Screening the Peanut Core Collection for Resistance to Tomato Spotted Wilt Virus

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ABSTRACT

Tomato spotted wilt virus (TSWV) is among the greatest yield-reducing viruses affecting peanut (*Arachis hypogaea* L.). The best known method of control of TSWV is through the use of resistant cultivars. Unfortunately, only a few peanut genotypes with moderate levels of resistance are known. The objectives of this study were to identify additional sources of resistance to TSWV and to determine whether plant descriptor information is associated with reaction to TSWV in the field. Peanut plant introductions from a core collection were evaluated for resistance to TSWV in field trials from 1991 to 1993. Great variability was found among PIs for reaction to natural TSWV epidemics at Attapulgus, GA. Accessions which exhibited potential resistance in 1991 or 1992 were reevaluated in subsequent years. Disease pressure was high in 1993 and 27 accessions exhibited significantly greater resistance than Florunner, and one (PI 262049) had lower disease incidence than Southern Runner. Only minor relationships existed between TSWV incidence and plant descriptor traits (growth habit and maturity) using the stepwise multiple regression procedure. Peanut accessions with resistance to TSWV were found among all maturity levels and growth habits. These accessions provide additional parents and may provide additional genes for resistance that may be useful in developing resistant cultivars.

Key Words: Core collection, peanut, resistance, tomato spotted wilt virus.

Many biological and environmental constraints limit peanut production and profits. Most currently available peanut cultivars have been developed and released solely on the basis of superior yield and acceptable seed quality traits. If use of pesticides becomes limiting, growers will have to accept lower yields or use cultivars with improved resistance to pests. No effective controls are available for some soilborne diseases and viruses. In the U.S., tomato spotted wilt virus (TSWV) has the greatest potential of the viruses to lower yields (Culbreath *et al.*, 1992). The occurrence of TSWV has increased in peanut production areas in the Southwest (Black *et al.*, 1986) and in the Southeast (Hagan *et al.*, 1990; Thompson and Brown, 1990).

Currently, Southern Runner is the only available peanut cultivar with partial resistance to multiple soilborne and foliar diseases, including TSWV (Gorbet *et al.*, 1987; Culbreath *et al.*, 1993). The discovery and use of additional sources of resistance to TSWV are important. The Southern Regional Plant Introduction Station in Experiment, GA has over 7000 peanut accessions collected from around the world. No systematic screening of the entire collection has been performed for most pests

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because of the limited availability of resources for proper screening. Significant resistance to both early (*Cercospora arachidicola* Hori) and late leaf spot [*Cercosporidium personatum* (Berk. & Curt.) Deighton] (Sowell *et al.*, 1976; Anderson *et al.*, 1993), root-knot nematode [*Meloidogyne arenaria* (Neal) Chitwood] (Holbrook and Noe, 1992), and Cylindrocladium black rot [*Cylindrocladium parasiticum* (Crous, Wingefield, and Alfenas)] (Coffelt, 1980) has been found by screening parts of the germplasm collection.

A core collection was established to represent the U.S. peanut germplasm collection (Holbrook *et al.*, 1993). This allows screening approaches that reduce the number of accessions to be initially evaluated while maintaining most of the genetic variability present in the larger collection. Holbrook and Anderson (1995) demonstrated that screening this core collection would have been an efficient and effective approach for identifying germplasm resistant to late leaf spot. The objectives of this study were to utilize the core collection to (a) identify peanut plant introductions with resistance to TSWV and (b) determine whether plant descriptor information is associated with reaction to TSWV in the field.

Methods and Materials

Genotype screening for resistance to TSWV was conducted at the Univ. of Georgia Attapulgus Res. Stn., Attapulgus, GA. For initial screening trials, seed were planted in a randomized complete-block design with four replications and included 335, 168 and 91 plant introductions from the peanut core collection in 1991, 1992, and 1993, respectively. Plots consisted of two rows 0.91 m apart and 1.6 m long, with 2 m between plots. Ten seeds were planted in each row on 24 April 1991, 23 April 1992, and 22 April 1993. Multiple plots of Florunner and Southern Runner were included in each test as checks.

Genotypes with low TSWV ratings in 1991 or 1992 were retested the following year. These tests contained 68 and 55 genotypes with 10 replications during 1992 and 1993, respectively. Seeds were planted in 1.6 m double-row plots on 23 April 1992 and 22 April 1993. Twenty-four genotypes with 10 replications were screened a third time by planting on 22 April 1993 in 3.2-m rows. Test location and seed spacing were consistent with previous tests.

All plots were maintained as recommended by the Georgia Ext. Serv. (Johnson *et al.*, 1987); however, no insecticides were applied. Plant stand counts were recorded approximately 30 d after planting. Plants were examined for symptoms of TSWV at 3-wk intervals starting 3-wk after stand counts. The presence of TSWV was confirmed by serological assay on symptomatic plants in adjacent peanut tests. A total of four ratings were recorded each year. The final count of diseased plants was divided by the number of initial plants per plot and then multiplied by 100 to obtain a percentage of infected plants.

Seed increase plots of all core collection accessions were planted at the Coastal Plain Expt . Stn. at Tifton on 27 April 1991 in two-row 6.4-m plots. At approximately 90 d after planting the following peanut descriptors (Pittman, 1995) were recorded for each entry:

1. Growth habit (1 = prostrate, 2 = spreading, 3 = spreading bunch, 4 = bunch, 5 = erect, 6 = mixed)
2. Mainstem prominence (1 = not apparent, 2 = somewhat apparent, 3 = apparent, 4 = mixed)
3. Flowers on mainstem (1 = no flowers, 2 = flowers present)
4. Leaf color (1 = very light green, 2 = light green, 3 = green, 4 = dark green, 5 = very dark green, 6 = mixed, 7 = other)
5. Stem pigmentation (1 = green, 2 = purple, 3 = mixed, 4 = other)

At harvest three more plant growth characteristics were recorded:

6. Plant size (1 = dwarf, 2 = small, 3 = medium, 4 = large, 5 = extra large, 6 = mixed)
7. Mainstem prominence (same as no. 2)
8. Maturity (1 = very early, 2 = early, 3 = medium, 4 = late, 5 = very late, 6 = mixed)

Analyses of variance (SAS, 1985) and a Waller-Duncan k ratio t-test (Waller and Duncan, 1969) on entry means were performed for TSWV incidence. The means of TSWV incidence for initial testing were standardized over years by dividing entry means by the mean of Florunner (susceptible check). These TSWV values were then used to regress on plant descriptor traits using PROC STEPWISE of SAS (SAS, 1985) to determine relationships between TSWV incidence and plant growth characters.

Results

Of the 335 peanut accessions (PIs) screened in 1991, 20 showed no visible symptoms of TSWV disease. The average disease incidence for all genotypes in the test was 6.75% with a range between 0 and 28%. Florunner and Southern Runner had 8.6 and 2.8% plants infected with TSWV, respectively. Accessions with low (52 PIs) and high (14 PIs) TSWV incidence in 1991 were reevaluated in 1992. Four high and 18 low selections were evaluated a third time in 1993 (Table 1). LSD values were larger than disease incidence for Florunner in 1991 and 1992, so no significant levels of resistance were possible. Disease incidence was higher in 1993 than in the previous 2 yr. Ten PIs had significantly lower disease incidence than Florunner, and one (PI 262049) had lower disease incidence than Southern Runner in 1993. All of these PIs exhibited numerically, but not significantly, lower disease incidence than Florunner and Southern Runner in the two previous years of testing. The high selections were consistent also. Contrasts between high and low selections were highly significant ($P \leq 0.001$) each year, indicating consistency of genotype reaction over environments.

A second set of 168 peanut accessions from the core collection was initially screened in 1992. The overall TSWV incidence in 1992 was low and 27 PIs showed no symptoms of disease. These 27 PIs along with 24 other low selections and two high selections were included in a 10-replicate test in 1993. Seventeen accessions exhibited less ($P \leq 0.05$) disease than Florunner in 1993 (Table 2).

No PIs escaped disease among a third set tested in 1993 (Table 3). The LSD value for this four-replicate test was larger than disease incidence for Florunner, so

Table 1. Incidence of tomato spotted wilt virus (TSWV) in plant introductions of peanut tested for 3 yr at Attapulgus, GA.

PI/cultivar	Core collection no.	Country of origin	Maturity	Growth habit	Disease incidence[a] 1991	1992	1993
					--------%--------		
497631	131	Ecuador	Medium	Erect	27.8	17.8	26.6
493880	68	Argentina	Early	Erect	28.1	6.1	16.1
501987	141	Peru	Early	Erect	21.0	10.5	14.8
159664	234	India	Late	Spreading	17.8	10.5	13.1
162859	370	Sudan	Late	Spreading bunch	1.7	2.8	16.9
493799	60	Argentina	Early	Erect	1.8	1.3	12.4
497522	114	Brazil	Early	Erect	1.5	2.0	12.4
262028	412	Brazil	Early	Erect	1.8	0.6	10.7
162404	214	Bolivia	Medium	Erect	1.9	2.7	9.7
277188	229	India	Late	Spreading	1.7	3.4	9.0
196712	283	Mali	Late	Spreading bunch	1.3	1.2	7.9
262027	401	Brazil	Early	Erect	2.3	1.2	7.2
261982	316	Paraguay	Late	Spreading	3.6	0.0	7.1
259767	275	Malawi	Early	Erect	1.6	1.1	6.8
268621	359	Sudan	Early	Erect	1.5	2.9	6.7
331299	186	Argentina	Early	Erect	1.9	2.7	5.6
338503	217	India	Medium	Spreading	0.0	2.9	5.4
268656	479	Zambia	Early	Erect	0.0	1.5	4.9
268868	367	Sudan	Medium	Spreading bunch	1.6	1.8	4.5
371853	243	Israel	Medium	Bunch	1.6	1.3	4.4
259813	271	Malawi	Late	Spreading bunch	1.4	1.9	4.4
262049	402	Brazil	Medium	Erect	1.6	2.3	3.1
Florunner		U.S.	Late	Spreading	8.6	6.5	14.1
Southern Runner		U.S.	Very late	Spreading	2.8	3.0	9.6
Mean					6.7	4.8	9.7
LSD (0.05)					21.0	9.4	6.4

[a]Percentage of plants showing symptoms of TSWV at harvest. All plots used two rows. 1991 had four replications and 1.6-m long plots, 1992 had 10 replications and 1.6-m long plots, and 1993 had 10 replications and 3.2-m long plots.

no significant level of resistance was possible. However, eight genotypes had a numerically lower mean incidence of TSWV than Florunner and Southern Runner and need to be retested.

Growth habit, maturity, and leaf color were the only plant characteristics associated with TSWV incidence (Table 4). The low partial R^2 (square of the multiple correlation coefficient) values indicate that only a very small portion of the TSWV variability among PIs can be associated with these traits. Examination of the mean disease incidence revealed no significant differences between type of growth habit or between maturity groups.

Discussion

Experiments confirmed that a large amount of variability exists among peanut plant introductions for reaction to TSWV. Disease pressure was highest in 1993 and 27 PIs exhibited significantly greater resistance than Florunner; however, only one PI exhibited significantly greater resistance than Southern Runner. These PIs provide additional parents and may provide additional genes for resistance that may be useful in developing resistant cultivars.

No morphological characteristic of peanut plants was closely associated with degree of TSWV incidence. This indicates that indirect selection for TSWV resistance through plant descriptor traits may not be possible. Further, partial resistance may be found within any phenotypic group of interest. For incorporation of TSWV resistance into useful peanut lines in the Southeast, breeders could select resistant accessions with a spreading or spreading bunch growth habit, medium to late maturity, and desirable fruit characteristics among the PIs identified in the study. In other production regions, breeders could select growth characters similar to types grown in their area. Potentially useful parents should be assessed for yield potential and seed quality before being used in a breeding program.

It has been shown that the peanut core collection is effective in more efficiently identifying accessions with desirable characteristics (Holbrook and Anderson, 1995). The next step in identification of sources of resistance to TSWV would be to screen all PIs of the U.S. collection that are within the same clusters as the resistant core accessions.

Table 2. Incidence of tomato spotted wilt virus (TSWV) in plant introductions of peanut tested for 2 yr at Attapulgus, GA.

PI/cultivar	Core collection no.	Country of origin	Maturity	Growth habit	Disease incidence[a] 1992	1993
					----- %	-----
502082	152	Peru	Medium	Erect	23.1	18.6
346382	247	Israel	Medium	Spreading bunch	22.3	11.1
292305	491	Argentina	Medium	Bunch	1.6	28.5
403772	589	Argentina	Early	Erect	3.1	28.2
259603	500	Australia	Early	Erect	1.5	9.9
288129	511	India	Late	Spreading	1.3	9.8
319782	532	Israel	Medium	Mixed	0.0	9.6
355271	287	Mexico	Medium	Spreading	0.0	9.2
196719	1	Gambia	Medium	Spreading	1.9	9.0
295250	540	Israel	Medium	Mixed	1.4	8.9
378019	248	Israel	Medium	Spreading bunch	0.0	8.8
319756	530	Israel	Medium	Spreading bunch	1.3	8.7
295754	558	China	Medium	Bunch	1.7	8.6
290971	171	Columbia	Early	Erect	0.0	8.5
319768	529	Israel	Medium	Bunch	1.7	8.2
269003	462	Zambia	Medium	Spreading bunch	0.0	7.9
264188	501	Australia	Early	Erect	0.0	7.8
158840	555	China	Medium	Spreading	1.4	7.4
313167	564	China	Medium	Spreading bunch	0.0	7.0
264172	497	Australia	Medium	Bunch	0.0	6.6
288174	521	India	Medium	Spreading	0.0	3.1
Florunner		U.S.	Late	Spreading	5.3	21.3
Southern Runner		U.S.	Very late	Spreading	1.8	7.5
Mean					4.7	14.5
LSD (0.05)					23.2	11.0

[a]Percentage of plants showing symptoms of TSWV at harvest. Tests were replicated four times in 1992 and 10 times in 1993.

Table 3. Peanut plant introduction that exhibited high and low incidence of tomato spotted wilt virus (TSWV) when tested for 1 yr (1993) at Attapulgus, GA.

PI/ cultivar	Core collection no.	Country of origin	Maturity	Growth habit	Disease incidence[a]
					%
393641	714	Peru	Late	Erect	47.4
475849	601	Bolivia	Medium	Erect	34.2
268870	765	Zimbabwe	Medium	Mixed	31.6
475918	605	Bolivia	Early	Erect	31.3
408731	729	S. Africa	Early	Erect	31.2
275707	620	Brazil	Late	Spread. bunch	6.9
433356	648	China	Late	Spreading	6.8
461427	647	China	Early	Erect	6.4
415000	661	Israel	Very early	Erect	6.1
442715	619	Brazil	Medium	Erect	5.5
476454	695	Nigeria	Late	Mixed	4.8
442579	663	Japan	Medium	Erect	2.5
331337	604	Bolivia	Late	Bunch	1.8
399563	696	Nigeria	Late	Mixed	1.8
Florunner		U.S.	Late	Spreading	12.6
S. Runner		U.S.	Very late	Spreading	6.9
Mean					15.5
LSD (0.05)					24.4

[a]Percentage of plants in a four-replicate test showing symptoms of TSWV at harvest.

Table 4. Relationship of plant descriptors to incidence of variable tomato spotted wilt virus (TSWV) using initial evaluations of 520 peanut plant introductions.

Variable	Partial R^2	Model R^2	C(p)	F	Prob>F
Growth habit	0.0085	0.0085	3.79	4.45	0.0354
Maturity	0.0075	0.0160	1.85	3.95	0.0474
Leaf color	0.0040	0.0200	1.77	2.09	0.1486

Literature Cited

Anderson, W. F., C. C. Holbrook, and T. B. Brenneman. 1993. Resistance to *Cercosporidium personatum* within peanut germplasm. Peanut Sci. 20:53-57.

Black, M. C., P. F. Lumus, D. H. Smith, and J. W. Demski. 1986. An epidemic of spotted wilt disease in south Texas peanuts in 1985. Proc. Amer. Peanut Res. Educ. Soc. 18:58 (abstr.).

Coffelt, T. A. 1980. Reaction of spanish-type peanut genotypes to Cylindrocladium black rot. Peanut Sci. 7:91-94.

Culbreath, A. K., J. W. Todd, and J. W. Demski. 1992. Productivity of Florunner peanut infected with tomato spotted wilt virus. Peanut Sci. 19:11-14.

Culbreath, A. K., J. W. Todd, D. W. Gorbet, and J. W. Demski. 1993. Spotted wilt apparent disease progress in the component lines of Southern Runner cultivar. Peanut Sci. 20:81-84.

Gorbet, D. W., A. J. Norden, F. M. Shokes, and D. A. Knauft. 1987. Registration of 'Southern Runner' peanut. Crop Sci. 27:817.

Hagan, A. K., J. R. Weeks, J. C. French, R. T. Gudauskas, J. M. Mullen, W. S. Gazaway, and R. Shelby. 1990. Tomato spotted wilt virus in peanut in Alabama. Plant Dis. 74:615.

Holbrook, C. C., and W. F. Anderson. 1995. Evaluation of a core collection to identify resistance to late leafspot in peanut. Crop Sci. 35:1700-1702.

Holbrook, C. C., W. F. Anderson, and R. N. Pittman. 1993. Selection of a core collection from the U.S. germplasm collection of peanut. Crop Sci. 33:859-861.

Holbrook, C. C., and J. P. Noe. 1992. Resistance to peanut root-knot nematode (*Meloidogyne arenaria*) in *Arachis hypogaea*. Peanut Sci. 19:35-37.

Johnson, W. C., J. P. Beasley, S. S. Thompson, H. Womack, C. W. Swann, and L. E. Samples. 1987. Georgia peanut production guide. Univ. Georgia Coll. Agric. Coop. Ext. Serv. Bull. 23.

Pittman, R. N. (ed.). 1995. United States peanut descriptors. U.S. Dept. of Agriculture. Agric. Res. Serv., ARS-132.

SAS Institute. 1985. SAS User's Guide: Statistics, Vers. 5. SAS Inst., Cary, NC.

Sowell, G., Jr., D. H. Smith, and R. O. Hammons. 1976. Resistance of peanut plant introductions to *Cercospora arachidicola*. Plant Dis. Reptr. 60:494-498.

Thompson, S. S., and S. L. Brown. 1990. Survey for tomato spotted wilt disease. Georgia Coop. Peanut Res. Ext. Rept. Publ. No. 2.

Waller, R. A., and D. B. Duncan. 1969. A Bayes rule for the symmetric multiple comparison problem. J. Amer. Stat. Assoc. 64:1484-1499.

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