RESISTANCE ASSESSMENT OF COMMERCIAL COTTON CULTIVARS AGAINST *VERTICILLIUM DAHLIAE* IN COTTON

Huiping Zhou
Hui Fang
Soum Sanogo
Jinfa Zhang
New Mexico State University
Las Cruces, NM
Robert P. Flynn
New Mexico State University
Artesia, NM
Michael Gore
USDA-ARS
Maricopa, AZ

Abstract

A total of 76 commercial cultivars and breeding lines were evaluated for Verticillium wilt (VW) resistance in three separate tests using artificial inoculation in the greenhouse. The results showed that (1) Pima cotton is generally more resistant, of which PHY800, PHY830, and DP357 were highly resistant; (2) Upland cultivars FM9160B2F, PHX4912WRF and ST4288B2F and breeding lines including TAM03WZ-37, MD25ne and PD05041 also showed good VW resistance; (3) more than 20 cultivars and lines displayed a moderate level of resistance to VW; and 46 cultivars (60.5% of the total) were susceptible to VW.

Introduction

Verticillum wilt, caused by *Verticillium dahliae* Kleb, is one of the most severe fungal diseases in cotton worldwide. Annual yield loss caused by VW is 0.5 ~ 3.5% nationwide in the U.S. and as high as 3.5 ~ 5.0% in New Mexico (Blasingame and Patel, 2005). Although control methods such as crop rotation, chemical fumigation, and soil amendments may be helpful, it is virtually impractical to control the disease without the use of resistant cotton cultivars (Lüders et al., 2008). So far, highly resistant cultivars to VW are lacking in Upland cotton. The resistance sources are mainly from Pima cotton, which is grown in very limited areas; and some Acala cotton cultivars also display good VW resistance (Zhang et al., 2011). Breeding and using resistance cultivars can significantly reduce yield and quality loss caused by VW. However, information on resistance levels against VW is lacking for many newly released commercial cultivars. The objective of this study was to evaluate VW resistance in 76 commercial cotton cultivars and advanced breeding lines.

Materials and Methods

Seventy-six entries were divided into three different tests including 32 in Trial HQ- commercial cotton provided from the National Variety Test and High Quality Test in 2010, 34 in Trial RB- advanced breeding lines provided from the Regional Cotton Breeders' Testing network in 2010 and 10 in Trial B- Pima cotton. The tests were randomized complete block designs with 4 replicates. Seed was planted in a 4-inch plastic pot with 10 seed/pot (5 hill/pot, 2 seed/hill) in the greenhouse on Sept 15th, 2011. The pots were filled with potting soil (Scott 450, Scotts Co., Marysville, OH) mixed with slow release Osmocote® fertilizer (Marysville, OH). After emergence, seedlings were thinned to 5 - 6 plant/pot.

The pathogen, *V. dahliae* was isolated from an infected cotton plant and was cultivated in Czapek - Dox broth for 20 days. The suspension was passed through a double-layer cheesecloth to separate spores (conidia) from mycelia. When seedlings were at the 2nd/3rd true leaf stage, root inoculation was made by pouring 100 mL of conidia suspension per pot. Double inoculations were made on Oct, 26th (3.45×10^6 conidia/mL) and Nov. 10th, 2011 (1.71×10^6 conidia/mL) to ensure that escape from pathogen infection was minimal.

Assessment of the severity of wilt symptoms was made 41 days after inoculation using a 0 - 5 score scale described by Zhang et al (2011) as follows,

0 No symptom
1 <25% chlorotic/necrotic leaves
2 25-50% chlorotic/necrotic leaves
3 50-75% chlorotic/necrotic leaves
4 >75% chlorotic /necrotic leaves
5 Complete defoliation or plant death

Total number of leaves and numbers of infected leaves and defoliated leaves were recorded separately on an individual plant basis. Percentages of infected leaves and defoliated leaves were then calculated. An average rating was also calculated on a replication basis for each genotype.

Data Analysis

The data were subjected to analysis of variance (ANOVA) using SAS 9.2 (SAS Institute Inc, 1999). The least significant difference at the 5% significant level was used to compare differences between cultivars or genotypes.

Results

Commercial Upland Cotton Cultivars

Difference in disease rating and percentages of infected and defoliated leaves were not significant among the 32 cultivars based on ANOVA (Table 1), even though the range of disease rating was 1.88 to 3.32. FM9160B2F had the lowest disease rating, while ST4288B2F had the lowest percentages of infected (50.46%) and defoliated (14.58%) leaves with a rating of 2.00, followed by MD25ne and PHX4912WRF. DP1048B2RF had the highest disease rating, percentages of infected (80.69%) and defoliated (51.59%) leaves.

Table 1. Greenhouse evaluation of VW resistance in commercial Upland cotton, Las Cruces, NM, 2011.

Genotype	Infected leaves (%)	Defoliated leaves (%)	Rating
FM9160B2F	56.55	35.52	1.88
ST4288B2F	50.46	14.58	2.00
MD25ne	55.46	29.50	2.06
PHX4912WRF	54.91	25.97	2.07
FM9170B2RF	60.30	24.46	2.25
PHY565WRF	57.48	31.64	2.26
MD25y	63.95	23.19	2.41
DP555BG/RP*	57.92	25.12	2.48
TAM03-WZ-37	67.14	26.02	2.48
ArK0102-48	68.81	34.28	2.50
PHY499WRF	65.26	45.34	2.50
ArK9803-23-04	62.27	37.95	2.57
PHY72	64.06	33.18	2.58
TAM04WB-33s	68.26	40.69	2.61
FM9058F	70.15	26.9	2.62
FM1773LLB2	65.32	47.85	2.68
FM1845LLB2	66.34	41.87	2.70
TAM06WE-64-2	67.12	25.83	2.74
DP1032B3RF	65.22	31.48	2.82
NM03N155	67.68	41.61	2.83

NM03012	71.39	37.50	2.99
PHY755WRF	75.23	45.54	3.04
DP1050B2RF	76.00	45.04	3.06
PHY367WRF	73.72	47.23	3.09
MD10	74.65	43.17	3.10
PHY72*	75.30	49.40	3.11
DP161B2RF	70.29	39.22	3.14
DP555BG/RR	62.03	30.81	3.17
ST4554B2RF	80.48	37.79	3.18
DP1043B2RF	76.48	38.67	3.19
PHY375WRF	72.89	42.69	3.21
DP1048B2RF	80.67	51.59	3.32
F Value	1.34	1.49	1.37
Pr > F	0.14	0.08	0.13
LSD(0.05)	18.66	20.93	0.96

* Tested twice under separate entry identifications.

Advanced Upland Breeding Lines

Difference in disease rating and percentages of infected and defoliated leaves were also not significant among the 32 genotypes, even though the disease rating ranged from 1.96 to 3.37 (Table 2). There were positive correlations among the three criteria in this test (data not shown). TAM03WZ-37 had the lowest percentage of infected and defoliated leaves and disease rating, followed by MD25ne and PD05041, while PX03202-65-1 and DP393 were most susceptible to VW.

Table 2. Greenhouse evaluation of VW resistance in advanced Upland breeding lines, Las Cruces, NM, 2011.

Genotype	Infected leaves (%)	Defoliated leaves (%)	Rating
TAM03WZ-37	53.24	8.27	1.96
MD25ne	54.44	23.55	2.04
PD05041	59.81	24.84	2.04
LBB-07-21-311	65.11	22.25	2.17
PX03201-66-1	53.54	29.31	2.17
NM06N1104	60.01	27.75	2.29
PD05035	57.60	25.93	2.30
Ark0232-24	59.53	22.96	2.33
AU3202	60.71	17.41	2.42
GA2006106	64.94	33.88	2.42
AU6001	66.04	39.91	2.42
AU6202	65.69	30.97	2.50
NM03012	61.66	41.83	2.50
LA07307111	67.60	28.17	2.58
NMW1218	68.73	37.89	2.63
AU3111	66.11	32.15	2.71
LA07307106	74.46	42.23	2.71
GA2007095	64.12	40.71	2.78

Ark0203-11	71.51	37.90	2.83
Ark0222-12	70.91	27.68	2.86
NC05AZ06	68.97	36.14	2.88
GA2004143	69.21	42.53	2.88
FM958	73.33	31.42	2.89
GA2006053	67.94	38.19	2.96
Ark0219-15	68.19	37.50	2.99
NM06N1166	70.16	43.06	3.00
SG105	75.76	49.42	3.00
0033-6	75.67	40.26	3.04
MD25Y	73.02	49.65	3.08
NC09AZ09	76.68	45.22	3.09
LA0730712	76.97	48.45	3.10
LA06307025	72.85	41.94	3.12
PX03202-65-1	79.66	48.79	3.25
DP393	79.60	43.13	3.37
F Value	1.24	1.32	1.54
Pr > F	0.21	0.15	0.06
LSD(0.05)	18.42	23.78	0.86

Pima Cotton

The disease rating and percentages of infected and defoliated leaves were significantly different among the 10 Pima cotton genotypes tested (Table 3). The disease rating for PHY 800, PHY 830, and DP 357 was less than 2.00, showing the highest level of VW resistance and the percentages of infected and defoliated leaves were also relatively low. However, the disease ratings for Pima S-7, 06E2032-1 and 06E2023-1 were 308, 3.33 and 3.46, respectively, being most susceptible to VW.

Table 3. Greenhouse evaluation of VW resistance in Pima cotton, Las Cruces, NM, 2011.

Genotype	Infected leaves (%)	Defoliated leaves (%)	Rating
PHY 800	43.53	29.48	1.29
PHY 830	66.12	46.88	1.83
DP357	64.01	33.09	1.97
COBALT	55.55	31.16	2.08
DP360	64.20	42.20	2.21
DP340	68.25	50.04	2.33
NM06E2062-1	70.05	48.50	2.53
Pima S-7	85.22	44.47	3.08
NM06E2032-1	86.76	51.34	3.33
NM06E2023-1	91.96	55.58	3.46
F Value	3.93	2.92	3.65
Pr > F	0.00	0.01	0.00
LSD(0.05)	21.76	15.45	1.06

Summary

The disease rating and percentages of infected and defoliated leaves were different among 76 cotton cultivars and lines. However, significant genotypic variation was detected in only one of the three tests due to high experimental errors. The greenhouse tests will be repeated. The three criteria were positively correlated. Overall, six cultivars including Pima PHY800, PHY830 and DP357 and Upland FM9160B2F, PHX4912WRF and ST4288B2F were more resistant than others; several advanced breeding lines including TAM03WZ-37, MD25ne and PD05041 also showed good VW resistance; more than 20 cultivars and lines displayed a moderate level of resistance to VW; and 46 cultivars (60.5% of the total) were susceptible to VW.

References

Blasingame, D. and M.V. Patel. 2005. Cotton disease loss estimate committee report. Proc. Beltwide Cotton Conf. pp. 259–262.

Lüders, R. R., R. Galbieri, M. G. Fuzatto, and E. Cia. 2008. Inheritance of Resistance to Verticillium Wilt in Cotton. Crop Breed. Appl. Biotech. 8:265–270.

Zhang, J. F., S. Sanogo, R. Flynn, J.B. Baral, S. Bajaj, S. Hughs, and R.G. Percy. 2011. Germplasm Evaluation and Transfer of Verticillium Wilt Resistance from Pima (*Gossypium barbadense*) to Upland Cotton (*G. hirsutum*). Euphytica (online)