EFFECT OF VARIETY AND ENVIRONMENTAL VARIABLES ON VERTICILLIUM WILT IN THE SOUTHERN HIGH PLAINS OF TEXAS

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Abstract

Small plot variety trials were conducted in five commercial cotton fields where Verticillium wilt was a problem. Entries were rated for wilt incidence, defoliation, yield, and lint quality. The top 8 entries based on these four attributes were: Fibermax (FM) 2484B2F, FM 2322GL, FM 9170B2F, ST 4747GLB2, NexGen 4111RF, FM 2989GLB2, Deltapine 1044B2RF, and FM 2011GT. Verticillium wilt incidence across a number of different fields was predicted by microsclerotia density of the fungus (*Verticillium dahliae*) interacting with soil temperature during the middle of July through August. Yield across a number of different sites was also predicted by soil temperature or soil moisture, but not by microsclerotia density, wilt incidence, or interactions with soil temperature or moisture.

Introduction

Verticillium wilt has been a historic problem in the Southern High Plains of Texas. Management of this disease includes four options: using partially resistant varieties; crop rotation with nonhosts to reduce microsclerotia density; not overwatering; and using an appropriate seeding rate (El-Zik, 1985; Leyendecker, 1950; Wheeler et al., 2010, 2012). There are no strong sources of genetic resistance in commercial varieties for this disease, though there are certainly differences between commercial varieties in their performance in Verticillium wilt fields. All commercial varieties appear to be susceptible to some extent to this disease and allow reproduction of the fungus. However, yield differences do consistently occur in Verticillium wilt fields between varieties, and the higher yielding germplasm is often associated with a reduction in wilt incidence and/or defoliation (Wheeler and Woodward, 2011, 2013). Crop rotation with nonhosts has been less effective once the density of the fungus has built to higher levels, because it takes many years to reduce the fungal density with nonhosts (Huisman and Ashworth, 1976), though crop rotation can be effective in slowing the buildup of the fungus initially if implemented before there is a Verticillium wilt problem (Wheeler et al., 2012). High irrigation rates leads to higher microsclerotia population densities and higher wilt symptom expression (Wheeler, et al., 2012). However, yield potential is also a function of available water. It is a challenge to manage irrigation rate appropriately to maximize yield in Verticillium wilt fields. In nonwilt fields in this region, higher yield is typically associated with higher irrigation capacity, but that is not always true in Verticillium wilt fields. This is an area that requires much more investigation to be used effectively as a tool.

Materials and Methods

Variety Trials

Small plot variety trials were conducted at five producer fields with a history of Verticillium wilt. Sites were located near the towns of Halfway, Plainview, Floydada, Ropesville, and Garden City, TX. Plot size was 36 ft. long, 2-rows wide, with 30 or 40-inch centers. There were 32 entries per site, arranged in a randomized complete block design with four replications. There were four varieties included as checks at all sites: Fibermax (FM) 2484B2F, FM 9180B2F, Deltapine (DP) 0912B2RF, and Americot (AM) 1504B2RF. All entries were planted at a seeding rate of 4 seed/ft. of row using a cone planter. Two soil samples were collected at the time of planting and assayed for *Verticillium dahliae* microsclerotia (Wheeler et al., 2012). Data collected for each plot included: plant stands for both rows, incidence of wilt for both rows, defoliation at 20 locations/plot, and lint yield. A sample (approximately 1,000 g) of the stripper harvested cotton was collected at the time of harvest and two of the four replicates were ginned to determine lint turnout. A fiber sample from the ginned cotton was sent to Texas Tech Fiber and Biopolymer Center for HVI analysis and a loan value was obtained for each variety as a result of the HVI analysis. A value parameter was created by multiplying the lint yield by the loan value. Wilt incidence was calculated as the number of plants exhibiting symptoms of Verticillium wilt/total number of plants in a plot. Defoliation was rated on a 0 to 3 scale, 0 = no defoliation; 1 = < 33% of the plant defoliated; 2 = between 33 and 66% of the plant defoliated; and 3 = > 66% of the plant is defoliated. For analysis, the midpoint of each defoliation category was used to calculate % defoliation (i.e. 0, 16.7%, 49.5%, and 82.5%) for each of the 20 values obtained per plot. Analysis for all parameters were conducted using Proc GLM in SAS version 9.3, (SAS Institute, Cary, NC), and mean separation was conducted with the Waller-Duncan k-ratio t-test (*P*=0.05). An overall ranking of the germplasm across all test sites was obtained by creating a relative value for wilt, defoliation, yield, and value. The relative value was the individual plot value for each parameter, divided by the highest average value for an entry in that test site. The relative values for entries were then analyzed using PROC MIXED in SAS, version 9.3.

Environmental Effects on Verticillium Wilt Fields

Soil moisture and temperature probes were placed at a 4-inch depth before 1 July at all test sites listed above as well as a number of other locations (34 total data sets) where Verticillium wilt was being monitored on a large plot, or entire field scale. Microsclerotia density was obtained from each field. For small plot trials, the wilt incidence and yield for FM 2484B2F and DP 0912B2F were used to represent that field for partially resistant and susceptible varieties. In the model development, the values of 1 and 0 were used to describe the type of variety. For fields that were monitored for the model development, 20 locations were selected at random, soil sampled for *V. dahliae* microsclerotia, and monitored for incidence of Verticillium wilt. An additional factor of irrigation type (drip versus center pivot) was also included in the model development with drip =1 and center pivot = 0. The producer provided the average yield for the field. Soil temperature and soil moisture values for each week from 1 July – 31 August was averaged and used with microsclerotia density, irrigation type and variety type to predict Verticillium wilt incidence and yield.

Results and Discussion

Variety Trials

At the Floydada site, average microsclerotia density was 6.5/cc soil, and significant wilt symptoms were late to develop. Wilt incidence on 29 August ranged from 12 to 36%, defoliation in September ranged from 22 to 72%, and yield ranged from 1,409 to 2,170 lbs of lint/acre. Incident of wilt and defoliation explained 30 and 34% of the variation of yield, respectively. The top three performers in terms of yield x loan value at this site were FM 2484B2F, FM 2322GL, and FM 2989GLB2 (Table 1). At the Plainview site, average microsclerotia density was 5.5/cc soil and wilt symptoms developed earlier than usual. Wilt incidence on 30 July ranged from 23 to 55%, defoliation in September ranged from 30 to 76% and yield ranged from 932 to 1,965 lbs of lint/acre. Incident of wilt and defoliation explained 35 and 24% of the variation of yield, respectively. The top three performers in terms of lint yield x loan value were NexGen (NG) 4111RF, FM 2484B2F, and FM 2322GL (Table 2). At the Halfway site, average microsclerotia density was 19.5/cc soil, and significant wilt symptoms developed during the last several weeks of August, which is typical of this region. Wilt incidence on 24 August ranged from 15 to 45%, defoliation ranged from 22 to 65%, and yield ranged from 925 to 1,752 lbs of lint/acre. Incident of wilt and defoliation explained 22 and 14% of the variation of yield, respectively. The top three performers in terms of lint yield x loan value were FM 2484B2F, ST 4747GLB2, and FM 2011GT (Table 3). At the Ropesville site, average microsclerotia density was 32/cc soil, and significant wilt developed during the last two weeks of August. This site also had root-knot nematode present, but it did not appear to be as important a yield limiting problem as Verticillium wilt. Wilt incidence on 26 August ranged from 45 to 80%, defoliation in September ranged from 34 to 71%, lint yield ranged from 593 to 1,464 lbs of lint/acre, and average root-knot nematode density in September ranged from 130 to 21,030 per 500 cm^3 soil (Table 4). Incident of wilt and defoliation explained 17 and 40% of the variation of yield, respectively. The top three performers in terms of lint yield x loan value were FM 2484B2F, NG 4111RF, and DP 1311B2RF (Table 4). At the Garden City site, average microsclerotia density was 47.5/cc soil and significant wilt symptoms were somewhat late to develop at this site. Wilt incidence on 28 August ranged from 13 to 46%, defoliation ranged from 11 to 71%, and lint yield ranged from 1,244 to 2,294 lbs of lint/acre (Table 5). Incident of wilt and defoliation explained 35 and 29% of the variation of yield, respectively. The top three performers in terms of lint yield × loan value were an experimental line from Bayer CropSciences BX 1445GLB2, FM 2484B2F, and FM 9170B2F (Table 5).

Table 1. The effect of Verticillium wilt on varieties in Floydada.

Variety	Plants/ft	%Wilt on 8/29	%Defol-iation	Lbs lint/acre	Turn out	Yield × Loan ($/a)	Loan ($/lb)
FM 2484B2F	2.9	12	23	2170	0.3071	1241	0.5720
FM 2322GL	1.8	9	23	2149	0.3440	1225	0.5700
FM 2989GLB2	2.5	18	29	2132	0.2930	1221	0.5725
FM 9170B2F	2.6	12	29	2012	0.3021	1161	0.5773
FM 2011GT	2.6	19	38	2037	0.3118	1156	0.5678
CT 13545B2RF	2.7	19	24	1979	0.2983	1143	0.5773
NGX 3306	2.9	23	45	1997	0.2968	1126	0.5640
DP 1219B2RF	2.6	12	22	1945	0.2998	1122	0.5770
FM 9180B2F	2.7	21	28	1951	0.2846	1114	0.5710
ST 4747GLB2	2.6	14	34	2054	0.2946	1107	0.5390
FM 1944GLB2	2.6	22	41	1872	0.2937	1073	0.5733
PHY 339WRF	2.9	13	34	1848	0.3140	1063	0.5455
AT Nitro-44B2RF	2.8	21	22	1928	0.2989	1052	0.5753
DP 1212B2RF	3.1	19	68	1948	0.2932	1045	0.5363
PHY 499WRF	2.7	36	63	1902	0.2989	1037	0.5453
NG 4111RF	2.6	16	35	1795	0.2972	1031	0.5745
DP 0912B2RF	2.9	16	58	1781	0.3038	1001	0.5618
FM 9250GL	2.8	14	39	1834	0.2876	996	0.5433
NG 1511B2RF	2.5	23	53	1816	0.3008	990	0.5450
FM 1320GL	2.2	18	60	1717	0.3049	962	0.5603
CG 3428B2RF	2.4	22	56	1649	0.3151	950	0.5758
AT EdgeB2RF	3.1	24	53	1825	0.2762	948	0.5195
PHY 3080-1	2.6	24	48	1696	0.2911	944	0.5568
NG 3348B2RF	2.2	13	28	1719	0.2816	915	0.5323
NGX 2322B2RF	2.6	18	40	1599	0.2807	912	0.5705
PHY 4433-25	2.8	23	64	1708	0.2944	887	0.5193
NG 2051B2RF	2.7	21	39	1623	0.2542	870	0.5358
AM 1532B2RF	2.7	24	54	1591	0.2749	869	0.5460
CG 3156B2RF	2.7	35	62	1667	0.2955	864	0.5185
CT 13363B2RF	2.7	33	54	1558	0.2758	863	0.5540
AM 1504B2RF	2.1	25	44	1440	0.2668	806	0.5600
PHY 4433-27	2.5	33	72	1409	0.2675	690	0.4893
MSD(0.05)	0.4	13	15	199	0.021	104	0.025

*AM = Americot, AT=All-Tex, BX=experimental line for Bayer Cropsciences, CG=Croplan Genetics, CT= experimental line for Dynagro, DP = Deltapine, FM=Fibermax, NG=NexGen, NGX=experimental line for NexGen, PHY= Phytogen, ST=Stoneville.

Table 2. The effect of Verticillium wilt on variety in Plainview.

Variety	Plants/ft	%Wilt on 7/31	%Defol-iation	Lbs lint/a	Turnout	Yield × Loan ($/a)	Loan ($/lb)
NG4111RF	2.7	37	48	1965	0.287	1111	0.5658
FM2484B2F	3.2	23	30	1910	0.278	1025	0.5370
FM 2322GL	1.7	38	30	1746	0.317	1016	0.5820
FM2011GT	2.9	27	50	1774	0.298	984	0.5545
ST 4747GLB2	2.6	34	46	1884	0.297	979	0.5195
DP1321B2RF	3.4	27	73	1675	0.299	909	0.5430
FM9180B2F	3.1	34	42	1632	0.259	904	0.5543
NGX3306	3.5	36	47	1594	0.288	897	0.5628
PHY339WRF	3.3	33	42	1623	0.279	877	0.5400
FM 1320GL	1.6	49	57	1512	0.295	873	0.5775
ATNitro-44B2RF	3.1	31	40	1692	0.263	847	0.5008
FM9250GL	2.7	31	57	1512	0.273	825	0.5458
PHY3080-1	2.4	32	55	1457	0.281	820	0.5630
NG1511B2RF	2.8	37	63	1415	0.295	803	0.5675
DP1044B2RF	3.2	32	36	1590	0.258	800	0.5035
FM2989GLB2	2.8	37	41	1470	0.260	791	0.5383
NG3348B2RF	2.3	28	35	1472	0.251	785	0.5335
PHY4433-27	2.6	38	64	1473	0.277	784	0.5325
FM1944GLB2	2.7	36	45	1501	0.249	772	0.5143
DP1219B2RF	2.7	33	38	1526	0.261	767	0.5025
DP1311B2RF	1.8	54	36	1465	0.263	764	0.5215
PHY367WRF	2.9	35	68	1432	0.267	748	0.5225
DP0912B2RF	2.5	35	60	1340	0.275	715	0.5335
NG2051B2RF	2.9	37	51	1293	0.238	703	0.5435
CT13883	2.9	36	57	1332	0.254	684	0.5133
CG3156B2RF	3.1	40	67	1272	0.281	674	0.5300
PHY375WRF	3.0	31	76	1259	0.261	651	0.5173
CT13125B2RF	2.9	33	74	1196	0.276	609	0.5093
AM1532B2RF	2.6	41	53	1109	0.245	591	0.5328
AM1504B2RF	1.8	45	47	1076	0.246	543	0.5047
CG3428B2RF	1.4	54	54	977	0.251	506	0.5178
CT13513RF	2.1	55	67	932	0.251	499	0.5350
MSD (0.05)	0.3	14	13	137	0.023	73	0.0600

*AM = Americot, AT=All-Tex, BX=experimental line for Bayer Cropsciences, CG=Croplan Genetics,CT= experimental line for Dynagro, DP = Deltapine, FM=Fibermax, NG=NexGen, NGX=experimental line for NexGen, PHY= Phytogen, ST=Stoneville.

Table 3. The effect of Verticillium wilt on variety in Halfway.

Variety	Plants/ft	%Wilt on 8/24	%Defol-iation	Lbs lint/a	Turnout	Yield × Loan ($/a)	Loan ($/lb)
FM 2484B2F	2.99	19	30	1752	0.395	936	0.534
ST 4747GLB2	2.49	21	32	1547	0.384	822	0.532
FM 2011GT	2.64	26	36	1445	0.370	792	0.548
FM 2322GL	1.94	16	22	1404	0.421	786	0.560
PHY 339WRF	2.63	40	25	1320	0.379	739	0.560
FM 9180B2F	2.74	30	34	1321	0.338	735	0.557
FM 2989GLB2	2.71	21	39	1372	0.362	733	0.534
NG 4111RF	2.47	28	40	1296	0.369	713	0.551
PHY 367WRF	2.94	36	52	1222	0.377	682	0.558
DP 1212B2RF	2.92	39	65	1204	0.358	670	0.557
DP 1321B2RF	2.97	29	60	1212	0.372	667	0.551
FM 1944GLB2	2.15	24	31	1175	0.372	665	0.566
DP 1219B2RF	2.44	26	33	1157	0.377	649	0.561
FM 9250GL	2.65	15	36	1218	0.356	644	0.529
DP 1311B2RF	2.74	19	25	1173	0.397	643	0.548
DP 0912B2RF	2.18	36	45	1188	0.379	639	0.538
NG 1511B2RF	2.44	27	51	1180	0.391	636	0.539
NG 3348B2RF	2.44	23	36	1193	0.357	630	0.529
PHY 3080-1	2.59	30	38	1173	0.364	617	0.526
AM 1532B2RF	2.34	30	41	1101	0.356	610	0.554
NG 4010B2RF	2.39	31	45	1069	0.347	605	0.566
NG 2051B2RF	2.76	29	47	1098	0.317	595	0.543
CT 13545B2RF	2.93	36	46	1099	0.369	591	0.538
FM 1320GL	1.72	21	35	1069	0.372	590	0.552
CG 3156B2RF	2.75	40	61	1196	0.374	585	0.489
NGX 2322B2F	2.49	26	40	1061	0.354	579	0.546
PHY 4433-27	2.49	33	62	1137	0.352	570	0.502
CT 13125B2RF	2.45	40	64	1129	0.364	567	0.502
CT 13363B2RF	2.02	42	48	1018	0.373	566	0.557
CT 13663	2.76	45	54	1080	0.340	548	0.507
AT EdgeB2RF	2.74	41	58	1119	0.330	537	0.480
AM 1504B2RF	1.75	37	34	925	0.342	473	0.511
MSD(0.05)	0.40	17	9	217	0.023	115	0.048

*AM = Americot, AT=All-Tex, BX=experimental line for Bayer Cropsciences, CG=Croplan Genetics,CT= experimental line for Dynagro, DP = Deltapine, FM=Fibermax, NG=NexGen, NGX=experimental line for NexGen, PHY= Phytogen, ST=Stoneville.

Table 4. The effect of Verticillium wilt on variety in Ropesville.

Variety	Plants/ft	% Wilt on 8/26	%Defol i-ation	Lbs lint/a	Turn out	Yield × Loan ($/a)	Loan ($/lb)	RK/ 500 cc soil**
FM 2484B2F	3.0	49	38	1464	0.292	786	0.5373	21,030 a
NG 4111RF	2.6	54	39	1349	0.279	736	0.5458	4,650 a-d
DP 1311B2RF	2.0	56	34	1401	0.286	722	0.5153	1,885 a-d
BX 1445GLB2	2.4	68	47	1336	0.305	707	0.5290	18,450 ab
FM 9180B2F	2.9	61	43	1343	0.277	700	0.5210	1,680 a-d
FM 2989GLB2	2.7	52	54	1224	0.278	604	0.4935	4,620 a-d
FM 9250GL	2.9	46	55	1196	0.260	574	0.4803	9,720 ab
NG 4012B2RF	2.7	53	51	1116	0.272	571	0.5123	3,960 abc
FM 1320GL	1.5	64	54	1156	0.278	544	0.4708	3,210 cd
DP 1044B2RF	2.9	45	35	1193	0.251	543	0.4550	9,600 abc
FM 2011GT	3.1	47	63	1174	0.270	542	0.4613	1,530 a-d
NG 2051B2RF	3.0	52	45	1157	0.244	538	0.4645	7,440 abc
NG 3348B2RF	2.4	56	39	1138	0.263	534	0.4688	7,020 abc
DP 0912B2RF	2.8	60	60	1098	0.272	530	0.4833	795 a-d
NGX 2322B2RF	2.8	61	40	1050	0.247	523	0.4980	18,510 abc
DP 1212B2RF	3.2	58	71	1105	0.278	519	0.4698	6,775 a-d
ST 6448GLB2	2.4	64	48	1026	0.281	502	0.4893	13,380 abc
NG 1511B2RF	2.5	63	68	972	0.298	480	0.4943	3,270 a-d
PHY 499WRF	3.0	57	60	1021	0.272	477	0.4670	15,390 abc
ST 4946GLB2	2.6	58	58	1016	0.268	466	0.4585	480 d
PHY 565WRF	2.4	57	52	998	0.274	461	0.4623	1,650 a-d
PHY 4433-25	2.8	53	55	1006	0.266	451	0.4488	130 b-d
DP 1219B2RF	2.3	55	45	941	0.264	444	0.4715	10,170 abc
NG 5315B2RF	1.6	70	60	836	0.274	430	0.5145	770 a-d
AM 1504B2RF	1.9	66	52	877	0.248	425	0.4850	5,750 abc
CT 13663	2.8	63	63	924	0.256	423	0.4583	5,340 abc
CT 13883	2.8	59	52	921	0.244	417	0.4533	4,410 abc
DP 1359B2RF	2.9	46	53	855	0.259	405	0.4740	9,395 abc
CG 3787B2RF	2.5	68	64	815	0.258	393	0.4825	1,950 a-d
PHY 367WRF	2.9	46	66	862	0.237	387	0.4490	3,600 a-d
DP 1252B2RF	1.9	80	56	741	0.258	373	0.5030	4,800 a-d
CT 13513RF	1.9	68	71	593	0.248	275	0.4648	9,630 abc
MSD(0.05)	0.3	16	11.6	152	0.027	74	0.0487	LOG_{10}(RK)

*AM = Americot, AT=All-Tex, BX=experimental line for Bayer Cropsciences, CG=Croplan Genetics, CT= experimental line for Dynagro, DP = Deltapine, FM=Fibermax, NG=NexGen, NGX=experimental line for NexGen, PHY= Phytogen, ST=Stoneville.

**Mean separation based on Log_{10} transformation of root-knot nematode (RK) density.

Table 5. The effect of Verticillium wilt on varieties at Garden City.

Variety	Plants/ft	%Wilt on 8/28	%Defol-iation	Lbs lint/a	Turnout	Yield x Loan ($/a)	Loan ($/lb)
BX 1445GLB2	2.7	28	23	2294	0.298	1251	0.5455
FM 2484B2F	2.9	17	18	2105	0.273	1149	0.5458
FM 9170B2F	2.8	17	24	2051	0.286	1110	0.5410
NG 4012B2RF	2.8	24	30	1828	0.280	1015	0.5555
FM 9180B2F	2.8	28	31	1888	0.260	1014	0.5370
DP 1311B2RF	2.0	32	29	1908	0.296	1008	0.5280
FM 2989GLB2	2.8	15	17	1904	0.265	993	0.5213
DP 1321B2RF	2.8	37	58	1820	0.296	991	0.5445
FM 1944GLB2	2.6	23	18	1811	0.265	988	0.5455
ST 4747GLB2	2.6	22	32	1938	0.271	972	0.5015
NG 4010B2RF	2.5	32	34	1733	0.244	940	0.5428
PHY 3080-1	2.7	35	52	1692	0.270	910	0.5380
CG 3787B2RF	2.6	36	48	1666	0.281	907	0.5443
ST 4946GLB2	2.7	31	50	1784	0.275	899	0.5040
FM 2322GL	1.8	13	11	1646	0.297	897	0.5450
AM 1532B2RF	2.7	34	46	1583	0.259	893	0.5640
DP 1219B2RF	2.4	26	20	1689	0.267	885	0.5238
CG 3428B2RF	2.4	36	46	1670	0.274	884	0.5290
NG 2051B2RF	2.9	21	29	1609	0.248	859	0.5340
NG 5315B2RF	2.1	39	36	1598	0.283	857	0.5363
DP 1252B2RF	2.1	42	40	1564	0.284	851	0.5445
AT Nitro-44B2RF	2.8	23	25	1711	0.263	850	0.4968
PHY 375WRF	2.8	25	53	1629	0.268	843	0.5178
PHY 565WRF	2.6	25	31	1619	0.255	839	0.5183
DP 0912B2RF	2.0	42	50	1581	0.274	832	0.5263
PHY 499WRF	3.1	31	44	1634	0.269	830	0.5080
PHY 4433-25	2.6	31	46	1663	0.274	795	0.4778
DP 1359B2RF	2.8	29	37	1586	0.258	765	0.4828
CT 13125B2RF	2.8	32	71	1456	0.268	743	0.5100
ST 6448GLB2	2.5	36	38	1481	0.261	740	0.4995
CT 13513RF	2.1	46	60	1294	0.248	678	0.5238
AM 1504B2RF	2.0	45	41	1244	0.241	653	0.5253
MSD(0.05)	0.4	12	11	132	0.018	70	NS

*AM = Americot, AT=All-Tex, BX=experimental line for Bayer Cropsciences, CG=Croplan Genetics, CT= experimental line for Dynagro, DP = Deltapine, FM=Fibermax, NG=NexGen, NGX=experimental line for NexGen, PHY= Phytogen, ST=Stoneville.

Environmental Effects on Verticillium Wilt Fields

A model was developed that included a quadratic component for microsclerotia density (Ms) and its interaction with soil temperature. The R^2 values for this model were better than for soil moisture or soil temperature alone (Fig. 1). The soil temperatures where none of the 34 fields had damaging levels of wilt was 78, 81, 80, 79, 77, and 76º F for 15-21 July, 22-28 July, 29 July – 4 Aug, 5-11 Aug, 12-18 Aug, and 19-25 Aug, respectively.

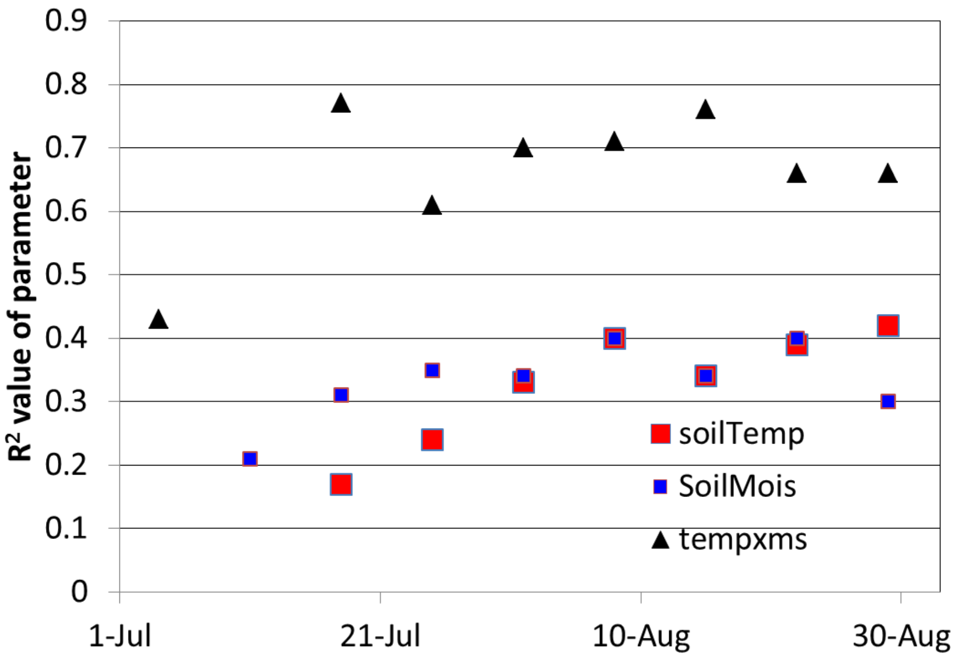

Figure 1. R^2 values for a model with square root of microsclerotia of *Verticillium dahliae*/cc soil and the interaction with soil temperature ( ) and the incidence of wilt for 34 data sets collected in 2012 and 2013. The relationship between wilt incidence and soil temperature alone ( ) or soil moisture ( ) is also presented.

Yield was not related to microsclerotia density, variety type, or their interactions with soil temperature or soil moisture. Yield was negatively related to soil temperature and positively related to soil moisture during the middle of July through August. Yield was also related to irrigation type, and was higher with drip irrigation than with center pivot irrigation.

Summary

Cotton varieties that performed better in Verticillium wilt fields were: Fibermax 2484B2F, FM 2322GL, FM 9170B2F, ST 4747GLB2, NG 4111RF, FM 2989GLB2, DP 1044B2RF, and FM 2011GT. It was possible to predict wilt with the interaction between soil temperature and microsclerotia density. Yield was predicted with soil temperature or moisture, but not with disease specific parameters like microsclerotia density, status of variety type (resistant or susceptible), or wilt incidence.

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