Genotype x Seeding Rate Interaction among TSWV-Resistant, Runner-Type Peanut Cultivars[1]

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ABSTRACT

Tomato spotted wilt virus (TSWV) resistant, runner-type peanut (*Arachis hypogaea* L.) cultivars are the most important defense to control spotted wilt disease in southeast U.S. peanut production. The objective of this 3-yr (1999-01) study was to evaluate six TSWV-resistant, runner-type cultivars (Southern Runner, Florida MDR 98, C-99R, ViruGard, Georgia Green, and Georgia-01R) at three different seeding rates (3, 5, and 7 seed/30.5 cm) in single conventional row patterns for possible genotype (GE) x seeding rate (SR) interaction at the Univ. of Georgia, Coastal Plain Experiment Station. The combined split-plot analyses of variance resulted in highly significant ($P \leq 0.01$) GE x SR interaction, which indicates that not all six runner-type cultivars performed the same at each of these three seeding rates. A good example was the TSWV-resistant, runner-type peanut cultivar Georgia Green. It performed subpar at the below normal or lowest seeding rate; whereas at the highest seeding rate, Georgia Green and Georgia-01R produced the highest pod yields and dollar value returns per hectare among all of these runner-type cultivars. TSWV disease incidence was also significantly lower for the TSWV-resistant Georgia Green cultivar at each of the two higher seeding rates compared to the lowest seeding rate.

Key Words: *Arachis hypogaea* L., groundnut, tomato spotted wilt virus, disease incidence, pod yield, dollar value.

Tomato spotted wilt virus (TSWV), a tospovirus, is the causal agent for the devastating tomato spotted wilt disease of peanut (*Arachis hypogaea* L.). TSWV has now been found in all major peanut producing regions (SW, SE, and VC) of the U.S., and results in multimillion dollar losses each growing season. The single most important defense to TSWV is resistant cultivars.

In the Southeast, runner-type peanut cultivars are the predominant U. S. market type. Southern Runner, Florida MDR 98, and C-99R are three such runner-type cultivars that were released in 1984, 1998, and 1999, respectively, by the Univ. of Florida (9,11,12). Each cultivar has moderate or partial resistance to TSWV, spreading runner growth habit, and late maturity. ViruGard is another runner-type cultivar that was released in 1997 by the private peanut breeding program, AgraTech Seeds, Inc. ViruGard has moderate resistance to TSWV with a semi-bunch growth habit and early maturity. Georgia Green and Georgia-01R are two runner-type cultivars that were released in 1995 and 2001, respectively, by the Univ. of Georgia (2, 3). Both of the Georgia peanut cultivars also have TSWV resistance. However, Georgia Green has a medium maturity and smaller intermediate runner growth habit; whereas, Georgia-01R has later maturity and spreading runner growth habit, similar to Southern Runner, Florida MDR 98, and C-99R.

Seed size varies considerably among these six TSWV-resistant, runner-type cultivars. Georgia Green and Southern Runner have more typical regular runner seed size of 55-65 g/100 seed; whereas, C-99R, Florida MDR 98, ViruGard, and Georgia-01R are larger-seeded runner-type cultivars at 65-75 g/100 seed. Consequently, seed cost to plant at a given seeding rate per hectare will be higher for these large-seeded cultivars as compared to Georgia Green and Southern Runner.

Earlier reports have shown that seeding rates may or may not have a significant influence on TSWV disease incidence among some runner-type peanut cultivars (1,10,14). The objective of this study was to evaluate a set of TSWV-resistant, runner-type cultivars at different seeding rates in single conventional row patterns for possible genotype x seeding rate interaction. Efforts were made to minimize other environmental and cultural practices to prevent additional confounding TSWV effects. Good crop rotation, early-May planting dates, and in-furrow systematic insecticides were used each year according to the TSWV spotted wilt risk index (4).

Materials and Methods

For 3 consecutive yr 1999-2001, six TSWV-resistant, runner-type cultivars (Southern Runner, Florida MDR 98, C-99R, ViruGard, Georgia Green, and Georgia-01R) were evaluated for TSWV disease incidence, pod yield, and dollar value return per hectare at three different seeding rates (3, 5, and 7 seed/30.5 cm). The three seeding rates represent below normal (3 seed), normally recommended (5 seed), and above normal (7 seed) number of seed planted per 30.5 cm of row for runner-type peanut production.

A split-plot field design was used each year with six replications. Runner-type cultivars were the main or whole plots, and seeding rates were the sub-plots. Plots consisted of two single rows 6.10 m long by 1.83 m wide (0.81 m between rows within plots and 1.02 m between rows on adjacent plots). Test sites were on a Tifton loamy sand soil (fine-loamy, siliceous, thermic Plinthic Kandiudult) at the Univ. of Georgia, Coastal Plain Experiment Station, Tifton, GA.

Three-year crop rotation involved cotton, corn, and peanut. Planting dates were 11 May 1999, 8 May 2000,

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and 3 May 2001. Irrigation and standard cultural practices were used each growing season, and individual cultivars were dug at optimum maturity based upon the hull-scrape maturity method (15) assessed from adjoining border plots. In general, Virugard matured about 10-14 d earlier than Georgia Green, and Southern Runner, Florida MDR 98, C-99R, and Georgia-01R were about 14-21 d later in maturity than Georgia Green.

TSWV disease incidences were evaluated at 50, 90, and 130 d after planting (DAP). A disease hit consisted of one or more symptomatic plants in a 30.5-cm section of row. The incidence of TSWV was determined from the counted number of diseased plants (hits) compared to total linear row lengths per plot. After picking pods with a small-plot thresher, pods were dried with forced air to 6% moisture and then were hand-cleaned over a screen table before weighing for yield. Dollar values were calculated from yield and grade based upon USDA-FSA 1014 peanut loan schedules for each crop year. Peanut loan schedules annually provided price support or dollar values after adjusting for percentage of total sound mature kernels (TSMK), other kernels (OK), sound splits (SS), damaged kernels (DK), and foreign material (FM). These grade factors were determined according to federal state inspection service standards for runner market type (13).

Data from each split-plot designed test and combined across tests were statistically analyzed by analysis of variance. Waller-Duncan's Baysean t-test (k-ratio = 100) was used for means separation.

Results and Discussion

The combined analysis of variance results from this 3-yr study showed highly significant differences ($P \leq 0.01$) among the six runner genotypes (GE), three seeding rates (SR), and GE x SR interaction for all variables (Table 1). The highly significant GE x SR interaction indicates that runner-type peanut cultivars performed differently at these three seeding rates.

Table 1. Combined analysis of variance across years, genotypes, and seeding rates for TSWV disease incidence, pod yield, and dollar value, 1999-2001.

Source of variation	df	Disease incidence (at DAP) 50	90	130	Pod yield	Dollar value
Year (YR)	2	***	***	***	***	***
Rep within YR	15	ns	**	**	ns	ns
Genotype (GE)	5	***	***	***	***	***
YR x GE	10	***	***	**	**	***
Error a	75	–	–	–	–	–
Seeding Rate (SR)	2	***	***	***	***	***
YR x SR	4	ns	ns	**	ns	ns
GE x SR	10	***	**	***	***	***
YR x GE x SR	20	ns	ns	ns	ns	ns
Error b	180	–	–	–	–	–

ns, *, **, *** Denote not significantly different, significantly different at $P \leq 0.05$, $P \leq 0.01$, and $P \leq 0.001$, respectively.

At 50-DAP, the results indicate that Southern Runner had the highest percentage of TSWV disease at each of the three seeding rates, and Georgia-01R had the lowest disease incidence at the same three seeding rates (Table 2). However, Georgia Green had a relatively high percentage of disease incidence at the below-normal or lowest seed rate of 3 seed/30.5 cm, but was not significantly different from Georgia-01R at the normally recommended and highest seeding rate. Each cultivar had a significant reduction in TSWV disease incidence with each increase in seeding rate, except for Georgia-01R between the two higher rates.

Table 2. Three-year average TSWV disease incidence at 50-d after planting (DAP) among six runner-type peanut cultivars at three different seeding rates in Georgia, 1999-2001.

Cultivar	50-DAP disease incidence[a] 3 seed[b]		5 seed		7 seed	
	----------%----------					
Southern Runner	20.4 a	A	15.0 a	B	9.3 a	C
ViruGard	16.9 b	A	13.5 ab	B	8.6 a	C
Florida MDR 98	16.4 bc	A	11.8 b	B	7.4 a	C
C-99R	14.0 c	A	11.2 b	B	7.4 a	C
Georgia Green	17.5 b	A	8.2 c	B	3.2 b	C
Georgia-01R	11.4 d	A	6.0 c	B	4.2 b	B

[a]Means within columns followed by the same lower case letter or means within rows followed by the same upper case letter do not differ significantly at $P \leq 0.05$.

[b]Number of seed per 30.5 cm of row.

At 90-DAP, Southern Runner had the highest TSWV disease incidence and Georgia-01R had the lowest disease incidence at all three seeding rates (Table 3). Likewise, Georgia Green had a much higher disease incidence at the lower seeding rates as compared to the higher rates. At the 5 and 7 seed/30.5 cm seeding rates, Georgia Green

Table 3. Three-year average TSWV disease incidence at 90-d after planting (DAP) among six runner-type peanut cultivars at three different seeding rates in Georgia, 1999-2001.

Cultivar	90-DAP disease incidence[a] 3 seed[b]		5 seed		7 seed	
	----------%----------					
Southern Runner	37.2 a	A	31.0 a	B	21.1 a	C
Florida MDR 98	32.4 b	A	23.3 b	B	20.8 a	B
ViruGard	27.9 cd	A	22.4 bc	B	16.2 b	C
C-99R	24.9 de	A	19.0 cd	B	17.6 ab	B
Georgia Green	30.3 bc	A	17.8 de	B	11.4 c	C
Georgia-01R	23.1 e	A	14.3 e	B	11.1 c	B

[a]Means within columns followed by the same lower case letter or means within rows followed by the same upper case letter do not differ significantly at $P \leq 0.05$.

[b]Number of seed per 30.5 cm of row.

and Georgia-01R had the lowest disease incidence of all cultivars, except for C-99R at 5 seed/30.5 cm. A significant reduction in TSWV incidence was observed for each cultivar with each increase in seeding rate, except for Florida MDR 98, C-99R, and Georgia-01R between the two higher rates.

Near harvest time at 130-DAP, Southern Runner persisted in maintaining the highest disease incidence throughout the growing season, and Georgia-01R had the lowest disease incidence across all three seeding rates (Table 4). Georgia Green was similar to Georgia-01R in having the lowest disease incidence at the highest seeding rate. Each cultivar was observed to have a significant reduction in TSWV incidence with each increase in seeding rate, except for Florida MDR 98, C-99R, and Georgia-01R.

Table 4. Three-year average TSWV disease incidence at 130-d after planting (DAP) among six runner-type peanut cultivars at three different seeding rates in Georgia, 1999-2001.

Cultivar	130-DAP disease incidence[a]		
	3 seed[b]	5 seed	7 seed
	----------%----------		
Southern Runner	53.9 a A	44.9 a B	33.9 a C
ViruGard	48.1 b A	37.9 b B	31.0 ab C
Florida MDR 98	44.6 b A	38.2 b B	33.1 a B
Georgia Green	49.4 ab A	29.4 c B	19.9 c C
C-99R	36.0 c A	31.7 c AB	27.1 b B
Georgia-01R	30.0 d A	21.5 d B	17.4 c B

[a]Means within columns followed by the same lower case letter or means within rows followed by the same upper case letter do not differ significantly at $P \leq 0.05$.

[b]Number of seed per 30.5 cm of row.

Relative incidence of spotted wilt at 130 DAP was similar to results at seeding rate of 3.8 seed/30.5 cm of row for Southern Runner, ViruGard, Florida MDR-98, and Georgia Green in 1997 and 1998 (7), for Georgia Green and Southern Runner at 3.8 seed/30.5 cm of row in 1993 and 1994 (5), and for Florida MDR-98 (formerly UF 91108) and Southern Runner in 1994 and 1995 (8) in which final incidence values were similar among these cultivars. Final incidence between Georgia Green and C-99R at 3 seed/30.5 cm in this study are also consistent with comparisons of spotted wilt incidence for these cultivars at 3.8 seed/30.5 cm of row in tests conducted in 1997 and 1998 (6), where final incidence was lower in C-99R than in Georgia Green. Previous studies were conducted using low seeding rates to maximize potential for severity of spotted wilt epidemics, and none of these earlier studies addressed spotted wilt or yield response to increasing seeding rates or genotype x seeding rate interactions.

Georgia-01R had among the highest pod yield at all three seeding rates, but was not significantly different from C-99R at the lowest seeding rate (Table 5). Georgia Green and Georgia-01R had the highest pod yields at the normally recommended and highest seeding rate. Florida MDR 98 and Southern Runner were consistently the lowest in pod yield at each of the three seeding rates but were not significantly different from ViruGard. Georgia Green was the only cultivar with a significant yield increase at each increased seeding rate. In general, the other runner cultivars only showed a significant yield increase between the lowest and highest seeding rates.

Table 5. Three-year average pod yield among six runner-type peanut cultivars at three different seeding rates in Georgia, 1999-2001.

Cultivar	Pod yield[a]		
	3 seed[b]	5 seed	7 seed
	----------kg/ha----------		
Georgia-01R	4794 a B	5341 a A	5685 a A
Georgia Green	3811 c C	4975 ab B	5767 a A
C-99R	4388 ab B	4731 bc AB	5045 b A
ViruGard	4039 bc B	4310 cd B	4828 bc A
Florida MDR 98	3797 c B	4136 d AB	4312 d A
Southern Runner	3708 c B	3559 d B	4501 cd A

[a]Means within columns followed by the same lower case letter or means within rows followed by the same upper case letter do not differ significantly at $P \leq 0.05$.

[b]Number of seed per 30.5 cm of row.

Gross dollar values per hectare results were very similar to mean pod yield rankings among these six TSWV-resistant cultivars (Table 6). Georgia-01R and C-99R had the highest dollar value at the lowest seeding rate, whereas Georgia Green and Georgia-01R had the highest dollar value return of all other runner-type cultivars at the normally recommended and highest seeding rates. Georgia Green was the only runner cultivar with a significant increase in gross dollar value return with each increase in seeding rate. In contrast, no significant differences were observed for dollar values between any seeding rate for Florida MDR 98. Thus, not all runner-type cultivars per-

Table 6. Three-year average dollar value among six runner-type peanut cultivars at three different seeding rates in Georgia, 1999-2001.

Cultivar	Dollar value[a]		
	3 seed[b]	5 seed	7 seed
	----------$/ha----------		
Georgia-01R	3253 a B	3836 a A	4010 a A
Georgia Green	2800 c C	3620 ab B	4224 a A
C-99R	3171 ab B	3405 b AB	3604 b A
ViruGard	2878 bc B	2978 c B	3438 bc A
Florida MDR 98	2724 c A	2929 c A	3014 d A
Southern Runner	2655 c B	2741 c B	3206 cd A

[a]Means within columns followed by the same lower case letter or means within rows followed by the same upper case letter do not differ significantly at $P \leq 0.05$.

[b]Number of seed per 30.5 cm of row.

formed the same at each of the three seeding rates.

The findings in this study agree with earlier reports (10,14) that showed the benefit of higher seeding rates for reducing TSWV disease incidence and the corresponding increased pod yields and dollar values. However, a highly significant GE x SR interaction was found in this study. The high-yielding, TSWV-resistant, runner-type peanut cultivar Georgia Green is a good example of this GE x SR interaction. It performed subpar at the below-normal or lowest seeding rate of 3 seed/30.5 cm; whereas, at the highest seeding rate, Georgia Green equaled Georgia-01R in producing the highest yields and dollar values among all of the other runner-type cultivars. TSWV disease incidence was also significantly lower for the TSWV-resistant Georgia Green cultivar at each of the two higher seeding rates. These results also demonstrate the need to continue conducting similar GE x SR interaction studies with advanced runner-type breeding lines for future releases as new peanut cultivars.

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