THE RESPONSE OF VARIETIES TO VERTICILLIUM WILT IN THE SOUTHERN HIGH PLAINS OF TEXAS IN 2012

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Abstract

Verticillium wilt can be a serious problem in the Southern High Plains of Texas. Management includes planting varieties with tolerance/partial resistance to this disease. Small plot trials were conducted at three locations where the disease was present, using commercial varieties and advanced breeding lines. The best yielding lines or varieties were: FiberMax (FM) 2484B2F, FM 9170B2F, FM 2011GT, NexGen 4111RF, and BX 1347GLB2 (Bayer CropScience experimental). The consistency of cultivar performance was a testimony to the impact that Verticillium wilt had on cotton yield, even in a year with above average temperatures and reduced disease overall.

Introduction

Verticillium wilt in cotton is caused by the soilborne fungus *Verticillium dahliae*. This fungus has long-lived microsclerotia that initiate infection of roots in the soil (Isaac, 1953). Disease severity is typically a function of variety selection, microsclerotia density and environment (Bell, 1992; Paplomatas et al., 1992; Talboys and Wilson, 1970). Management of this disease then involves practices that reduce microsclerotia density, results in a less conducive environment for disease, or by planting a variety that is more tolerant to the disease. Varieties change rapidly, and the purpose of this paper is to compare some of the newer varieties/experimental cultivars against ones that have historically been partially resistant or partially tolerant to Verticillium wilt.

Materials and Methods

Six locations were chosen with a history of Verticillium wilt, and with at least 7 microsclerotia/cm^3 soil; however, only three sites developed adequate disease, and only those sites will be presented. Plots were two rows wide and 36 feet long, and were arranged in a randomized complete block design with 32 cultivars and four replications at each site. There were four seed planted/foot of row. Site locations are listed from north to south, and with a short description of the test site:

1) Plainview: Center pivot irrigation system with good water; average of 102 microsclerotia/cm^3 soil; and planted flat into heavy millet residue. The test was planted 3 May; wilt incidence was measured on 13 August; defoliation was rated on 5 September; and the test was harvested on 29 October.
2) Floydada: Center pivot irrigation system with good water; average of 87 microsclerotia/cm^3 soil; planted into slight beds with a wheat cover, and minimum tillage system. The test was planted on 17 May; wilt incidence was measured on 28 August; defoliation was measured on 7 September; and the test was harvested on 16 October.
3) Garden City: Drip irrigation under every bed with good water; an average of 126 microsclerotia/cm^3 soil; planted into beds with conventional tillage. The test was planted on 4 May; wilt incidence was measured on 21August; defoliation was measured on 14 September; and the test was harvested on 26 October.

Data collection included *V. dahliae* microsclerotia density in soil at planting; plant stands (every plant in the plot); wilt incidence; defoliation; and yield. Wilt incidence involved counting all the plants in the plot with observable symptoms of wilt (leaf discoloration and defoliation typical for the disease) and dividing this number by the plant stand. Wilt incidence was typically recorded in early and late August. If there was little wilt (<10%) development on average by the end of August, then the trial was not included in the results. Wilt incidence was already relatively high at the Plainview site by 13 August, so only the one rating was taken at that site. Wilt incidence had developed sufficiently by the last week of August also at Floydada and Garden City, but not at Seminole, Wilson, or Littlefield. Defoliation ratings were taken in September at Floydada, Plainview and Garden City. Plots were typically rated at 20-22 locations within a plot and ratings were averaged for each plot. The rating system was 0 = no defoliation, 1 = < 33% defoliation, 2 = 33-66% defoliation, and 3 = >66% defoliation.

Two composite soil samples were taken at planting across the test area with 15 subsamples taken per sample. The soil was dried for 1 wk, and then assayed for *V. dahliae* microsclerotia (Wheeler and Rowe, 1995). The assay consisted of 20 cm^3 soil placed in 80 ml of water and stirred. Five 1-ml aliquots were placed on *V. dahliae* selective media (Butterfield et al., 1978) and distributed across each of the five plates. This process was repeated for each sample, resulting in 10 petri plates/sample. After 2 wks, the soil was gently washed off the plate and the microsclerotia were counted.

The plots were harvested with a two-row cotton stripper and weighed. A 1000 g cotton sample was taken from the harvested plot and ginned to determine turnout. A sample of lint was sent for HVI analysis at Texas Tech Fiber and Biopolymer Institute (Lubbock, TX) and a loan value obtained. The estimate of lbs of lint/acre (based on plot weight and turnout) was multiplied by the loan value to obtain a value ($)/acre.

Temperature and soil moisture sensors (Spectrum Technologies, Inc. Plainfield, IL) were placed at a 4-inch depth in plots at each site and attached to a data logger (WatchDog 1000 series Micro Station) in a waterproof container. Data was collected hourly. Average temperature and moisture were calculated at 2-week intervals, starting on 1-July and through 31 August. These sensors were placed at sites included in this study (small plot variety tests) and also at other cotton sites where Verticillium wilt was being monitored across the Southern High Plains of Texas.

Analyses were conducted on each site individually using Proc GLM (SAS Institute, Cary, NC version 9.3). Mean separations were conducted using the Waller-Duncan k-ratio t-test at P=0.05.

Results and Discussion

Sufficient Verticillium wilt developed only at the locations with the highest densities of *V. dahliae* (Fig. 1), and where there were relatively cool soils in the upper part of the soil profile (Fig. 2). The locations with the best water are the most likely to develop higher densities of *V. dahliae* (Wheeler et al., 2012). It was an unusually hot and dry summer in the Southern High Plains of Texas, resulting in less wilt than most years. Only those fields with the highest soil densities of *V. dahliae* and best water resulted in sufficient Verticillium wilt to compare cultivars for susceptibility to this disease. The same five cultivars had the greatest yield at all of these sites, or at two of the three sites, if only planted to two sites. They were: FiberMax (FM) 2484B2F, FM 2011GT, FM 9170B2F, BX (Bayer CropScience Experimental) 1347GLB2, and NexGen (NG) 4111RF (Tables 1-3). When quality factors were included (yield × loan value), then FM 2484B2F was the number 1 variety at all three sites, FM 2011GT was in the top 5 at all 3 sites, FM 9170B2F was in the top 5 at both sites it was planted, NG 4111RF was in the top 5 at 2 of the 3 sites it was planted, and BX 1347GLB2 was in the top 5 at 1 of the 2 sites it was planted. Other varieties in the top 5 for the combination of quality and yield included FM 9160B2F (1 of 3 sites), FM 9180B2F (1 of 3 sites), and FM 9250GL (2 of 3 sites).

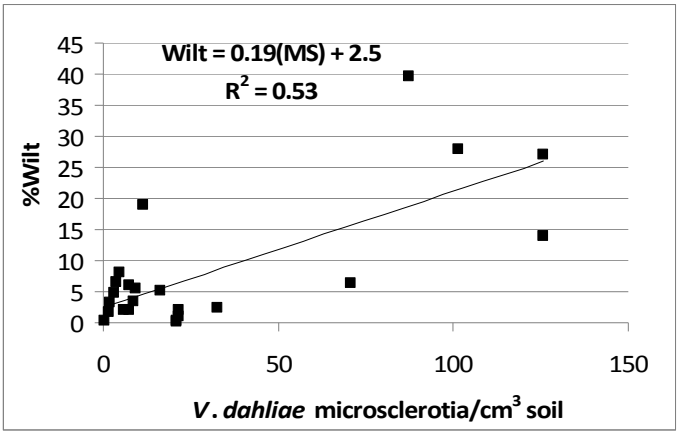

Figure 1. Relationship between *Verticillium dahliae* microsclerotia (MS) and incidence of wilt across cotton fields in the Southern High Plains of Texas in 2012. Data were included from 20 cotton fields being monitored for Verticillium wilt.

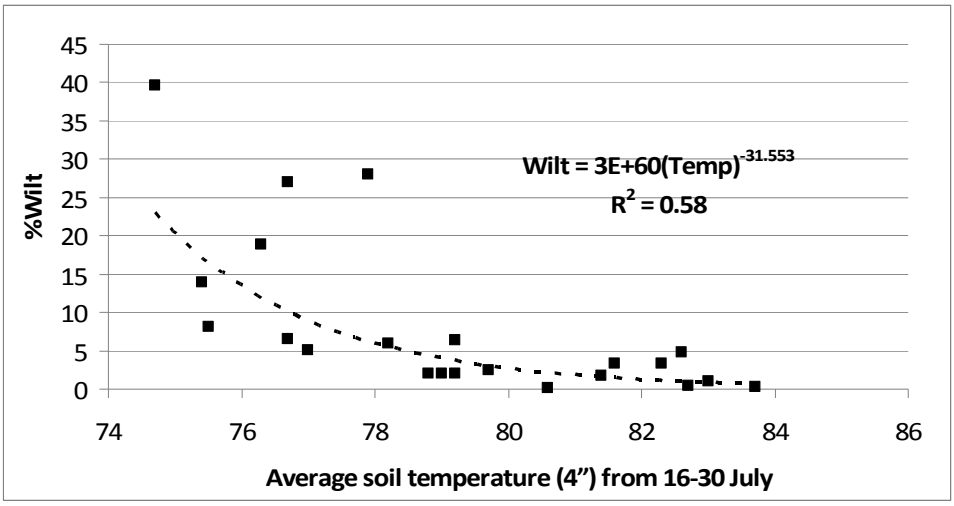

Figure 2. Relationship between soil temperature (°F) (TEMP) and incidence of Verticillium wilt at 20 cotton fields in the Southern High Plains of Texas.

Verticillium wilt developed much later than normal for Garden City, and was slightly delayed for Floydada. Wilt developed in early August for Plainview, as is typical for that site. There was probably less damage due to wilt than in years where the temperatures are more moderate, both due to the lateness in observing wilt foliar symptoms and in reduced defoliation compared to most years. Among the cultivars that had the greatest yield, FM 2484B2F had the lowest or second lowest wilt incidence at the three sites (Tables 1-3). BX 1347GLB2 also had the lowest wilt incidences at the two sites (Floydada and Garden City) where it was planted (Table 1 and 3). FM 2011GT was ranked 3rd, 5th, and 9th at Floydada, Plainview, and Garden City for wilt incidences. FM 9170B2F was ranked 13th and 6th for wilt incidence at Floydada and Garden City (Table 1 and 3). NexGen 4111RF had greater wilt incidences than the other top 5 cultivars, and was ranked 18th, 25th, and 12th for wilt incidence at the three sites (Tables 1-3). The NexGen variety with better wilt ratings was NG 3348B2RF, which is considered an excellent partially wilt resistant variety, but probably has lower yield potential than NG 4111RF and NG 4012B2RF (ranked 9th in yield x loan value at Garden City, Table 3).

Defoliation was less than usual for these locations, and only appeared to be an important factor at the Floydada site. FM 2484B2F had the lowest defoliation ratings at all three sites (Tables 1-3). BX 1347GLB2 and FM 9170B2F also had excellent defoliation ratings at Floydada and Garden City, and they were not planted at Plainview. FM 2011GT was a bit more erratic in terms of defoliation ratings, ranking 19th, 17th, and 5th (Tables 1-3). NG 4111RF had fairly good defoliation ratings, ranking 5th, 9th, and 11th (Tables 1-3).

Summary

Five cultivars consistently performed with high yields at the sites where Verticillium wilt was an important deterrent to yield. They were: FM 2484B2F, FM 9170B2F, BX 1347GLB2, FM 2011GT, and NG 4111RF. FM 2484B2F and BX 1347GLB2 also had consistently the lowest wilt incidence and defoliation ratings.

Table 1: The effect of variety in a Verticillium wilt trial in Floydada on yield, wilt and defoliation.

Variety[a]	Yield x loan	Lbs lint /Acre	Plants/ft. Of row	%Wilt on 28 Aug.	Defoliation on 7 Sept.[b]	Turnout	Loan ($/lb)
FM 2484B2F	801	1711	3.58	27.6	0.95	0.2875	0.46800
FM 9170B2F	795	1665	3.55	40.2	0.99	0.2875	0.47750
BX 1347GLB2	763	1613	3.84	20.1	1.16	0.2727	0.47325
FM 2011GT	732	1551	3.47	32.7	1.82	0.2868	0.47175
FM 9160B2F	706	1455	3.20	39.7	1.09	0.2803	0.48500
DG 4	698	1535	3.54	46.0	1.46	0.2645	0.45475
FM 1740B2F	693	1472	3.34	39.2	1.65	0.2956	0.47075
NG 4111RF	692	1475	3.24	45.2	1.20	0.2693	0.46900
DP 1219B2RF	661	1414	3.40	40.7	1.61	0.2705	0.46725
FM 9250GL	658	1451	3.41	37.5	1.73	0.2680	0.45325
NG 3348B2RF	654	1464	3.06	36.4	1.33	0.2736	0.44700
DG 3	650	1295	3.28	37.8	1.92	0.2707	0.50225
NG X00012	633	1232	3.07	55.6	1.80	0.2689	0.51350
AT C253B2RF	620	1392	3.64	53.5	2.20	0.2798	0.44575
FM 9180B2F	614	1325	3.17	45.7	1.28	0.2584	0.46300
DP 0912B2RF	595	1304	3.30	45.0	1.77	0.2764	0.45625
ST 4288B2F	595	1268	3.54	34.6	1.53	0.2391	0.46925
DP 104B2RF	584	1305	3.36	45.2	1.52	0.2503	0.44725
DP 1212B2RF	582	1226	3.38	46.4	2.55	0.2571	0.47450
NG 1511B2RF	573	1249	3.34	50.6	1.86	0.2740	0.45825
PG 367WRF	567	1302	3.56	38.6	1.60	0.2555	0.43450
FM 9103GT	559	1262	3.33	49.5	1.88	0.2431	0.44325
DP 0949B2RF	553	1219	3.47	37.6	1.97	0.2713	0.45350
AM1550B2RF	542	1266	3.39	41.1	2.12	0.2513	0.42850
AT RapidB2RF	537	1245	3.55	38.8	2.05	0.2565	0.43100
NG 2051B2RF	533	1217	3.20	51.4	1.34	0.2268	0.43850
DG 10	517	1203	3.60	50.2	2.20	0.2593	0.43000
AT 789381RF	514	1152	3.05	60.3	1.78	0.2582	0.44675
DG 2	511	1124	2.71	50.8	1.90	0.2520	0.45450
AT C106466B2RF	505	1176	3.63	56.5	1.97	0.2418	0.42975
DG 8	501	1123	3.51	48.0	2.39	0.2531	0.44575
DG 7	491	1107	3.57	41.9	2.13	0.2588	0.44300
MSD (0.05)	48	105	0.20	12.5	0.55	0.019	0.049

[a]AM=Americot, AT = All Tex, BX = Experimental for Bayer CropScience, DP=Deltapine, DG = DynaGro, FM = FiberMax, NG = NexGen, PG=Phytogen, ST = Stoneville. MSD=minimum significant difference.

[b]The defoliation goes from 0 (no defoliation), 1 = 1/3 or less of plant is defoliated, 2 = 1/3 – 2/3 of plant is defoliated, and 3 = > 2/3 of plant is defoliated.

Table 2. The effect of variety in a Verticillium wilt trial in Plainview on yield, wilt and defoliation.

Variety[a]	Yield X Loan ($/a)	Lbs of Lint/ Acre	Plants/ Ft. of row	%Wilt On 13 Aug.	Defol-[b] iation on 5 Sept.	Turnout	Loan Value ($/lb)
FM 2484B2F	947	1,673	2.87	10	0.27	0.302	0.566
FM 9180B2F	829	1,455	2.41	20	0.40	0.281	0.570
NG 4111RF	812	1,425	1.45	28	0.61	0.281	0.570
FM 2011GT	810	1,540	2.68	17	0.79	0.306	0.526
FM 9250GL	757	1,443	2.49	16	0.83	0.284	0.525
FM 1944GLB2	738	1,373	2.06	23	0.56	0.275	0.537
BX 1348GLB2	704	1,267	2.06	24	0.61	0.268	0.555
FM 9160B2F	698	1,232	1.67	15	0.58	0.280	0.567
NG 3348B2RF	696	1,281	1.89	14	0.59	0.288	0.543
DG 9	696	1,251	2.34	18	0.77	0.281	0.556
DP 1219B2RF	687	1,304	2.18	19	0.83	0.277	0.527
FM 1740B2F	680	1,310	2.31	24	0.70	0.287	0.519
AT EdgeB2RF	650	1,267	3.05	23	0.82	0.263	0.513
BX 1346GLB2	641	1,240	1.95	19	0.75	0.280	0.517
NG 2051B2RF	635	1,206	2.41	18	0.64	0.247	0.526
DP 1212B2RF	623	1,225	2.69	23	1.49	0.284	0.509
DP 104B2RF	620	1,254	2.26	21	0.55	0.250	0.494
DP 0912B2RF	614	1,184	1.69	28	0.84	0.276	0.518
AT C202B2RF	608	1,125	1.97	25	0.75	0.267	0.540
DG 3	596	1,141	1.86	32	1.17	0.258	0.522
PG 367WRF	562	1,157	2.13	23	0.77	0.256	0.486
DP 0949B2RF	556	1,167	2.08	25	0.85	0.270	0.476
AT 10WR585RF	545	1,000	1.05	36	0.57	0.287	0.545
DG 1	543	977	1.39	33	0.87	0.257	0.556
NG 1511B2RF	543	1,088	1.98	23	1.03	0.269	0.499
DG 2	533	957	1.09	42	0.93	0.292	0.557
DG 5	533	1,046	1.31	36	0.83	0.277	0.509
DG 6	522	1,025	2.04	34	0.99	0.278	0.509
FM 9103GT	520	1,048	1.29	28	0.70	0.258	0.496
AT RapidB2RF	487	982	2.48	23	1.70	0.255	0.496
AM 1550B2RF	428	1,023	2.29	26	1.31	0.254	0.419
AT 91139B2RF	363	772	1.03	55	1.30	0.257	0.470
MSD (0.05)	70	134	0.4	9	0.31	0.023	0.057

[a]AM=Americot, AT = All Tex, BX = Experimental for Bayer CropScience, DP=Deltapine, DG = DynaGro, FM = FiberMax, NG = NexGen, PG=Phytogen, ST = Stoneville. MSD=Minimum significant difference

[b]The defoliation goes from 0 (no defoliation), 1 = 1/3 or less of plant is defoliated, 2 = 1/3 – 2/3 of plant is defoliated, and 3 = > 2/3 of plant is defoliated.

Table 3. The effect of variety in a Verticillium wilt trial in Garden City on yield, wilt and defoliation.

Variety[a]	Yield X Loan	Lbs of Lint/ Acre	Plants/ Ft. of row	%Wilt On 21 Aug.	Defoli-ation on 12 Sept.[b]	Turnout	Loan Value ($/lb)
FM 2484B2F	1,363	2,454	3.43	7	0.79	0.285	0.556
FM 2011GT	1,357	2,501	3.18	17	1.31	0.316	0.542
NG 4111RF	1,353	2,386	2.61	19	1.50	0.283	0.567
FM 9170B2F	1,321	2,365	2.82	15	1.05	0.284	0.559
FM 9250GL	1,228	2,263	3.05	15	1.50	0.269	0.543
BX 1347GLB2	1,227	2,390	3.52	8	1.05	0.292	0.514
FM 2989GLB2	1,226	2,224	2.63	21	1.38	0.274	0.551
FM 9160B2F	1,213	2,273	2.94	14	1.01	0.293	0.534
NG 4012B2RF	1,170	2,186	2.83	15	1.53	0.283	0.536
AT CR253B2RF	1,158	2,218	2.76	19	1.54	0.250	0.522
AT Nitro-44B2RF	1,126	2,133	2.68	18	1.50	0.282	0.528
DP 0935B2RF	1,124	2,054	2.79	23	2.01	0.291	0.548
FM 1944GLB2	1,102	2,082	2.91	15	1.58	0.280	0.529
FM 9180B2F	1,094	2,114	2.81	21	1.37	0.264	0.518
DP 1137B2RF	1,062	1,939	2.58	28	1.78	0.303	0.548
DP 1133B2RF	1,052	1,989	1.97	34	1.66	0.293	0.529
BX 1346GLB2	1,049	2,039	2.76	26	2.11	0.269	0.515
DP 1050B2RF	1,034	1,835	2.21	36	1.80	0.303	0.564
DP 1044B2RF	1,030	1,987	2.94	19	1.74	0.259	0.493
DP 1032B2RF	1,019	1,872	2.09	34	1.93	0.294	0.545
BX 1348GLB2	994	1,949	3.10	20	1.70	0.279	0.510
FM 8720GLB2	986	1,858	2.89	10	1.35	0.275	0.531
PG 499WRF	943	1,798	3.07	23	1.81	0.278	0.525
NG X00012	937	1,694	1.94	48	1.80	0.303	0.553
DG 8	930	1,742	2.95	22	2.07	0.270	0.534
DP 1252B2RF	929	1,750	2.05	41	1.82	0.305	0.531
DP 0912B2RF	923	1,750	2.22	27	1.83	0.282	0.528
PG 375WRF	918	1,736	2.48	21	2.13	0.273	0.529
DG 10	915	1,690	3.12	31	2.08	0.279	0.541
DP 1048B2RF	914	1,671	2.40	29	1.82	0.283	0.547
AM 1550B2RF	835	1,684	2.85	25	2.44	0.264	0.498
AT CR106466B2RF	777	1,641	2.94	20	1.66	0.311	0.474
MSD (0.05)	108	203	0.34	9	0.4	0.037	0.053

[a]AM=Americot, AT = All Tex, BX = Experimental for Bayer CropScience, DP=Deltapine, DG = DynaGro, FM = FiberMax, NG = NexGen, PG=Phytogen, ST = Stoneville. MSD = Minimum significant difference.

[b]The defoliation goes from 0 (no defoliation), 1 = 1/3 or less of plant is defoliated, 2 = 1/3 – 2/3 of plant is defoliated, and 3 = > 2/3 of plant is defoliated.

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