Stem Rot (White Mold) and Tomato Spotted Wilt Resistance among Peanut Genotypes

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ABSTRACT

Stem rot, also known as white mold (WM), caused by *Sclerotium rolfsii* Sacc., and tomato spotted wilt, caused by *Tomato spotted wilt virus* (TSWV), are two major disease problems in Georgia peanut (*Arachis hypogaea* L.) production. Current fungicides for stem rot control are very effective but expensive, and insecticides usually have little effect on TSWV, which is transmitted by thrips. Consequently, the objective of this study was to evaluate different peanut genotypes for resistance to both of these pathogens. Field test evaluations were conducted for four consecutive years (2010-13) at a site on the agronomy research farm near the Coastal Plain Experiment Station which has a long history of continuous peanut production and a high incidence of stem rot (WM) and TSWV. Results from these field tests showed significant differences among the peanut genotypes evaluated for combined resistance to both diseases. Several genotypes showed low TSWV incidence at mid-season and mid-to-late season. However by late season and after digging, the best combination of stem rot (WM) and TSWV disease resistance and highest consistent yield over years was in the runner-type peanut cultivar 'Georgia-12Y', along with 'York', 'Georgia-07W', and 'Georgia-10T'.

Key Words: *Arachis hypogaea* L., breeding lines, cultivars, groundnut, pathogens, *Sclerotium rolfsii* Sacc., *Tomato spotted wilt virus* (TSWV).

Stem rot, also known as white mold (WM) and southern blight, are all common names for the same peanut (*Arachis hypogaea* L.) disease caused by the soil-borne fungus, *Sclerotium rolfsii* Sacc. Tomato spotted wilt disease is caused by the tospovirus *Tomato spotted wilt virus* (TSWV).

Both stem rot and TSWV are currently major disease problems not only in the southeast but also in the major peanut production areas of the U.S. and throughout other parts of the world. In Georgia (2010-2012), damage and cost of control for these two diseases have been estimated to be among the highest losses ranging from $50 to $60 million annually (Kemerait, 2012, 2013, 2014).

Branch and Csinos (1987) proposed the use of both low disease incidence and high yield performance in evaluating peanut genotypes for *S. rolfsii* resistance among all four of the U.S. market types: valencia, spanish, runner, and virginia. Branch and Brenneman (1993) then reported stem rot resistance in the late season maturing cultivar 'Southern Runner' (Gorbet *et al.*, 1987), and equal or greater resistance was noted in the medium-maturing advanced Georgia breeding line, GA T-2741, which was subsequently released as 'Georgia Browne' (Branch, 1994).

Gorbet *et al.,* (2004) reported that 'C-99R' (Gorbet and Shokes, 2002) and other relatively later maturing peanut genotypes, 150 or greater days after planting (DAP) to maturity, in the Florida breeding program were a more reliable source of stem rot (white mold) resistance as compared to the early (ca. 125 DAP) and medium maturity (ca. 135 to140 DAP) genotypes. However, 'AP-3' (Gorbet, 2007) a medium maturing cultivar was likewise reported in this same study to have the highest yield and lowest stem rot (white mold) disease ratings among the medium maturity peanut lines (Gorbet *et al.*, 2004). Recently, the medium-late (ca. 140 to 145 DAP) maturing cultivar 'Florida-07' (Gorbet and Tillman, 2009) was released with resistance to both TSWV and stem rot. Branch and Brenneman (2009) reported that the combination of stem rot and TSWV resistance and highest yield over multiple years was consistently found in the medium-maturity, runner-type peanut cultivars, 'Georgia-07W' (Branch and Brenneman, 2008), 'Georgia-03L' (Branch, 2004), and 'AP-3'.

Consequently, new and improved resistant cultivars are continually needed to minimize damage, reduce chemical control costs, and increase peanut yield. The objective of this research was to evaluate several recently released peanut genotypes for combined resistance to both stem rot (white mold) and TSWV.

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Table 1. TSWV and stem rot (white mold) disease incidence and pod yield among 10 peanut genotypes when planted early in a heavily soil infected field trial at the Coastal Plain Experiment Station, Tifton, GA, 2010[a].

Peanut genotype	TSWV mid-season	TSWV + WM mid-late season	WM + TSWV late season	WM after digging	Pod yield
			%		kg/ha
Georgia-07W (ck)	2.9 c[b]	6.2 cde	10.0 d	50.4 b	3696 a
Georgia-10T	2.5 c	5.0 e	8.3 d	35.0 bc	3569 ab
York	6.2 a	9.2 bc	16.2 cd	22.9 c	3228 bc
AP-3 (ck)	6.2 a	10.0 b	24.6 c	41.2 b	2918 c
Georgia-03L (ck)	4.2 bc	5.8 de	23.8 c	67.5 a	2455 d
Florida-07	6.7 a	10.4 b	34.6 ab	81.2 a	1971 e
C 724-19-25	5.4 ab	14.2 a	36.2 ab	78.3 a	1924 ef
Georgia-06G	2.5 c	5.8 de	42.9 a	77.9 a	1787 ef
Georgia Greener	2.9 c	8.8 bcd	35.0 ab	81.7 a	1723 ef
Tifguard	5.8 ab	9.6 b	33.8 b	78.3 a	1503 f

[a]Disease ratings were based on the percent of 30.5 cm-row sections with symptoms of tomato spotted wilt (TSWV) and/or stem rot (WM). The ''mid-season'' rating is almost entirely TSWV; whereas, the ''WM after digging'' represents the stem rot incidence in the inverted plants when symptoms of the two diseases are clearly distinguished. The ''mid-late'' and ''late season'' ratings are a composite of both diseases.

[b]Means within the column followed by the same letter do not differ significantly at $P \leq 0.05$.

Materials and Methods

From 2010 to 2013, several peanut cultivars and breeding lines were compared to one or three of the previously reported (Branch and Brenneman, 2009) runner-type check cultivars (AP-3, Georgia-03L, and Georgia-07W). Field test evaluations were conducted each year on a Tifton loamy sand soil type (fine-loamy, siliceous, thermic, Plinthic Kandiudult) at the Gibb's research farm near the Coastal Plain Experiment Station. The field site has a long history of continuous peanut production and a very high incidence of stem rot (WM). Plots consisted of two rows 6.1m long x 1.8 m wide, and six peanut seed were planted per 30.5 cm of row. Early-planting dates of 19 April 2010, 15 April 2011, 16 April 2012, and 11 April 2013 were used to increase tomato spotted wilt and stem rot disease pressure (Tillman *et al.*, 2007 and Culbreath *et al.*, 2009). Irrigation was applied as needed during drought stress periods to ensure host-plant development. Recommended production practices were followed throughout each growing season, except no fungicides with known activity against *S. rolfsii* were used. Individual genotypes were dug and inverted according to hull-scrape determination based upon adjacent border plots (Williams and Drexler, 1981). After harvest, peanut pods were dried with forced warm air to approximately 6% moisture, and cleaned over a screen table before weighing for yield.

Incidence of TSW was first assessed at mid-season (ca. 60 DAP) when TSW is usually the primary disease present. At mid-to-late season (ca. 100 DAP), the combination of TSW and stem rot (WM) incidence was also assessed, which generally included predominantly TSW and some stem rot (WM). Prior to digging (ca. 140 DAP), the incidence of stem rot and TSW combined was again assessed, which generally included a higher proportion of stem rot than TSW. Immediately after digging and inverting, the incidence of only stem rot was also assessed among the different genotypes. This is the most definitive stem rot rating as signs and symptoms of this disease are often below ground. For both TSWV and stem rot assessments, the disease incidence was determined by counting the number of 30.5 cm-sections of a row with one or more infected plants and converting to a percentage of total row length for each plot.

A randomized complete block design was used each year with six replications. Data from each test was statistically compared using ANOVA, and Waller-Duncan's T-test (k-ratio = 100) was used for mean separation in SAS (SAS Institute, Inc., Cary, NC).

Results and Discussions

The 10 total peanut genotypes used each year in this disease evaluation study were not the same for all four years (2010 to 2013). Consequently, each test was analyzed separately, and the results from these field tests will be discussed individually.

During 2010, all three check cultivars, Georgia-07W, AP-3, and Georgia-03L, were included (Table 1). TSWV incidence at mid-season and at mid-late season was the lowest among the Georgia cultivars, 'Georgia-06G' (Branch, 2007a), 'Geor-

Table 2. TSWV and stem rot (white mold) disease incidence and pod yield among 10 peanut genotypes when planted early in a heavily soil infected field trial at the Coastal Plain Experiment Station, Tifton, GA, 2011[a].

Peanut genotype	TSWV mid-season	TSWV + WM mid-late season	WM + TSWV late season	WM after digging	Pod yield
	%				kg/ha
Georgia-12Y	2.9 d[b]	12.1 cd	21.2 c	20.4 cd	5282 a
GA 072523	2.9 d	13.3 bcd	20.0 c	12.9 de	5057 ab
York	7.9 ab	13.3 bcd	19.6 c	6.7 e	4833 abc
Georgia-07W (ck)	3.8 cd	11.2 cd	16.7 c	19.6 cde	4800 abc
Georgia-10T	2.5 d	16.7 bc	19.2 c	17.9 cde	4662 bc
GA 072514	3.8 cd	9.6 d	24.6 c	30.0 c	4384 c
Florida-07	9.2 a	29.2 a	49.6 a	66.2 a	3675 d
Georgia-06G	2.5 d	19.6 b	35.4 b	47.5 b	3606 d
Georgia Greener	4.2 cd	26.2 a	39.6 b	54.2 ab	3308 d
Tifguard	5.8 bc	30.8 a	53.8 a	54.6 ab	3199 d

[a]Disease ratings were based on the percent of 30.5 cm-row sections with symptoms of tomato spotted wilt (TSWV) and/or stem rot (WM). The ''mid-season'' rating is almost entirely TSWV; whereas, the ''WM after digging'' represents the stem rot incidence in the inverted plants when symptoms of the two diseases are clearly distinguished. The ''mid-late'' and ''late season'' ratings are a composite of both diseases.

[b]Means within the column followed by the same letter do not differ significantly at P≤0.05.

gia-10T' (Branch and Culbreath, 2011), Georgia-07W, 'Georgia Greener' (Branch 2007b), and Georgia-03L. However, stem rot (WM) results by late-season and after digging had Georgia-07W (ck), Georgia-10T, and 'York' (Gorbet and Tillman, 2011) with less disease incidence and higher pod yields that the other genotypes. It is also interesting to note that the currently grown runner-types, Florida-07, Georgia-06G, Georgia Greener, and 'Tifguard' (Holbrook *et al.*, 2008), were consistently and equally susceptible to stem rot (WM) all four years (Tables 1-4).

Beginning in 2011, Georgia-07W was the only check cultivar used since the other two were no longer grown (Table 2). At mid-season and mid-late season, TSWV was the least among Georgia-06G, Georgia-10T, GA 072514, GA 072523, 'Georgia-12Y' (Branch, 2013), and the check cultivar, Georgia-07W. However again by late-season and after digging, stem rot (WM) disease was the lowest and pod yield the highest among Georgia-12Y, York, GA 072523, Georgia-07W (ck), and Georgia-10T.

Likewise in 2012, TSWV at mid-season and TSWV and stem rot (WM) at mid-late season was

Table 3. TSWV and stem rot (white mold) disease incidence and pod yield among 10 peanut genotypes when planted early in a heavily soil infected field trial at the Coastal Plain Experiment Station, Tifton, GA, 2012[a].

Peanut genotype	TSWV mid-season	TSWV + WM mid-late season	WM + TSWV late season	WM after digging	Pod yield
	%				kg/ha
Georgia-12Y	0.8 c[b]	6.7 d	10.0 d	2.5 e	5204 a
Georgia-13M	2.1 bc	6.2 d	17.5 cd	22.9 cd	5175 ab
Georgia-10T	2.9 b	5.8 d	10.4 d	11.2 de	4922 ab
Georgia-07W (ck)	2.1 bc	6.7 d	12.1 d	13.3 de	4753 ab
York	5.4 a	13.3 bc	17.5 cd	2.5 e	4671 bc
GA 072515	2.5 bc	8.8 d	20.8 c	30.8 bc	4203 cd
Georgia Greener	2.1 bc	9.6 cd	36.7 b	52.9 a	3723 de
Florida-07	6.7 a	17.5 a	45.0 a	47.9 a	3518 e
Georgia-06G	0.8 c	5.8 d	30.4 b	52.5 a	3509 e
Tifguard	2.9 b	13.8 ab	33.8 b	42.1 ab	3263 e

[a]Disease ratings were based on the percent of 30.5 cm-row sections with symptoms of tomato spotted wilt (TSWV) and/or stem rot (WM). The ''mid-season'' rating is almost entirely TSWV; whereas, the ''WM after digging'' represents the stem rot incidence in the inverted plants when symptoms of the two diseases are clearly distinguished. The ''mid-late'' and ''late season'' ratings are a composite of both diseases.

[b]Means within the column followed by the same letter do not differ significantly at P≤0.05.

Table 4. TSWV and stem rot (white mold) disease incidence and pod yield among 10 peanut genotypes when planted early in a heavily soil infected field trial at the Coastal Plain Experiment Station, Tifton, GA, 2013[a].

Peanut genotype	TSWV mid-season	TSWV + WM mid-late season	WM + TSWV late season	WM after digging	Pod yield
			%		kg/ha
Georgia-12Y	0.8 cd[b]	10.4 de	11.7 e	11.7 d	4972 a
Georgia-13M	0.4 cd	7.1 e	15.4 de	30.0 c	4582 ab
Georgia-07W (ck)	2.1 c	10.4 de	13.3 de	13.8 d	4329 b
Georgia-10T	2.1 c	12.5 cd	19.2 cd	16.2 d	4169 b
Georgia-14N	2.1 c	7.9 de	15.0 de	15.0 d	3518 c
Georgia Greener	2.1 c	10.8 de	24.6 bc	47.1 b	3483 c
Georgia-06G	0.0 d	10.4 de	24.6 bc	45.4 b	3348 c
TUFRunner™ '727'	5.4 ab	17.9 ab	31.7 ab	47.9 b	3217 cd
Florida-07	7.1 a	22.9 a	32.5 a	67.1 a	3198 cd
Tifguard	4.2 b	17.1 bc	28.3 ab	45.8 b	2750 d

[a]Disease ratings were based on the percent of 30.5 cm-row sections with symptoms of tomato spotted wilt (TSWV) and/or stem rot (WM). The ''mid-season'' rating is almost entirely TSWV; whereas, the ''WM after digging'' represents the stem rot incidence in the inverted plants when symptoms of the two diseases are clearly distinguished. The ''mid-late'' and ''late season'' ratings are a composite of both diseases.

[b]Means within the column followed by the same letter do not differ significantly at $P \leq 0.05$.

the lowest with Georgia-06G, Georgia-12Y, 'Georgia-13M' (Branch, 2014), Georgia-10T, Georgia-07W (ck), GA 072505, and Georgia Greener (Table 3). However by late-season and after digging, stem rot (WM) disease incidence was the lowest and pod yield was the highest for Georgia-12Y, Georgia-13M, Georgia-10T, Georgia-07W (ck) and York.

Again in 2013 (Table 4), TSWV disease incidence at mid-season and mid-late season was the lowest for Georgia-13M, Georgia-12Y, Georgia-07W (ck), Georgia-10T, 'Georgia-14N' (Branch and Brenneman, 2015), Georgia Greener, and Georgia-06G. Stem rot (WM) disease resistance at late-season and after digging was lowest and pod yield highest with Georgia-12Y, Georgia-13M, Georgia-07W (ck) and Georgia-10T. However, Georgia-14N had similarly low stem rot (WM) disease incidence, but pod yield was significantly lower than these other resistant cultivars; whereas, Georgia-13M had higher stem rot (WM) disease incidence after digging but higher pod yields.

Conclusions

The results from this 4-yr field evaluation study indicated that the greatest combination of TSWV and stem rot (white mold) disease resistance and highest consistent pod yield over years were in runner-type peanut cultivar Georgia-12Y, along with York, Georgia-07W, and Georgia-10T. Georgia-12Y, York, and Georgia-10T are later-maturing than the medium maturity check cultivar, Georgia-07W. Improvements have occurred, and will continue, in peanut breeding for resistance to two major disease problems, tomato spotted wilt and stem rot (white mold).

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