

# PEANUT SCIENCE

The Journal of the American Peanut Research and Education Society

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ARTICLE

## General *Tomato Spotted Wilt Virus* Field Resistance among Spanish and Valencia Market Type Peanut Cultivars.

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ARTICLE INFORMATION

*Keywords:*

*Arachis hypogaea* L, groundnut, high-oleic, pod yield, TSMK grade, seed weight, dollar values

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DOI: 10.3146/0095-3679-491-PS21-17

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ABSTRACT

During 2016 through 2020, field tests were conducted to determine general *Tomato spotted wilt virus* (TSWV) resistance among seven spanish and seven valencia-type peanut (*Arachis hypogaea* L.) cultivars. These tests were planted early in April each year to enhance tomato spotted wilt (TSW) disease pressure at the University of Georgia, Coastal Plain Experiment Station, Tifton, GA. TSW disease incidence was first assessed at about midseason (60 DAP), and total disease (TD) incidence which was primarily TSW was again assessed prior to digging. The five-year average results showed significant differences ( $P \leq 0.05$ ) among the spanish-type cultivars. The lowest TSW and TD incidence was found with the TSWV-resistant spanish cultivar, 'Georgia-17SP'. This cultivar also produced the highest pod yield, total sound mature kernel (TSMK) grade, and gross dollar value returns per hectare. The five-year average results among the valencia-type cultivars also showed significant differences. The lowest TSW and TD incidence was found with the moderately TSWV-resistant valencia cultivar 'Georgia-Val/HO'. This cultivar also produced the highest pod yield, TSMK grade, and dollar value return. These new Georgia cultivars are not the traditional spanish and valencia-types; however, pod and seed traits meet or exceed the criteria for each market type, respectively.

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## INTRODUCTION

In the U.S, there are four market types of peanut (*Arachis hypogaea* L.). These include runner and virginia-types which represent subspecies *hypogaea* botanical variety *hypogaea*; and spanish and valencia-types which represent subspecies *fastigiata* botanical varieties *vulgaris* and *fastigiata*, respectively (Hammons, 1973; Krapovickas & Gregory, 2007). Plants of ssp. *hypogaea* generally lack flowers on the mainstem, have alternate fruiting nodes, and prostrate growth habit. Whereas, plants of ssp. *fastigiata* have flowers on the mainstem, have sequential fruiting nodes, and an erect growth habit.

Historically, all four market types have been grown in the southeast U.S. (Monfort and Branch, 2021). Since the release of 'Florunner' (Norden *et al.*, 1969), runner-types have dominated the other three market-types. However, spanish and valencia types are still being grown but at a much smaller hectare percentage.

Since mid-1980's, tomato spotted wilt (TSW) disease caused by *Tomato spotted wilt virus* (TSWV) continues to be a major peanut production problem in the U.S. The primary source of TSW disease control is cultivar resistance in combination with other management practices (Brown *et al.*, 2005). The objective of this study was to assess currently available spanish and valencia-type cultivars for general TSWV resistance.

## MATERIALS AND METHODS

During five years (2016 to 2020), field tests were conducted to determine general TSWV resistance among 14 peanut cultivars (seven spanish-types and seven valencia-types). These tests were planted early in April each year to enhance TSW disease pressure at the Coastal Plain Experiment Station, Tifton, GA. Maximum-input production practices as recommended by the Georgia Cooperative Extension Service were followed for weed, disease, and insect control with irrigation. Good early to mid-season insect control against thrips (*Frankliniella* spp.) injury was observed each year.

A randomized complete block field design with five replications was used each year. All plots in each test consisted of two-rows, 6.1m long by 1.8 m wide. The soil type was a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandult).

TSW disease incidence (0-100%) was first assessed near midseason (60-DAP), when TSW is typically the only disease occurring at this time. Percentages of total disease (TD) incidence were scored prior to digging, which included primarily TSW but also any soilborne disease. A disease "hit" equaled one or more diseased plants in a 30.5 cm section of row. After digging, the percentage of white mold or stem rot [*Athelia rolfsii* (Curzi) C.C.Tu & Kimbr.] = (*Sclerotium rolfsii* Sacc.) hits were also determined for each entry (Rodriguez-Kabana et al., 1975).

Each entry was individually dug near optimum maturity based upon the hull-scrape method from adjacent border plots (Williams and Drexler, 1981). Entries within each maturity groups were represented in these border plots for sampling to determine maturity. After harvest, peanut pods from each plot

were dried with forced warm-air to approximately 6% moisture. Pod samples were then cleaned before weighing for yield determination. Grade samples were presized and shelled on federal state inspection service equipment accordingly for spanish and valencia-type peanuts, respectively (Anonymous, 1998). Gross dollar values were calculated from pod yield and grade factors based upon peanut loan schedules for each crop year.

Data from these tests were statistically analyzed by analysis of variance (ANOVA) using the PROC GLM procedure in SAS 9.4 version (SAS Institute, Inc., Cary, NC). Waller-Duncan's T-test (k-ratio = 100) was used for mean separation at  $P \leq 0.05$ .

## RESULTS AND DISCUSSION

During 2020, the global COVID-19 pandemic caused by *Sars-CoV-2* virus prohibited white mold disease assessment after digging because of reduced essential personnel to work together at any one time. However, the previous four-year (2016-19) average percentage of white mold hits after digging each of the individual spanish and valencia-type cultivars showed very little disease (<1%) and no significant differences ( $P \leq 0.05$ ) among the cultivars each year. The combination of good rotation and currently recommended fungicides were highly effective in reducing disease interaction and any confounding effects for scoring TSW disease incidence.

Five-year (2016-20) average results showed significant differences ( $P \leq 0.05$ ) among seven spanish-type for TSW and total disease (TD) incidence when planted in early-April each year (Table 1). The lowest TSW and TD incidence was found with the TSWV-resistant spanish cultivar 'Georgia-17SP' (Branch and Brenneman, 2018).

**Table 1. Five-year average TSW and total disease incidence, pod yield, TSMK grade, seed weight, and dollar value of seven spanish-type peanut cultivars in Georgia, 2016-20.**

Peanut Cultivar	TSW† (%)	TD‡ (%)	Yield (kg/ha)	TSMK¶ (%)	Seed (g/100)	Value (\$/ha)
<b>Spanish-Type:</b>						
Georgia-17SP	1.5 c*	13.7 d	4347 a	73.9 a	53.9 a	1713 a
Georgia Browne	3.4 bc	31.0 bc	3820 b	72.6 a	40.6 c	1468 b
Georgia-04S	4.3 b	24.3 c	3790 b	72.2 a	40.8 c	1455 b
OLe'	6.5 a	39.7 ab	3094 c	64.0 bc	44.7 b	1080 c
Tamnut OL06	7.5 a	45.5 a	2729 d	62.3 bc	46.3 b	929 d
Schubert	6.6 a	40.2 a	2486 e	61.6 c	40.1 c	844 de
OLin	3.9 b	44.1 a	2163 f	65.6 b	40.3 c	768 e
*Within columns, means followed by the same letter are not significantly different at $P \leq 0.05$ .						
†TSW = Tomato spotted wilt incidence; ‡TD = Total disease incidence; ¶TSMK = Total sound mature kernels						

'Georgia Browne' (Branch, 1994) and 'Georgia-04S' (Branch, 2005) are similar to 'Georgia-17SP', with regard to growth habit and later maturity compared to typical spanish-types. These three cultivars are small-podded and small-seeded runner-types that are intended for the same spanish market, since each are similar in seed size, shape, texture, and flavor. These Georgia cultivars were developed with interest and encouragement from major candy manufacturers. These cultivars do not have the typical botanical characteristics of traditional spanish-types, but do have significantly higher pod yield, total sound mature kernel (TSMK) grade, and dollar value returned per hectare compared to the other spanish-type cultivars in Georgia.

Georgia-17SP is a large-seeded spanish cultivar with the desirable high-oleic trait for longer shelf-life of peanut and peanut products. Georgia-04S and Georgia Browne have similar seed size as many other spanish-type cultivars, and Georgia-04S also has the high-oleic oil chemistry.

This study corroborates previously reported TSWV field resistance in Georgia Browne (Branch, 1994; Culbreath *et al.*, 1994; Culbreath *et al.*, 1996). After tomato spotted wilt emerged as a peanut disease problem in the southeastern U.S., Georgia Browne was the first cultivar released with a moderate level of field resistance to TSWV (Branch, 1994; Culbreath *et al.*, 1994, 1996). Branch (1994) indicated that Georgia Browne

had resistance to TSWV but did not list cultivars to which it was compared. Culbreath *et al.*, (1994) reported that Georgia Browne had suppressive effects on epidemics of tomato spotted wilt that were similar to those of 'Southern Runner' (Gorbet *et al.*, 1987), one of its parental lines, with incidence in both cultivars lower than in Florunner, the predominant cultivar grown in Georgia at that time. Culbreath *et al.*, (1996) also reported final incidence of spotted wilt and area under the disease progress curves of spotted wilt epidemics were similar for Georgia Browne, Southern Runner, and 'Georgia Green' (Branch *et al.*, 1996), and lower for all three than in Florunner. These results also corroborated a previous report of similar reactions of Georgia Browne and Georgia-04S to TSWV (Branch, 2005). In contrast to the previous report, neither of these cultivars differed from 'OLin' (Simpson *et al.*, 2003) for mid-season TSW ratings in this study. However, both had lower total disease ratings than OLin. With low incidence of white mold for all entries, the field trial differences in total disease are likely due to late season manifestation of tomato spotted wilt (Fig. 1). These results are consistent with previous reports, and may serve as an indication of the stability of the moderate level of resistance in Georgia Browne, and evidence of field resistance to TSWV in this cultivar over 25 years after its release (Branch, 1994). The lowest TSW and TD incidence was found with the newer TSWV resistant spanish cultivar, Georgia-17SP.



Fig. 1. Field view of spanish and valencia cultivar test showing late-season TSW symptoms including stunted plants and chlorotic foliage.

The five-year (2016-20) average results among seven valencia-type cultivars likewise showed significant differences for TSW and TD incidence when planted early in April (Table

2). The lowest TSW and TD incidence was found with the moderately TSWV resistant valencia cultivar 'Georgia-Val/HO' (Branch, 2021).

**Table 2. Five-year average TSW and total disease incidence, pod yield, TSMK grade, seed weight, and dollar value of seven valencia-type peanut cultivars in Georgia, 2016-20.**

Peanut Cultivar	TSW† (%)	TD‡ (%)	Yield (kg/ha)	TSMK§ (%)	Seed (g/100)	Value (\$/ha)
<b>Valencia-Type:</b>						
Georgia-Val/HO	6.7 c*	41.1 d	3451 a	71.1 a	63.7 a	1300 a
Georgia Red	9.3 bc	58.8 c	2340 b	67.8 a	47.5 c	856 b
Georgia Valencia	9.5 bc	48.6 d	2442 b	58.9 b	54.3 b	781 b
New Mexico Val. A	12.1 b	68.9 b	1567 c	56.5 bc	37.8 d	497 c
NuMex-01	11.6 b	71.5 b	1581 c	51.1 d	38.0 d	472 c
H&W Val. 136	18.3 a	79.5 a	1485 c	53.3 cd	38.7 d	444 c
New Mexico Val. C	11.9 b	71.7 ab	1332 c	58.3 b	39.7 d	436 c
*Within columns, means followed by the same letter are not significantly different at P≤0.05.						
†TSW = Tomato spotted wilt incidence						
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Georgia-Val/HO is a new high-yielding, high-oleic, large-podded, large-seeded valencia-type peanut cultivar. It was developed from an intersubspecific (*ssp. hypogaea* x *ssp. fastigiata*) cross combination between two Georgia cultivars, 'Georgia-11J' (Branch, 2012) and 'Georgia Valencia' (Branch, 2001). Georgia-Val/HO has an atypical semi-prostrate growth habit, alternate fruiting nodes and lacks flowers on the mainstem. However below-ground, it has typical valencia predominantly three seed per pod and the dominant red (*R<sub>i</sub>*) testa color gene (Branch, 2011).

'Georgia Red' (Branch and Hammons, 1987) and Georgia Valencia are similar in TSW disease incidence, pod yield, and dollar value. However, Georgia Valencia was also found to be similar to Georgia-Val/HO in TD incidence. All three of these Georgia valencia-type cultivars were found to have significantly better late-season resistance to TSWV compared to all of the

other New Mexico developed cultivars which had 70-80% TD incidence late in the growing season (Fig. 1).

In the combined analysis (Table 3), the seven spanish cultivars were found to have lower TSW and TD incidence (better TSWV resistance) compared to the seven valencia cultivars. However, Georgia-Val/HO was comparable to several spanish-type cultivars in TSW and TD incidence. Overall field performance found Georgia-17SP to be higher in pod yield and dollar value compared to all other spanish and valencia-type cultivars. Georgia-Val/HO was also comparable to Georgia-17SP, Georgia Browne, and Georgia-04S in TSMK grade, and it produced the largest seed weight of any spanish or valencia cultivar in this study. While these newer Georgia spanish and valencia-type cultivars are not the traditional botanical subspecies, each of these Georgia cultivars have the pod and seed trait characteristics needed to meet or exceed the criteria for each market-type, respectively.

**Table 3. Five-year average TSW and total disease incidence, pod yield, TSMK grade, seed weight, and dollar value of 14 spanish and valencia-type peanut cultivars in Georgia, 2016-20.**

Peanut Cultivar	TSW† (%)	TD‡ (%)	Yield (kg/ha)	TSMK§ (%)	Seed (g/100)	Value (\$/ha)
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§TSMK = Total sound mature kernels

This study furthermore shows that TSW disease caused by TSWV has not diminished. In fact, these susceptible valencia-type cultivars each year continuously averaged >70% TSW incidence by late-season. However, this study also clearly shows

that progress has been made in breeding for TSWV resistance among the spanish and valencia-type cultivars similar to that recently reported among runner and virginia-types in Georgia (Branch *et al.*, 2021).

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