EFFECT OF VERTICILLIUM WILT ON COTTON VARIETIES IN TEXAS

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Abstract

Small plot, replicated variety tests were planted in fields with a history of Verticillium wilt. In 2006 and 2007, there were 3 and 5 test sites that developed sufficient wilt to affect yield. Wilt was monitored from late July through August. Plots were harvested and HVI testing was done on fiber to determine loan value, and obtain a value for each variety/acre ((lint yield x loan value) – seed and technology fees). Yield (lbs of lint/acre), incidence of wilt, and value/acre at each site were divided by the highest average value for each parameter at that site. This put everything on a 0 to 1 scale relative to the best yielding or worse wilted variety per site. An analysis was conducted on these three parameters across all sites, for any variety that was tested in at least two sites. The top 10% yielding varieties in order of rank were: Deltapine (DP) 455 BG/RR, FiberMax (FM) 960BR, NexGen (NG) 2448R, FM 9058RF, FM 960B2R, and FM 9150RF. The top 10% in terms of value of the variety/acre in order of rank were: NG 2448R, FM 960BR, Paymaster (PM) 2326RR, DP 455 BG/RR, DP 167RF, and FM 9058RF. The top 10% of varieties with the least amount of wilt were: PM 2326RR, FM 1880B2RF, FM 1840B2RF, AFD 5064F, AFD 5065B2F, and Stoneville (ST) 4427B2RF.

Introduction

Verticillium wilt is a significant yield reducing problem in the Southern High Plains of Texas. Since 2004, Verticillium wilt has been the most important disease of cotton, even surpassing nematode damage most years. The disease can be found on any soil type, and in any of the 20 counties that make up district 2 of Texas. The disease was found in the 1990's, and while important in some years during that decade, it has become an every-year issue with many producers since 2004. In 2007, many producers in the Southern High Plains switched to Roundup Ready Flex varieties for their irrigated cotton. The local extension agronomist, Randy Boman, puts out a number of large plot variety tests in producer's fields, and in 2007, every single producer/cooperator, had switched to Roundup-Ready Flex varieties. In contrast, of the seven producers that agreed to put variety tests on their Verticillium wilt problem fields in 2007, 6 of 7 had not planned to put Roundup-Ready Flex varieties in the field, and instead were going with varieties proven to yield well under Verticillium wilt conditions. It was not possible to test Roundup-Ready Flex varieties in Verticillium wilt fields until 2006, due to rules of harvest under EPA, so there was relatively poor information available on Verticillium wilt tolerance in Roundup Ready Flex varieties for producers coming into the 2007 planting season. The objective of this paper was to provide information on the yield and wilt tendencies for varieties that are currently available for cotton producers. In addition, a fungicide was advertised as having some activity on Verticillium wilt. This is a biological product containing *Streptomyces lydicus* strain WYEC 108. It is mainly used as a foliar spray or soil drench, but does have a seed treatment label and claims suppression or control of *Verticillium*. A number of producers were interested as to whether the product would be beneficial in their Verticillium wilt fields. Tests were conducted within the variety tests to examine this fungicide.

Materials and Methods

Variety testing

Cotton varieties were obtained from All-Tex, Bayer Crop Sciences, Delta and Pineland, Monsanto, and Americot. The selection of which variety to plant at which sites was based on the maturity of the variety. The early to mid-maturities were planted at the more northern sites, and the mid to long-season were planted at the more southern sites. Sites were identified by initially contacting producers with wilt problems, and then taking soil samples at sites of interest and assaying them for *Verticillium dahliae* (Wheeler and Rowe, 1995). In 2007, one site was in the northern part of District 2 of Texas (Floyd county), one in the middle part of District 2 (Hockley county), two in the southern part of District 2 (Dawson and Gaines county), and one site in District 6 near Garden City. In 2006, sites were in Hale (northern part of District 2), Hockley, and Lubbock (middle part of District 2) counties. Four of these

sites were under drip irrigation (Hockley co. in both years, Lubbock co., and Garden City), and four sites were irrigated with a center pivot system (Gaines, Dawson, Floyd, and Hale counties). At each site, 2-row plots on 40-inch centers, and 35 ft. long were planted with the varieties. The varieties were arranged in a randomized complete block design, with four replications. Stand counts were taken on both rows of the 2-row plots at least one month after planting when plant stand had stabilized. Fields were monitored for the initiation of wilt from late July through August. Once wilt was seen, the number of plants with wilt symptoms in a plot were counted, and divided by the plant stand to obtain an incidence of wilt. Wilt ratings were terminated around 1 September, or earlier if wilt incidence exceeded 40% for many varieties. The tests were harvested with a 2-row John Deere 484 stripper that had been converted to catch plot weights in a small cage, inside the stripper that was attached to load cells. Samples were taken of the lint in two of the four replications, and after ginning, the lint had HVI testing conducting at the Texas Tech International Textile Center (Lubbock, TX). A loan value was obtained for each variety. The yield (harvested weight x percent turnout from ginning) times the loan value, was calculated per acre, and then the seed and technology fees were subtracted, based on prices obtained by the Plains Cotton Growers (http://www.plainscotton.org/Seed/seedindex.html). If a variety was not marketed in a given year, such as Deltapine (DP) 174RF, then the price of a variety from that same company with similar technology, for example DP 167RF, was used instead. All-varieties were calculated at a population of 52,272 seed/acre.

The three measured parameters, incidence of wilt, lbs of lint/acre, and value/acre were all adjusted to a relative scale by dividing the average for a variety, by the highest average value found at that site. So incidence of wilt was divided by the highest average incidence of wilt at that site. A score of 1 indicates that the variety had the highest average wilt at a site, or a score of 0.5 indicates that a variety had ½ the wilt of the worst variety at that site. Lbs of lint/acre, was divided by the highest yielding variety at each site, so that a score of 0.5 would indicate that the variety yielded only ½ of the best variety at a site. Similarly value/acre, which takes into account yield and quality of the variety, was on a scale of 0 to 1, with 1 being the best valued variety at a site. An analysis was conducted on each of the measured parameters using PROC MIXED of SAS (SAS Institute, Cary, NC, version 9.1). Site was a random factor and variety was a fixed factor. Since there was not an equal number of observations across the varieties, the LSMEANS function was used to calculate the average relative wilt, yield, and value/acre parameters, and the PDIFF option allowed the comparison of individual variety combinations. Varieties were considered significantly different at $P \leq 0.05$. The parameters were then ranked from 1 to 59 for each variety. Any variety that was not tested at a minimum of two sites was removed from the analysis. There was no HVI data for Dawson county in 2007 yet, so no value/acre analysis was done on the varieties for that site.

Actinovate activity

The product called Actinovate ®AG (Natural Industries, Inc., Houston, TX), was applied as a seed treatment at 3 oz/100 lbs seed. At the five sites that were used for variety testing in 2007, a test was conducted with Actinovate ®AG was applied to the variety FM 9063B2RF and compared with the variety alone. The plot size was the same as described above, and all measurements were conducted as described above. The two treatments were arranged as a split-plot design, with variety randomized within the variety tests, and the order of the seed treatment versus no treatment being random. There were four replications at each site. Analysis was conducted similarly as described above using PROC MIXED, with treatment being the fixed factor, and site, nested with replication, and site x treatment being random factors.

Results and Discussion

Variety tests

There were a total of 59 varieties that were tested in at least two sites with Verticillium wilt in 2006 and 2007. The top six varieties (10%) in terms of relative yield were DP 455 BG/RR (0.94), FM 960BR (0.94), FM 9058RF (0.90), NexGen (NG) 2448R (0.89), FM 960B2R (0.89), and FM 9150RF (0.89) (Table 1). These varieties are listed as medium to early maturity. The top ranked variety (DP 455 BG/RR) was not significantly different in relative yield than varieties ranked from 2 to 13. The top yielding Roundup Ready Flex variety was FM 9058RF (ranked 4) and its relative yield was not significantly different than Roundup Ready Flex varieties ranked from 6 to 18 including FM 9150RF, FM 9180B2RF, FM 9060RF, FM 9063B2RF, FM 9068RF, AFD 5064F, DP 167RF, PM 2140B2RF, FM 1880B2RF, and FM 1840B2RF. The lowest yielding variety was Phytogen 370WR, which was not significantly different ($P = 0.05$) than varieties with a ranking of 34 and lower.

The top six varieties (10%) in terms of relative value/acre were: NG 2448R (0.94), FM 960BR (0.90), PM 2326RR (0.89), DP 455 BG/RR (0.88), DP 167RF (0.88), and FM 9058RF (0.85) (Table 1). DP 167RF, which was listed at 15th for relative yield (0.81), had excellent loan values, which pushed it into the top 10% in terms of value/acre. Varieties that were ranked 1-16 had value/acres that were not significantly different from each other at $P = 0.05$. The variety with the lowest ranking in terms of relative value/acre was Phytogen 370WR. This variety was not significantly different ($P = 0.05$) than varieties ranked from 32 to 58.

Varieties that had the lowest incidence of wilt symptoms were: PM 2326RR (0.28), FM 1880B2RF (0.37), FM 1840B2RF (0.37), AFD 5064F (0.42), AFD 5065B2F (0.42), and Stoneville (ST) 4427B2RF (0.43). Of those varieties which had the best value/acre, only PM 2326RR and NG 2448R had both high value and low wilt ratings (0.28 and 0.45, respectively). The Roundup Ready Flex varieties that were ranked in the top 20% in value/acre (FM 9058RF, FM 9150RF, FM 9180B2RF, FM 9063B2RF, and FM 9060RF) averaged 0.72 relative wilt ratings. The older picker varieties that were recommended in previous years (DP 455 BG/RR, FM 960BR, FM 960B2R, FM 989BR, and FM 989B2R) averaged relative wilt ratings of 0.55. So, the newest Roundup Ready Flex varieties are prone to worse Verticillium wilt incidence than previously recommended varieties. It is unknown whether this will lead ultimately to less stability in performance in particularly bad wilt years, or higher population densities of *V. dahliae* in the soil than under the older Roundup Ready varieties. Even with the newer Roundup Ready Flex varieties having both higher yield and higher wilt, overall, there was a significant ($P = 0.001$) and negative correlation between relative wilt and relative yield (r = -0.23) or relative value/acre (r = -0.17).

Table 1. Relative yield, value of the lint/acre and wilt for varieties tested during 2006 and 2007 in fields infested with *Verticillium dahliae*.

Variety	Relative yield (rank)	Relative value/acre[b] (rank)	Relative wilt (rank)	Number of sites
Deltapine 455 BG/RR	0.937 (1)	0.879 (4)	0.62 (30)	5
FiberMax 960BR	0.936 (2)	0.901 (2)	0.56 (22)	7
NexGen 2448R	0.894 (3)	0.940 (1)	0.45 (8)	2
FiberMax 9058RF	0.896 (4)	0.845 (6)	0.76 (49)	6
FiberMax 960B2R	0.890 (5)	0.837 (8)	0.53 (17)	4
FiberMax 9150RF	0.889 (6)	0.831 (9)	0.77 (50)	3
FiberMax 9180B2RF	0.884 (7)	0.845 (7)	0.72 (46)	3
Paymaster 2326RR	0.882 (8)	0.892 (3)	0.28 (1)	6
FiberMax 989BR	0.878 (9)	0.803 (13)	0.48 (9)	2
FiberMax 9060RF	0.874 (10)	0.813 (12)	0.78 (51)	3
FiberMax 9063B2RF	0.864 (11)	0.820 (10)	0.55 (20)	6
FiberMax 989B2R	0.855 (12)	0.818 (11)	0.55 (21)	3
FiberMax 9068RF	0.847 (13)	0.779 (16)	0.82 (54)	4
AFD 5064F	0.834 (14)	0.777 (17)	0.42 (4)	6
Deltapine 167RF	0.808 (15)	0.878 (5)	0.66 (37)	3
Paymaster 2140B2RF	0.794 (16)	0.710 (21)	0.49 (10)	2
FiberMax 1880B2RF	0.792 (17)	0.711 (20)	0.37 (2)	2
FiberMax 1840B2RF	0.790 (18)	0.627 (34)	0.37 (3)	3
Deltapine 164B2RF	0.790 (19)	0.779 (15)	0.51 (12)	4
FiberMax 960RR	0.768 (20)	0.700 (26)	0.59 (26)	2
Deltapine 174RF	0.763 (21)	0.785 (14)	0.66 (38)	3
FiberMax 1740B2RF	0.763 (22)	0.679 (28)	0.66 (40)	2
CS 370001G (DG 2100B2RF, CG 3020B2RF, BW 3255B2RF)[a]	0.758 (23)	0.676 (29)	0.44 (7)	3
AFD 5065B2F	0.755 (24)	0.725 (18)	0.42 (5)	6
Phytogen 470WR	0.755 (25)	0.615 (35)	0.55 (18)	2
Deltapine 147RF	0.753 (26)	0.702 (24)	1.00 (59)	2
Deltapine 143B2RF	0.751 (27)	0.670 (31)	0.88 (57)	2
Phytogen 425RF	0.735 (28)	0.709 (22)	0.64 (35)	5
Phytogen 485WRF	0.734 (29)	0.673 (30)	0.80 (52)	4
Deltapine 488 BG/RR	0.728 (30)	0.691 (27)	0.80 (53)	2

Phytogen 480WR	0.721 (31)	0.708 (23)	0.72 (47)	4
Stoneville 5327B2RF	0.721 (32)	0.649 (32)	0.71 (42)	3
CS 10001G (NG 3273B2RF, BW 4021B2RF)	0.715 (33)	0.615 (36)	0.52 (14)	2
Stoneville 4554B2RF	0.712 (34)	0.611 (37)	0.59 (28)	6
Deltapine 121RF	0.698 (35)	0.643 (33)	0.64 (34)	2
Stoneville 6611B2RF	0.697 (36)	0.700 (25)	0.53 (16)	3
CS 530001G (CG 3520B2RF, ST 4700B2F, DG 2242B2RF)	0.696 (37)	0.598 (39)	0.58 (24)	4
Deltapine 117B2RF	0.695 (38)	0.573 (43)	0.71 (41)	4
NexGen 1572RF	0.693 (39)	0.567 (45)	0.88 (58)	3
Stoneville 5283RF	0.676 (40)	0.604 (38)	0.84 (56)	4
Stoneville 4664RF	0.676 (41)	0.592 (40)	0.54 (18)	3
Stoneville 6622RF	0.672 (42)	0.719 (19)	0.66 (39)	3
Deltapine 454 BG/RR	0.670 (43)	0.484 (58)	0.76 (48)	4
All-Tex Summitt B2RF	0.667 (44)	0.587 (42)	0.64 (33)	2
All-Tex Marathon B2RF	0.664 (45)	0.552 (47)	0.83 (55)	2
NexGen 3550RF	0.659 (46)	0.561 (46)	0.72 (45)	4
Phytogen 125RF	0.656 (47)	0.592 (41)	0.52 (15)	5
CS 450001G (DG 2520B2RF, CG 4020B2RF, BW 4630B2RF, AM 1532B2RF)	0.653 (48)	0.547 (49)	0.71 (43)	6
Americot 1664B2RF	0.644 (49)	0.524 (54)	0.51 (13)	2
All-Tex Apex B2RF	0.643 (50)	0.572 (44)	0.64 (36)	5
Stoneville 4427B2RF	0.638 (51)	0.532 (51)	0.43 (6)	3
All-Tex Titan B2RF	0.622 (52)	0.529(52)	0.62 (31)	3
CS 170001G (ST 5007B2RF, AM 1622B2RF)	0.620 (53)	0.547 (48)	0.49 (11)	4
Americot 427R	0.607 (54)	0.537 (50)	0.71 (44)	2
Americot 2220RF	0.594 (55)	0.525 (53)	0.55 (19)	4
All-Tex Arid B2RF	0.593 (56)	0.501 (56)	0.63 (32)	3
Deltapine 110RF	0.585 (57)	0.501 (57)	0.60 (29)	
All-Tex Atlas RR	0.566 (58)	0.524 (55)	0.59 (27)	2
Phytogen 370WR	0.556 (59)	0.439 (59)	0.58 (25)	2

[a]CS stands for Cotton States varieties, and the varieties in parenthesis are those that were combined under the cotton states designation. Abbreviations are AM=Americot, BW=Beltwide, CG=Cropland Genetics, DG=DynaGro, NG=NexGen, and ST= Stoneville.

[b]Value/acre was calculated as the (lbs of lint/acre)(loan value in $/lb), and relative value/acre was the (average value/acre for a variety)/(average highest value/acre for a variety at each site).

Actinovate

There were no significant differences between FM 9063B2RF without the Actinovate seed treatment and with the seed treatment with respect to yield, incidence of wilt or value/acre (Table 2). The value/acre did not include the cost of the biological fungicide. There were also no significant differences at any individual site (data not shown). There is no evidence based on these results, to recommend the use of Actinovate ®AG at its labeled rates on cotton seed to manage Verticillium wilt.

Table 2. Affect of Actinovate ®AG as applied to cotton seed on yield, Verticillium wilt incidence or value of the cotton per acre when averaged over five locations.

Treatment	Lbs of lint/acre	Incidence of wilt	Value of yield[a] ($/acre)
none	1,359	18	773.73
Actinovate ®AG	1,302	20	740.12

[a] (lbs of lint/acre)(loan value in $/lb)

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