Peanut Cultivar Response to Tomato Spotted Wilt over Five Planting Dates

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ABSTRACT

Tomato spotted wilt virus (TSWV) is vectored by thrips and causes an economically damaging peanut disease in the southeastern U.S. Peanut planting was traditionally initiated when soil temperatures became favorable in April. Planting in the latter two thirds of May is recommended to avoid thrips feeding and reduce tomato spotted wilt (TSW) incidence. This regime concentrates work load for growers and buying points, increases risk of tropical storm damage during harvest, and may contribute to reduced crop maturity. Improved TSW tolerance in cultivars may allow growers to plant earlier spreading risk and work load. Cultivars Georgia Green, Georgia-03L, AT 3085RO, and Flavor Runner 458 were compared with the advanced breeding line EXP 271516 based on peanut foliar condition, pod yield, and grade in 2008 and 2009 in Dawson, Georgia and Headland, Alabama. Peanuts were planted at five planting dates starting in late April through early June each year. Disease incidence was variable according to year, location, and planting date. Planting dates in April and early May resulted in higher TSW incidence. Foliar TSW ratings for the susceptible cultivar Flavor Runner 458 ranged between 48–96% at harvest. Georgia Green had 10–65% TSW incidence while maintaining yields between 3,315–5,440 kg/ha. Other cultivars had better TSW tolerance resulting in higher yield under more intense TSW pressure. Planting in the middle of May or later resulted in the highest yields. Cultivars with improved tolerance to TSW maintained yield above 4,490 kg/ha in early plantings. These results indicate the least risky management is possible by planting the most TSW tolerant genotypes during the current recommended planting dates.

Key Words: *Arachis hypogaea*, groundnut, peanut, tomato spotted wilt virus, planting date, visual rating, peanut grade.

Tomato spotted wilt (TSW) caused by tomato spotted wilt virus (TSWV) (*Tospovirus Bunyaviridae)* is an economically important disease in peanut (*Arachis hypogaea* L.) produced in the southeastern U.S. The virus is vectored during thrips (*Thysanoptera sp*.) feeding on peanut foliage. Susceptible peanut varieties show a range of symptoms including mottling of leaves, moderate to severe stunting, mouse-ear shaped leaves, overall yellowing of foliage, and moderate to severe yield loss (Culbreath, *et al.*, 2000). Many weedy plants and other crops serve as hosts to TSWV making disease predictability and control difficult. Peanut planting is historically initiated when soil temperatures average >18.3 C at a 10 cm depth for 3 consecutive days with a favorable forecast as early as April 10 (Beasley, 2007). Many factors influence the incidence of TSW in peanut including plant population, row patterns, insecticide use, cultivar, thrips populations, and planting date. Research has shown that planting after May 10 and before June 1 helps to reduce incidence of TSW by avoiding high thrips populations (Brown, *et al.*, 2005) and is a major factor contributing to the TSWV risk index (Kemerait *et al.*, 2011). Traditionally, growers would start planting early to spread out the planting and harvest seasons. Planting early has several benefits including avoiding potential tropical storms and the risk of incurring cool temperatures in early fall that could reduce peanut maturity at harvest severely affecting yield, grade, and crop value. The tight window of planting required to avoid the majority of thrips feeding forces a greater workload on growers during planting and harvest. Later planting also puts peanut buying points under more duress due to the compressed harvest season. Previous research in the southeastern U.S. indicates variability in TSW incidence among locations and years (Tillman *et al.*, 2007; Culbreath *et al.*, 2010). Because of the unpredictability of TSWV pressure, Tillman *et al.* (2007) concludes to plant the least susceptible cultivars during the recommended plantings dates, while Culbreath *et al.* (2010) finds that cultivars showing higher TSW tolerance may be planted earlier than the recommended window. Breeding programs are focused on improving phenotypic tolerance to TSW for agronomic purposes. New cultivars continue to show improved tolerance to TSW (Holbrook *et al.*, 2008) and may allow

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Table 1. Planting dates, harvest dates, and full crop growth interval for peanut near Dawson, Georgia in 2008 and 2009.

Trt.	Planting date[a]	Digging date	CGI[b]	Planting date	Digging date	CGI
	2008			2009		
First	April 21	Sept. 2	134	April 21	Sept. 4	136
Second	May 1	Sept. 10	132	April 30	Sept. 11	134
Third	May 12	Sept. 19	130	May 11	Sept. 23	135
Fourth	May 21	Sept. 29	131	May 20	Sept. 23	126
Fifth	June 2	Oct. 3	123	June 1	Oct. 8	129

[a]The earliest planting date in each year and location was determined when the 4 inch soil temperature reached 18.3 C for 3 consecutive days.

[b]Crop Growth Interval in days, CGI.

growers to resume the historical mid-April initiation of planting date with less regard to the current planting window to avoid thrips feeding. The objectives of this study were to evaluate peanut cultivars Georgia Green (Branch, 1996), Georgia-03L (Branch, 2004), AT 3085RO, Flavor Runner 458 and the advanced breeding line EXP 271516 to their phenotypic tolerance to TSW in the field over a 40-day planting window. Evaluations were based on peanut foliar condition, pod yield, and grade in 2008 and 2009 in Dawson, Georgia and Headland, Alabama.

Materials & Methods

Replicated field experiments were conducted near Dawson, Georgia in 2008 [Tifton (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults; 2–5% slope] and 2009 [Tifton (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults; 0–2% slope)] and duplicated near Headland, Alabama [Dothan (Fine-loamy, kaolinitic, themic plinthic kandiudults; 0–2% slope)] in each year.

Four peanut cultivars and one advanced breeding line were selected for comparisons. Cultivar Georgia Green had been the accepted agronomic standard and was planted on a majority of acres in the Southeast prior to 2008, because of its tolerance to TSW. The more recently released cultivars Georgia-03L, AT 3085RO, and the experimental line EXP 271516 are considered to have greater field tolerance to TSW compared to Georgia Green. Cultivar Flavor Runner 458 was included in these experiments as a known TSW susceptible entry (Brown *et al.*, 2005). Peanuts were planted at five planting dates each year starting in April. The earliest planting date in each year and location was determined when the 10-cm soil temperature reached 18.3 C for 3 consecutive days after April 10. Once the initial planting date was determined, planting was repeated in 10-day intervals four times. Planting date is considered a fixed term in this study to establish the first two planting dates before the recommended planting window and the latest one after the window (Tables 1 and 2).

Peanuts were planted in single rows on 0.9 m centers with a cone planter applying 0.84 kg ai/ha aldicarb (Bayer CropScience, Research Triangle Park, North Carolina) in furrow. Each planting date at each location was arranged in a randomized complete block design in a separate block (Gomez and Gomez, 1984). Germplasm entries were replicated four times in each planting date block. All germplasm entries are considered to have similar maturity requirements, thus digging date was determined separately by location and planting date according to the hull scrape method (Williams and Drexler, 1981) of Georgia Green in each respective planting date block. Border rows were planted to Georgia Green to use for maturity determination. Plots size was 6.1 m by 2 rows in

Table 2. Planting dates, harvest dates, and full crop growth interval for peanut near Headland, Alabama in 2008 and 2009.

Trt.	Planting date[a]	Digging date	CGI[b]	Planting date	Digging date	CGI
	2008			2009		
First	April 21	Sept. 2	134	April 20	Sept. 4	137
Second	May 1	Sept. 8	130	April 30	Sept. 11	134
Third	May 12	Sept. 19	130	May 11	Sept. 22	134
Fourth	May 21	Sept. 29	131	May 20	Sept. 22	125
Fifth	June 2	Oct. 2	122	June 1	Oct. 1	122

[a]The earliest planting date in each year and location was determined when the 4 inch soil temperature reached 18.3 C for 3 consecutive days.

[b]Crop Growth Interval in days, CGI.

Table 3. Visual rating for foliar symptoms of TSW at midseason (July 22 Dawson; July 25 Headland) in 2008.

Plant date	Location	Variety	TSWV %	Group	Plant date	Location	Variety	TSWV %	Group
		FR458	34.3	a[a]			FR458	58.3	a
		GaGrn	15.0	b			GaGrn	24.8	b
1	Dawson	EXP271516	14.5	b	1	Headland	EXP271516	21.3	b
		AT3085RO	9.3	b			AT3085RO	18.3	b
		Ga03L	8.5	b			Ga03L	16.5	b
		FR458	30.0	a			FR458	44.0	a
		AT3085RO	15.5	b			GaGrn	25.8	b
2	Dawson	GaGrn	12.5	bc	2	Headland	EXP271516	16.8	b
		EXP271516	10.0	bc			AT3085RO	14.8	b
		Ga03L	9.0	c			Ga03L	12.5	b
		FR458	11.0	a			FR458	17.3	a
		GaGrn	9.0	a			AT3085RO	9.3	b
3	Dawson	EXP271516	8.8	a	3	Headland	Ga03L	8.0	b
		AT3085RO	7.3	ab			GaGrn	8.0	b
		Ga03L	3.3	b			EXP271516	6.8	b
		FR458	15.8	ns			GaGrn	15.3	ns
		AT3085RO	15.3	ns			FR458	12.3	ns
4	Dawson	GaGrn	15.0	ns	4	Headland	AT3085RO	10.0	ns
		Ga03L	12.0	ns			Ga03L	9.8	ns
		EXP271516	7.8	ns			EXP271516	9.3	ns
		FR458	5.0	ns			AT3085RO	12.0	ns
		EXP271516	3.8	ns			FR458	11.5	ns
5	Dawson	Ga03L	2.8	ns	5	Headland	Ga03L	11.5	ns
		AT3085RO	2.5	ns			GaGrn	10.8	ns
		GaGrn	1.3	ns			EXP271516	5.5	ns

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

2008 and 6.1 m by 4 rows in 2009 to ensure that yield samples were large enough for further testing. Agronomic management inputs and irrigation were applied according to University of Georgia (Beasley *et al.*, 2007) and Auburn University best management practices for peanut, respectively by location.

All plots in each planting date were visually rated for TSW symptoms to foliage according to the 1 to 10 method described by Tillman *et al.* (2007) once between July 22–25 and again immediately prior to digging. These ratings were converted to a 1 to 100 scale to be expressed as a percentage for presentation. After peanut digging and inverting, the roots and pods of 12.2 m linear row were visually rated for TSW symptoms. Disease hits were recorded per foot of row when yield loss from TSW was evident. Peanuts were threshed with a stationary harvester (Kingaroy Engineering Works, Kingaroy, Australia) after the vines were sufficiently field dried. Yield samples were dried to a kernel moisture content of $<10\%$, and yield calculations are shown corrected to 7% moisture. A uniform portion of the sample was cut out with a riffle divider to be graded.

Data were analyzed in SAS (version 9.1) with PROC GLM under the general linear model. The variety*location*year, planting date*year, planting date*location, and variety*location interactions were significant so each planting date is reported separately by year and location. Treatment effect F tests were carried out against their specific error source. Means were separated using Fisher's Protected LSD at $p \leq 0.05$.

Results and Discussion

Foliar TSW Ratings at Mid-Season

In 2008, foliar ratings recorded at mid-season (July 22 Dawson; July 25 Headland) for TSW were significant among genotypes for the first 3 planting dates at both locations (Table 3). Symptom ratings ranged between 1.3 and 15.8% for TSW tolerant genotypes across all planting dates at Dawson. In planting dates 1 and 2 at Dawson, Flavor Runner 458 showed 30–34% TSW, which was significantly higher than ratings for the other genotypes. The TSW ratings were much higher at Headland at mid-season resulting in a clear separation between Flavor Runner 458 and the tolerant genotypes in the first 3 planting dates. Ratings for TSW were considerably higher at mid-season (July 24 Dawson and Headland) in 2009 (Table 4). Scores for Flavor

Table 4. Visual rating for foliar symptoms of TSW at midseason (July 24) in 2009.

Plant date	Location	Variety	TSWV %	Group	Plant date	Location	Variety	TSWV %	Group
		FR458	87.3	a[a]			FR458	83.3	a
		GaGrn	55.0	b			GaGrn	41.8	b
1	Dawson	EXP271516	34.3	c	1	Headland	EXP271516	19.0	c
		AT3085RO	19.5	c			AT3085RO	14.0	c
		Ga03L	18.3	c			Ga03L	13.0	c
		FR458	58.8	a			FR458	77.5	a
		GaGrn	25.5	b			GaGrn	42.5	b
2	Dawson	Ga03L	10.5	c	2	Headland	Ga03L	18.8	c
		AT3085RO	8.8	c			EXP271516	17.0	c
		EXP271516	8.3	c			AT3085RO	9.3	c
		FR458	25.0	a			FR458	37.0	a
		GaGrn	8.3	b			GaGrn	11.0	b
3	Dawson	EXP271516	7.5	b	3	Headland	Ga03L	10.0	b
		AT3085RO	6.8	b			EXP271516	9.5	b
		Ga03L	5.5	b			AT3085RO	7.3	b
		FR458	26.8	a			FR458	60.0	a
		GaGrn	11.8	b			GaGrn	24.3	b
4	Dawson	EXP271516	11.3	b	4	Headland	EXP271516	15.5	bc
		Ga03L	9.5	b			Ga03L	10.0	cd
		AT3085RO	5.3	b			AT3085RO	5.3	d
		EXP271516	5.5	ns			FR458	30.0	a
		FR458	4.5	ns			EXP271516	11.3	b
5	Dawson	AT3085RO	4.0	ns	5	Headland	GaGrn	9.3	b
		GaGrn	2.3	ns			AT3085RO	8.0	b
		Ga03L	1.8	ns			Ga03L	4.8	b

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 5. Visual rating for foliar symptoms of TSW at digging in 2008.

Plant date	Location	Variety	TSWV %	Group	Plant date	Location	Variety	TSWV %	Group
		FR458	78.3	a[a]			FR458	89.3	a
		GaGrn	47.5	b			GaGrn	55.8	b
1	Dawson	EXP271516	22.5	c	1	Headland	Ga03L	42.5	bc
		Ga03L	21.8	c			AT3085RO	33.8	bc
		AT3085RO	21.3	c			EXP271516	31.3	c
		FR458	89.5	a			FR458	88.8	a
		GaGrn	49.8	b			GaGrn	46.8	b
2	Dawson	AT3085RO	28.3	c	2	Headland	AT3085RO	28.0	c
		EXP271516	25.5	c			EXP271516	27.5	c
		Ga03L	17.8	c			Ga03L	22.8	c
		FR458	77.5	a			FR458	62.5	a
		GaGrn	53.8	b			GaGrn	45.0	ab
3	Dawson	EXP271516	28.8	c	3	Headland	Ga03L	35.0	b
		Ga03L	27.5	c			AT3085RO	20.0	b
		AT3085RO	18.8	c			EXP271516	19.3	b
		FR458	77.5	a			FR458	70.0	a
		GaGrn	63.8	ab			GaGrn	37.5	b
4	Dawson	Ga03L	55.0	b	4	Headland	AT3085RO	19.3	c
		EXP271516	32.5	c			EXP271516	18.8	c
		AT3085RO	32.5	c			Ga03L	17.5	c
		FR458	81.3	a			FR458	85.0	a
		GaGrn	27.5	b			GaGrn	36.3	b
5	Dawson	Ga03L	23.8	bc	5	Headland	AT3085RO	15.0	c
		AT3085RO	18.8	bc			Ga03L	13.0	c
		EXP271516	13.0	c			EXP271516	12.5	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 6. Visual rating for foliar symptoms of TSW at digging in 2009.

Plant date	Location	Variety	TSWV %	Group	Plant date	Location	Variety	TSWV %	Group
		FR458	90.5	a[a]			FR458	84.0	a
		GaGrn	68.8	b			GaGrn	53.8	b
1	Dawson	AT3085RO	26.8	c	1	Headland	EXP271516	24.3	c
		Ga03L	23.8	c			AT3085RO	19.0	c
		EXP271516	22.5	c			Ga03L	16.5	c
		FR458	96.8	a			FR458	88.8	a
		GaGrn	65.5	b			GaGrn	51.3	b
2	Dawson	Ga03L	28.0	c	2	Headland	EXP271516	34.5	c
		EXP271516	23.0	c			AT3085RO	28.0	c
		AT3085RO	18.3	c			Ga03L	26.5	c
		FR458	83.3	a			FR458	86.8	a
		GaGrn	25.0	b			GaGrn	31.8	b
3	Dawson	Ga03L	19.5	bc	3	Headland	EXP271516	9.5	c
		EXP271516	15.8	bc			AT3085RO	9.0	c
		AT3085RO	12.8	c			Ga03L	8.5	c
		FR458	91.5	a			FR458	75.5	a
		GaGrn	35.0	b			GaGrn	36.3	b
4	Dawson	Ga03L	21.3	bc	4	Headland	Ga03L	6.0	c
		EXP271516	11.0	c			AT3085RO	5.3	c
		AT3085RO	8.3	c			EXP271516	4.3	c
		FR458	48.8	a			FR458	90.3	a
		EXP271516	12.8	b			GaGrn	18.3	b
5	Dawson	GaGrn	9.5	b	5	Headland	Ga03L	9.0	c
		AT3085RO	9.3	b			EXP271516	6.8	c
		Ga03L	4.8	b			AT3085RO	4.0	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Runner 458 were as high as 87% and were significantly higher than other genotypes in 9 of 10 comparisons. Mid-season ratings in 2009 also revealed a clear difference in the susceptibility of Georgia Green compared to the more TSW tolerant genotypes in planting dates 1 and 2 in Dawson and planting dates 1, 2, and 4 in Headland. These results indicate that mid-season TSW symptoms can vary significantly over planting dates, locations, and years. The more tolerant genotypes have fewer TSW symptoms at mid-season compared to susceptible genotypes and later planting dates reduce symptomology to the point of absence in some cases.

Foliar TSW Ratings prior to Digging

At maturity in 2008, visual ratings for TSW ranged between 62 and 89% for the susceptible Flavor Runner 458 which showed significantly more TSW symptoms than other genotypes in 8 of 10 comparisons (Table 5). Ratings for Georgia Green were greater than those for the more tolerant genotypes in planting dates 1, 2, and 3 at Dawson and planting dates 2, 4, and 5 at Headland. Similar results were observed by Culbreath *et al.* (2008) between cultivars Georgia Green to Georgia-03L. The visual ratings for foliar TSW symptoms in 2008 were more strongly affected by genotype than planting date. The level of TSW symptoms did not drop off significantly over planting dates for the susceptible Flavor Runner 458 and high disease symptoms were maintained in the recommended planting date window (dates 3 and 4) for Georgia Green. Among the 3 newer and more TSW tolerant genotypes, Georgia-03L had higher incidence of TSW in planting date 4 of 2008 at Dawson.

In 2009, TSW incidence in planting dates 1 through 4 was significantly stronger in Dawson than that of planting date 5 (Table 6). Regardless of disease pressure, Flavor Runner 458 received significantly higher ratings than other genotypes in all 10 comparisons. In plating dates prior to the recommended planting window at Dawson, Georgia Green had higher ratings than the more TSW tolerant genotypes. In all five planting dates at Headland, Georgia Green was rated better than Flavor Runner 458 but significantly more infected than the 3 advanced genotypes indicating improved TSW tolerance. These results conclude that genotypes with advanced tolerance to TSW help reduce TSW incidence compared to the susceptible check. Planting later, in most cases, reduces TSW incidence in the tolerant genotypes.

Table 7. Visual rating for pod load symptoms from TSW at digging in 2008.

Plant date	Location	Variety	Hits/ 12.2 m	Group	Plant date	Location	Variety	Hits/ 12.2 m	Group
		FR458	23.5	a[a]			FR458	30.5	a
		Ga03L	16.0	ab			Ga03L	17.8	b
1	Dawson	GaGrn	14.8	b	1	Headland	GaGrn	15.0	b
		AT3085RO	13.5	b			AT3085RO	13.5	b
		EXP271516	9.8	b			EXP271516	12.3	b
		FR458	22.5	a			FR458	27.3	ns
		AT3085RO	17.0	ab			EXP271516	24.3	ns
2	Dawson	EXP271516	14.0	b	2	Headland	GaGrn	22.3	ns
		GaGrn	13.3	b			Ga03L	22.0	ns
		Ga03L	12.3	b			AT3085RO	20.3	ns
		FR458	24.0	a			FR458	27.0	a
		EXP271516	20.0	ab			Ga03L	23.8	ab
3	Dawson	Ga03L	19.0	ab	3	Headland	AT3085RO	20.5	abc
		AT3085RO	18.5	b			GaGrn	20.0	bc
		GaGrn	16.3	b			EXP271516	14.8	c
		FR458	22.5	a			FR458	14.7	ns
		Ga03L	18.8	ab			GaGrn	14.0	ns
4	Dawson	AT3085RO	18.0	ab	4	Headland	Ga03L	13.3	ns
		GaGrn	15.0	b			AT3085RO	12.0	ns
		EXP271516	14.3	b			EXP271516	10.0	ns
		Ga03L	19.8	ns			FR458	23.0	a
		FR458	18.5	ns			GaGrn	16.3	ab
5	Dawson	AT3085RO	14.3	ns	5	Headland	Ga03L	15.5	b
		EXP271516	14.0	ns			AT3085RO	13.8	b
		GaGrn	14.0	ns			EXP271516	10.5	b

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Visual Ratings of Roots and Pods prior to Digging

In 2008, Flavor Runner 458 had a strong trend for higher TSW symptoms on visual pod load, however was only significantly different than all other genotypes in planting date 1 at Headland (Table 7). Other significant differences between genotype for visual pod load rating in 2008 were not consistent between planting date or location.

Genotype response for rating of TSW symptoms on pod load was more consistent in 2009 (Table 8). Visual yield loss was greater for Flavor Runner 458 compared to genotypes other than Georgia Green in all 10 comparisons. Ratings for Georgia Green were similar to the susceptible genotype in planting date 1 at Dawson. Among the 3 genotypes showing more foliar tolerance to TSW than Georgia Green, the advanced genotype, EXP 271516, consistently tended to maintain pod load over all planting dates at both locations and significantly protected visual pod load better than Georgia-03L in planting dates 2 and 3 at Dawson and planting dates 4 and 5 in Headland in 2009.

Yield and Grade

In 2008, planting dates 3, 4, and 5 provided the highest yields in both Dawson and Headland compared to planting dates 1 and 2 (Table 9). Although yield was higher for the more TSW tolerant genotypes compared to Flavor Runner 458, planting the more tolerant genotypes earlier than the recommended window significantly reduced their respective yield in 2008. In Headland, Georgia-03L produced an average of 730 kg/ha more than AT 3085RO in planting dates 1 through 4 and EXP 271516 also yielded 780 kg/ha more than AT 3085RO in planting date 4 at Headland. Yield produced by Georgia Green was often statistically similar to some of the more TSW tolerant genotypes. However, the trend was for Georgia Green to have intermediate yield potential over planting dates between the TSW susceptible genotype and the genotypes with greater TSW tolerance.

In 2009, Flavor Runner 458 had the lowest yield of all genotypes over planting dates and locations averaging 1250 kg/ha below Georgia green and 2190 kg/ha below the more tolerant genotypes (Table 10). Planting dates 3, 4, and 5 at Dawson had significantly higher yields by 855 kg/ha compared to planting dates 1 and 2, while planting dates 3 and 4 tended to be higher than the remaining planting dates in Headland by 335 kg/ha. Genotypes AT 3085RO and EXP 271516

Table 8. Visual rating for pod load symptoms from TSW at digging in 2009.

Plant date	Location	Variety	Hits/ 12.2 m	Group	Plant date	Location	Variety	Hits/ 12.2 m	Group
		FR458	36.0	a[a]			FR458	31.0	a
		GaGrn	31.5	a			GaGrn	22.0	b
1	Dawson	Ga03L	15.0	b	1	Headland	Ga03L	15.5	bc
		AT3085RO	14.5	b			AT3085RO	13.0	c
		EXP271516	10.5	b			EXP271516	8.0	c
		FR458	32.8	a			FR458	27.8	a
		GaGrn	18.5	b			GaGrn	12.8	b
2	Dawson	Ga03L	17.0	b	2	Headland	Ga03L	10.3	b
		AT3085RO	11.0	c			EXP271516	8.8	b
		EXP271516	10.3	c			AT3085RO	8.0	b
		FR458	26.0	a			FR458	34.0	a
		Ga03L	14.0	b			GaGrn	19.3	b
3	Dawson	AT3085RO	10.5	bc	3	Headland	AT3085RO	11.3	c
		GaGrn	10.3	bc			Ga03L	10.5	c
		EXP271516	7.8	c			EXP271516	8.8	c
		FR458	29.8	a			FR458	31.3	a
		Ga03L	14.5	b			GaGrn	15.5	b
4	Dawson	GaGrn	13.8	b	4	Headland	Ga03L	14.0	bc
		AT3085RO	13.5	b			AT3085RO	8.8	cd
		EXP271516	8.5	b			EXP271516	7.5	d
		FR458	23.5	a			FR458	19.5	a
		Ga03L	11.5	b			GaGrn	12.0	b
5	Dawson	AT3085RO	8.0	b	5	Headland	Ga03L	11.3	b
		GaGrn	6.8	b			AT3085RO	7.8	bc
		EXP271516	5.8	b			EXP271516	5.8	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 9. Peanut yield in 2008.

Plant date	Location	Variety	kg/ha	Group	Plant date	Location	Variety	kg/ha	Group
		AT3085RO	5026	a[a]			Ga03L	4503	a
		EXP271516	4842	a			EXP271516	3946	b
1	Dawson	Ga03L	4568	ab	1	Headland	AT3085RO	3594	bc
		GaGrn	4171	bc			GaGrn	3379	c
		FR458	3630	c			FR458	2442	d
		EXP271516	4989	a			Ga03L	4815	a
		Ga03L	4563	ab			AT3085RO	4234	b
2	Dawson	AT3085RO	4502	ab	2	Headland	EXP271516	4109	b
		GaGrn	4309	b			GaGrn	3690	c
		FR458	3332	c			FR458	2841	d
		EXP271516	6012	a			Ga03L	5298	a
		Ga03L	5978	a			EXP271516	5215	ab
3	Dawson	AT3085RO	5847	a	3	Headland	AT3085RO	4825	bc
		GaGrn	5442	ab			GaGrn	4638	c
		FR458	5212	b			FR458	3845	d
		EXP271516	6053	a			Ga03L	5633	a
		AT3085RO	5536	ab			EXP271516	5559	a
4	Dawson	Ga03L	5486	ab	4	Headland	AT3085RO	4780	b
		GaGrn	4808	bc			GaGrn	4503	b
		FR458	4270	c			FR458	3996	c
		EXP271516	6543	a			EXP271516	5313	a
		AT3085RO	6165	a			Ga03L	5003	a
5	Dawson	Ga03L	6103	a	5	Headland	AT3085RO	4820	ab
		GaGrn	4599	b			GaGrn	4450	b
		FR458	4489	b			FR458	3102	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 10. Peanut yield in 2009.

Plant date	Location	Variety	kg/ha	Group	Plant date	Location	Variety	kg/ha	Group
		AT3085RO	4521	a[a]			Ga03L	4677	a
		EXP271516	4283	a			AT3085RO	4599	a
1	Dawson	Ga03L	4275	a	1	Headland	EXP271516	4581	a
		GaGrn	3395	b			GaGrn	3893	b
		FR458	2037	c			FR458	2514	c
		AT3085RO	4845	a			EXP271516	5049	a
		EXP271516	4787	a			AT3085RO	4823	a
2	Dawson	Ga03L	3894	b	2	Headland	Ga03L	4744	a
		GaGrn	3316	b			GaGrn	4068	b
		FR458	1787	c			FR458	2752	c
		EXP271516	5708	a			Ga03L	5527	a
		AT3085RO	5573	a			EXP271516	5276	a
3	Dawson	Ga03L	4966	b	3	Headland	AT3085RO	4635	b
		GaGrn	4836	b			GaGrn	4045	b
		FR458	3153	c			FR458	2940	c
		EXP271516	5188	a			EXP271516	5346	a
		AT3085RO	5054	a			Ga03L	5210	a
4	Dawson	Ga03L	4386	b	4	Headland	AT3085RO	5100	a
		GaGrn	3777	c			GaGrn	4138	b
		FR458	2569	d			FR458	3138	c
		AT3085RO	5719	a			EXP271516	4893	a
		EXP271516	5469	a			Ga03L	4761	a
5	Dawson	Ga03L	4616	b	5	Headland	AT3085RO	4683	a
		GaGrn	4382	b			GaGrn	3828	b
		FR458	3144	c			FR458	3118	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 11. Peanut grade in 2008.

Plant date	Location	Variety	TSMK	Group	Plant date	Location	Variety	TSMK	Group
		GaGrn	68.8	a[a]			GaGrn	71.5	a
		EXP271516	67.8	ab			FR458	69.5	b
1	Dawson	FR458	66.5	ab	1	Headland	EXP271516	68.5	bc
		AT3085RO	66.5	ab			Ga03L	67.8	c
		Ga03L	65.8	b			AT3085RO	64.8	d
		GaGrn	67.8	a			GaGrn	72.0	a
		FR458	65.0	b			FR458	68.5	b
2	Dawson	EXP271516	64.8	b	2	Headland	Ga03L	67.3	bc
		Ga03L	63.5	b			EXP271516	66.5	c
		AT3085RO	63.0	b			AT3085RO	63.0	d
		GaGrn	70.3	a			GaGrn	71.3	a
		EXP271516	70.3	a			EXP271516	70.3	a
3	Dawson	FR458	69.8	a	3	Headland	FR458	69.5	ab
		AT3085RO	68.8	ab			Ga03L	67.8	bc
		Ga03L	67.8	b			AT3085RO	67.0	c
		EXP271516	71.8	a			GaGrn	71.8	a
		GaGrn	70.5	ab			FR458	70.3	ab
4	Dawson	FR458	70.0	ab	4	Headland	EXP271516	69.5	bc
		AT3085RO	70.0	ab			Ga03L	68.5	bc
		Ga03L	69.0	b			AT3085RO	68.0	c
		GaGrn	70.8	a			GaGrn	71.3	ns
		Ga03L	70.8	a			EXP271516	70.3	ns
5	Dawson	EXP271516	70.8	a	5	Headland	AT3085RO	68.0	ns
		AT3085RO	68.8	b			Ga03L	67.8	ns
		FR458	66.8	c			FR458	58.3	ns

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

Table 12. Peanut grade in 2009.

Plant date	Location	Variety	TSMK	Group	Plant date	Location	Variety	TSMK	Group
		GaGrn	67.7	a[a]			GaGrn	65.7	a
		AT3085RO	66.6	a			AT3085RO	64.6	ab
1	Dawson	EXP271516	66.1	a	1	Headland	EXP271516	63.6	b
		FR458	65.5	ab			FR458	61.7	c
		Ga03L	63.3	b			Ga03L	59.0	d
		GaGrn	66.7	a			EXP271516	65.3	a
		EXP271516	65.2	a			AT3085RO	64.6	ab
2	Dawson	AT3085RO	64.6	a	2	Headland	GaGrn	62.7	bc
		Ga03L	61.5	b			Ga03L	60.9	c
		FR458	58.3	c			FR458	60.6	c
		AT3085RO	69.7	a			GaGrn	66.9	ns
		EXP271516	68.5	a			AT3085RO	66.6	ns
3	Dawson	GaGrn	68.2	a	3	Headland	EXP271516	66.2	ns
		Ga03L	65.5	b			Ga03L	64.6	ns
		FR458	65.3	b			FR458	64.2	ns
		EXP271516	69.2	a			EXP271516	67.7	a
		AT3085RO	68.2	a			AT3085RO	67.0	a
4	Dawson	GaGrn	68.1	a	4	Headland	GaGrn	66.6	a
		Ga03L	64.2	b			FR458	65.2	b
		FR458	63.4	b			Ga03L	64.3	b
		EXP271516	71.3	a			EXP271516	73.5	a
		AT3085RO	70.7	a			AT3085RO	73.4	a
5	Dawson	GaGrn	70.5	a	5	Headland	FR458	69.8	b
		FR458	68.1	b			GaGrn	69.7	b
		Ga03L	67.8	b			Ga03L	66.7	c

[a]Means followed by the same letter within a column are not statistically different according to Fisher's Protected LSD at $p \leq 0.05$; not significant, ns.

yielded 825 kg/ha more than Georgia-03L in planting dates 2 through 5 at Dawson. In Headland, Georgia-03L and EXP 271516 had 680 kg/ha higher yield compared to AT 3085RO in planting date 3.

In 2008, Georgia Green had significantly higher grades than the other genotypes in planting date 2 (3.7 TSMK) at Dawson and in planting dates 1 and 2 in Headland (Table 11). In 2009, peanut grades were lower overall than in 2008 with Flavor Runner 458 in planting date 2 at Dawson and Georgia-03L in planting date 1 in Headland having abnormally low grades (Table 12). Peanut grade was affected more by peanut genotype than planting date.

Summary

The difference in magnitude of TSW incidence in several more tolerant genotypes compared to the susceptible entry in all planting dates is evidence of achieving greater genetic tolerance to the disease. The variability of ratings within a genotype between planting dates across site years is evidence of variable disease pressure. In this study, the overall trend was the later the planting date (planting dates 3, 4, and 5), the more likely that TSW foliar disease symptoms in tolerant genotypes would be reduced. The tolerance of Georgia-03L, AT 3085RO, and EXP 271516 was consistently higher than that of Georgia Green. Regardless of visual TSW disease tolerance and planting date, genetic yield potential has been improved through breeding efforts and following the recommended planting date window consistently improves yield over the earliest planting dates. The results of this research indicate that although greater TSW tolerance and yield potential does exists in the newer genotypes (Georgia-03L, AT 3085RO, and EXP 271516) (Culbreath *et al.*, 2010), risk is best managed by planting the most TSW tolerant genotypes during the recommended planting dates as previously shown by Tillman *et al.* (2007).

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