	7.9	62.1 b-e	56.93	2.20
NG 3994B3XF	1,087	0.317	601	0.7	0.6	50.7 e-i	55.25	2.12
DGX19001B3XF	1,065	0.291	560	0.3	0.6	64.7 b-d	52.55	2.39
DP 1908B3XF	1,040	0.284	577	1.2	2.3	53.4 d-h	55.53	2.09
NG 3956B3XF	1,030	0.275	588	1.2	0.0	44.6 g-k	57.10	2.59
DGX19025B3XF	857	0.203	457	1.0	0.2	47.7 f-j	53.35	2.59
Prob>F	0.001	0.001	0.001	0.016	0.002	0.001	0.001	0.001
MSD (0.05)[2]	140	0.024	77	2.2	5.2	11.9	2.72	0.45

[1]BX are experimental lines for BASF, CP is Croplan, DGX are experimental lines for DynaGro, DP is Deltapine, FM is Fibermax, MX are experimental lines for Americot, NG is NexGen, PHY is Phytogen, and PX are experimental lines for Phytogen.

[2]MSD is minimal significant difference. In the case of defoliation, letters indicating significant differences are provided. The best varieties were those that had the letter s following defoliation.

Table 3. Verticillium wilt results from Hale County in 2019.

Variety[1]	Lint Yield (lbs./a)	Turn out	Loan x Yield ($/acre)	%Wilt on 8/27	Defol-iation 9/20	Loan (¢/lb.)	Plants /ft row
DP 1612B2XF	1,467	0.302	612	5.2	6.8	41.70	2.63
NG 3500XF	1,403	0.267	619	4.6	1.9	44.13	2.20
DP 1822XF	1,295	0.255	493	3.5	1.9	38.05	1.94
PX2C14W3FE	1,290	0.254	589	1.2	0.8	45.65	2.55
FM 1320GL	1,262	0.265	614	3.0	2.7	48.63	2.26
CP 9210B3XF	1,224	0.262	535	3.2	3.5	43.68	2.46
DP 1820B3XF	1,220	0.272	590	7.8	2.5	48.33	1.69
FM 2334GLT	1,197	0.261	586	0.9	2.3	49.00	2.19
NG 3930B3XF	1,196	0.238	483	0.6	1.7	40.38	2.35
FM 2202GL	1,188	0.270	532	1.7	1.3	44.80	1.62
NG 2982B3XF	1,159	0.260	461	8.0	3.8	39.78	2.48
NG 3780B2XF	1,157	0.226	514	5.5	1.3	44.43	2.30
PHY 210W3FE	1,126	0.238	538	1.8	1.0	47.80	2.53
BX2005GLT	1,121	0.268	502	3.0	1.2	44.83	1.73
CP 9598B3XF	1,119	0.271	524	5.9	2.3	46.83	1.67
FM 2398GLTP	1,104	0.258	463	1.0	1.9	41.90	1.84
PX2B14W3FE	1,086	0.229	466	2.9	2.7	42.93	2.74
FM 1621GL	1,074	0.249	381	2.3	5.0	35.48	1.75
CP 9608B3XF	1,070	0.268	358	10.5	6.6	33.43	1.81
DP 1909XF	1,052	0.249	521	13.0	7.7	49.50	1.77
MX19A005B3XF	1,049	0.268	467	9.9	12.0	44.55	1.43
NG 3640XF	1,040	0.264	446	3.6	1.5	42.90	2.03
DGX19021B3XF	1,038	0.241	375	3.0	4.6	36.10	2.72
DGX19015B3XF	1,037	0.251	415	4.1	0.8	40.03	1.36
CP 9178B3XF	985	0.252	374	6.0	6.8	37.98	2.01
DP 1908B3XF	976	0.240	457	13.9	6.6	46.80	1.56
PHY 250W3FE	971	0.232	406	3.8	3.8	41.83	1.96
ST 5600B2XF	959	0.243	338	4.9	1.3	35.20	1.28
FM 2574GLT	957	0.241	420	0.6	2.7	43.88	2.02
DGX19011B3XF	947	0.218	335	4.4	1.5	35.40	1.90
FM 2322GL	942	0.253	368	3.2	2.9	39.08	1.18
NG 3956B3XF	935	0.225	313	0.8	2.1	33.48	1.88
WFU19XB9B3XF	935	0.220	329	2.6	5.0	35.23	2.15
DGX19010B3XF	920	0.255	345	6.2	8.3	37.50	1.40
FM 1911GLT	919	0.229	356	1.0	0.4	38.78	2.35
FM 1830GLT	918	0.236	398	2.3	0.6	43.38	1.61
BX2037GLT	896	0.255	387	1.5	0.6	43.23	1.08
DGX19007DB3XF	870	0.232	365	14.2	11.0	41.95	1.47
BX2076GLTP	861	0.221	304	2.5	2.7	35.30	1.86
DGX19004B3XF	852	0.224	323	12.3	10.8	37.90	1.55
Prob>F	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MSD (0.05)[2]	178	0.036	91	4.5	5.9	9.35	0.38

[1]BX are experimental lines for BASF, CG is Croplan Genetics, DGX are experimental lines for DynaGro, DP is Deltapine, FM is Fibermax, MX are experimental lines for Americot, NG is NexGen, PHY is Phytogen, PX are experimental lines for Phytogen, ST is Stoneville, and WFU are experimental lines for Winfield United.

[2]MSD is minimal significant difference. In the case of defoliation, letters indicating significant differences are provided. The best varieties were those that had the letter s following defoliation.

Table 4. Verticillium wilt trial in Hockley County in 2019

Variety[1]	Lint Yield (lbs./a)	Turn out	Loan x Yield ($/acre)	%Wilt on 8/27	Defol-iation 9/20	Loan (¢/lb.)	Plants /ft row
FM 2498GLT	2,038	0.311	1,156	6.1	3.5	56.70	3.19
NG 4777B2XF	2,006	0.311	1,135	2.8	5.2	56.60	2.89
NG 4792XF	1,956	0.307	1,082	4.2	6.2	55.33	2.51
CP 9598B3XF	1,954	0.340	1,075	5.6	6.8	55.05	1.93
FM 2398GLTP	1,938	0.307	1,080	5.4	3.5	55.70	2.48
FM 1830GLT	1,934	0.307	1,110	6.5	7.9	57.40	2.56
PX3D32W3FE	1,894	0.295	1,065	2.9	7.9	56.25	3.11
FM 2574GLT	1,880	0.307	1,079	2.3	2.3	57.43	2.74
PX3D43W3FE	1,879	0.289	1,041	6.1	9.7	55.43	3.13
BX2005GLT	1,876	0.316	1,066	5.2	6.4	56.83	2.62
NG 4098B3XF	1,871	0.294	1,016	7.2	5.6	54.30	2.74
PX2C14W3FE	1,871	0.279	1,042	3.3	5.2	55.70	2.92
BX2076GLTP	1,868	0.319	1,040	7.4	7.7	55.68	2.36
CP 9830B3XF	1,845	0.336	1,051	2.3	5.4	56.98	3.14
NG 4689B2XF	1,844	0.304	1,022	3.3	9.7	55.43	2.61
NG 3640XF	1,841	0.298	996	3.8	7.0	54.13	2.30
FM 2334GLT	1,831	0.314	1,048	2.3	5.0	57.25	2.73
ST 4550GLTP	1,818	0.323	1,042	8.2	16.6	57.35	2.56
ST 5707B2XF	1,784	0.283	952	6.0	7.7	53.38	2.83
WFU19XB9B3XF	1,765	0.295	983	2.5	8.3	55.70	3.84
DP 1612B2XF	1,744	0.307	963	6.7	22.6	55.20	2.98
DGX19019B3XF	1,742	0.298	997	11.9	24.7	57.23	3.05
DGX19011B3XF	1,736	0.286	994	10.2	1.5	57.30	2.26
DP 1909XF	1,732	0.281	985	12.2	6.4	56.85	2.22
DGX19007DB3XF	1,718	0.307	970	13.5	2.7	56.48	1.85
CP 9608B3XF	1,695	0.343	942	11.2	8.7	55.55	2.48
FM 1911GLT	1,661	0.315	945	2.7	1.9	56.88	2.87
DGX19004B3XF	1,660	0.303	933	8.5	6.8	56.20	2.11
DP 1948B3XF	1,625	0.308	915	9.9	9.3	56.33	2.11
DP 1840B3XF	1,621	0.293	902	5.6	3.9	55.63	2.30
ST 5600B2XF	1,608	0.316	858	2.9	3.5	53.40	1.58
DP 1845B3XF	1,606	0.292	886	9.8	4.4	55.15	2.22
DP 1916B3XF	1,600	0.316	886	10.3	19.5	55.38	2.38
NG 2982B3XF	1,560	0.278	855	6.9	20.0	54.85	2.96
NG 3930B3XF	1,537	0.271	870	4.2	12.5	56.63	2.84
DP 1851B3XF	1,524	0.299	846	9.6	14.7	55.53	2.14
NG 3994B3XF	1,522	0.317	855	10.1	19.5	56.20	1.85
NG 4936B3XF	1,520	0.289	868	5.2	9.7	57.13	2.42
MX19A005B3XF	1,467	0.307	825	13.5	9.9	56.25	2.25
DP 1835B3XF	1,420	0.297	788	12.5	15.1	55.48	2.26
Prob>F	0.001	0.006	0.001	0.001	0.001	0.017	0.001
MSD (0.05)[2]	203	0.039	112	5.4	9.8	2.82	0.26

[1]BX are experimental lines for BASF, CP is Croplan, DGX are experimental lines for DynaGro, DP is Deltapine, FM is Fibermax, MX are experimental lines for Americot, NG is NexGen, PHY is Phytogen, PX are experimental lines for Phytogen, ST is Stoneville, and WFU are experimental lines for Winfield United.

[2]MSD is minimal significant difference. In the case of defoliation, letters indicating significant differences are provided. The best varieties were those that had the letter s following defoliation.

Acknowledgements

We thank the seed companies that supported the bacterial blight project (BASF, Bayer CropSciences, Americot, Phytogen), Texas Cotton State Support Committee, Plains Cotton Improvement Program, Texas A&M AgriLife

Research and NIFA IPM project TEX09672. We also thank the producers who participated in this research: Ron Graves, Glen Schur, and Larry Smith.