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Variation in Yield and Resistance to Southern Stem Rot Among Peanut (*Arachis hypogaea* L.) Lines Selected for Pythium Pod Rot Resistance[1]

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ABSTRACT

Five spanish and seven runner peanut (*Arachis hypogaea* L.) genotypes and five check cultivars were compared for southern blight susceptibility on heavily *Sclerotium rolfsii*-infested soil. Inoculum density of *S. rolfsii* at the test site was enhanced by continuous years of residue management. The genotypes derived from crosses with PI 365553 and PI 475871 were selected based on reaction to Pythium pod rot and agronomic performance. Variation for southern blight incidence occurred among lines in both runner and spanish genotypes. Disease incidence was lower in four runner genotypes, Southern Runner, and TxAG-3 than in Okrun and Florunner. Significantly ($p = .05$) less disease occurred in one breeding line, TxS55138, than in other spanish entries. Three-year average yields of runner genotypes ranged to 25% higher than runner cultivars, while TxS55138 averaged 50% higher in yield than Tamnut 74. Over entries, the coefficients of correlation for yield and southern blight incidence, and southern blight incidence and disease discolored pods were not statistically significant.

Key Words: Groundnut, Southern stem rot, soil-borne disease.

Southern stem rot caused by *Sclerotium rolfsii* Sacc. is an important disease of peanut (*Arachis hypogaea* L.) in Texas (3, 11). The use of cultural methods alone such as crop rotation, deep plowing, and non-dirting cultivation are often inadequate to prevent disease losses but can help in managing stem rot (5, 9). Fungicides can effectively reduce disease incidence, but control is incomplete and fungicide applications increase production costs (11, 15).

The commonly grown peanut cultivars have little resistance to infection by *S. rolfsii* (15), but partial resistance in several genotypes has been reported by researchers (2, 4, 6, 7, 8, 10, 13, 14, 16, 19, 20). Wynne and Beute (23) reported NCSC to be partially resistant to *S. rolfsii*. They also noted that two breeding lines with resistance to black root rot caused by *Cylindrocladium crotalariae* (Loos) Bell and Sobers, were moderately resistant to *S. rolfsii* (22). Beute *et al.* (4) reported that three (NC2, NC AC 18016, and NC AC 17941A X Florigiant) of twelve peanut genotypes evaluated in the field had partial resistance to *S. rolfsii*, while Arnold *et al.* (2), Brenneman *et al.* (7), Jacobi and Backman (12) found that Southern Runner was more resistant to *S. rolfsii* than other cultivars tested.

Partial resistance of Toalson has been reported by several researchers (6, 19, 20). Smith and coworkers (20) reported that resistance of TxAG-3 was considerably better than Toalson. They also noted partial resistance to *S. rolfsii* with Tx798716 and Tx 798396, the latter being a derivative of PI 365553. TxAG-3, a selection from PI 365553, is a long season bunch type peanut introduction from Hondruas (1) of the subspecies *hypogaea*. With irrigation, timely planting, and good management, PI 365553 produces acceptable yields in South Texas. Low grade, red testae, and late maturity prevents its use for commercial production. PI 365553 has been used as a source for pod rot resistance in the Texas A&M breeding program. Lines of which PI 365553 is a parent have been selected on the basis of pod rot reaction and agronomic performance. The purpose of this study was to ascertain whether lines derived from crosses with PI 365553 and ones with partial resistance to Pythium pod rot would have partial resistance to *Sclerotium rolfsii* Sacc. An additional goal was to ascertain whether the *S. rolfsii* resistance level of PI 365553, as measured by these progenies, is sufficient to justify a continued program of incorporating resistance into adapted, acceptable cultivars.

Materials and Methods

Six cultivars and eleven breeding lines were planted for three years (1987-1989) in a field with a history of severe *S. rolfsii* infestation. The tests were conducted on Tremona loamy fine sand (clayey, mixed, thermic Aquic Arenic Paleustalfs), soil pH of 7.2, and 1% organic matter located in South Central Texas on the Texas Agricultural Research Station near Yoakum. Stubble from previous annual ryegrass (*Lolium multiflorium* Lam.) was left on the soil surface to enhance or maintain the propagules of *S. rolfsii*.

The four-replicate tests were each arranged in a randomized complete block design with each plot consisting of two rows spaced 92 cm apart and 6.7 m in length. Seed was planted at the rate of 20 seed per row meter for spanish entries and 15 seed per row meter for runner entries.

Weed control was obtained with a tank mix of trifluralin [2,6-dinitro-*N,N*-dipropyl-4-(trifluoromethyl)benzenamine] and metolachlor [2-chloro-

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N-(2-ethyl-6-methlphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] at 0.56 plus 1.68 kg ai ha^{-1}, respectively. Acifluorfen (5-[2-chloro-4-(trifluoromethyl) phenoxyl]-2-nitrobenzoic acid) at 0.56 kg ai ha^{-1} and bentazon [3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one,2,2-dioxide] at 1.12 kg ai ha^{-1} were applied postemergence as needed to control broadleaf weeds and yellow nutsedge (*Cyperus esculentus* L.), respectively.

The breeding lines included both spanish-and runner-type selections. Five spanish (Tx855106, Tx855125, Tx855138, Tx855143, and Tx855228) and one runner (Tx855228) line were advanced F8:12 sister line re-selections from Tx798396, an F4 derived population from a cross of PI 365553 and Tamnut 74. The remaining lines (all runner) consisted of Tx835820, Tx835829, Tx835841, and Tx855228 (F4:9-12 selections from Florunner x PI 365553); Tx833829 (Tamnut 74/PI 475871 F4:7-9); and Tx833841 (Florunner/PI 475871 F4:7-9). VP 8140 is a selection from Chico (T. A. Coffelt, personal communication), while PI 475871 is another runner-type introduction with red testae from Bolivia (18). All original selections were made from populations grown in soil infested with *P. myriotylum* on the basis of low pod disease, pod shape, pod load, pod size, and vine chracteristics. Subsequent yield and grade determinations were made to ascertain reasonable adaptation to Texas conditions. TxAG-3 and cultivars Florunner, Okrun, Southern Runner, and Tamnut 74 were included as checks.

Tests were planted June 25, 1987, June 3, 1988, and May 25, 1989. Cultural management was in accord with that recommended for irrigated peanut production. Leafspot was controlled with regular applications of chlorathalonil (tetrachloroisophtalonitrile). Spanish-type entries were dug October 25, 1987, October 4, 1988, and September 21, 1989. Runner-type entries were dug on November 2, and 18, 1987, October 21, 1988, and October 12, 1989. Due to heavy disease pressure, VP 8140 was dug at the same time as the spanish in 1988 and 1989.

Sclerotium rolfsii infection sites were counted approximately one week prior to digging in 1987 and immediately after digging in 1988 and 1989. Southern blight infection sites (hits) were determined by dead or wilted plant branches with visual confirmation of the fungus by mecelia or sclerotia growth. Maximum length for a target site if no healthy stems intervened was 30.5 cm. Differences between adjacent infection sites were based on the presence of healthy appearing intervening stems. Counts after digging were determined by the presence of mycelia or sclerotia according to Rodriguez-Kabana *et al.* (17). Positive identification of the fungus was obtained by plating diseased tissue on sterile petri dishes (90 mm diameter) containing laboratory prepared potato dextrose agar (PDA).

Peanut pods were allowed to dry in the field for three to five days prior to thrashing. Pods were subsequently detached by means of a stationary picker, dried to 10% moisture with a propane drier, and cleaned of pegs, stems, and inert matter by hand. A random 350 g pod sample was collected and visually rated for pod discoloration casued by *S. rolfsii*. Ratings were made on a 0 to 10 basis with 0=no disease symptoms and 10=pod tissue completely diseased.

Grades were determined on a 250 g pod sample of each plot following procedures described by the Federal-state Inspection Service. The damaged kernel percentages included only visually damaged seed. All data were subjected to analysis of variance and Duncan's Multiple Range Tests.

Table 1. Number of S. rolfsii infection sites for 17 peanut breeding lines and cultivars at Yoakum, TX, 1987-1989.

Market type Entry	Disease loci (No./6.7 Row m) 1987	 1988	 1989	 Mean
RUNNER				
TX AG-3	3.2 d-f[1/]	6.0 b-e	6.9 fg	5.4
Tx855228	2.6 ef	6.3 b-e	10.1 c-g	6.3
Tx833829	5.2 b-f	5.6 c-e	9.0 d-g	6.6
Southern Runner	4.5 c-f	4.5 de	11.9 a-e	6.9
Tx835829	9.0 a-e	7.8 a-e	6.0 g	7.6
Tx835820	3.7 d-f	8.6 a-d	10.8 b-f	7.7
Tx833841	7.7 b-f	5.7 b-e	10.7 b-f	8.1
VP8140	...	8.2 a-d	10.8 b-f	9.5
Florunner	8.1 a-f	10.1 a-c	14.0 a-c	10.7
Tx835841	12.2 ab	9.9 a-c	13.1 a-d	11.7
Okrun	10.4 a-d	10.1 a-c	15.9 a	12.2
SPANISH				
Tx855138	1.3 f	3.5 e	7.7 e-g	4.2
Tamnut 74	3.4 d-f	9.9 a-c	8.4 d-g	7.2
Tx855155	7.8 a-f	9.3 a-c	15.1 ab	10.7
Tx855143	8.8 a-e	11.6 a	15.7 a	12.0
Tx855106	11.0 a-c	10.2 ab	16.0 a	12.4
Tx855125	14.9 a	9.9 a-c	16.0 a	13.7
Average	7.0 B	8.1 B	11.6 A	

[1/]Entry means within each column, and yearly averages within the last row followed by the same letter are not different (P=.05) according to Duncan's Multiple Range Test.

Results and Discussion

Since there was a significant ($P \leq 0.05$) year x cultivar interaction, data for each year are analyzed separately. Although not analyzed, the three-year means are also listed.

Moderate to heavy disease pressure prevailed during 1987, 1988, and 1989 growing season (Table 1). In the latter part of the growing season, main stems of infected plants wilted during peak temperatures of the day. Immediately after digging and inversion of the peanut plants, crown and root decay was readily apparent along with a general reduction of pods when infection occurred early in the season. Slight damage, caused by *Rhizoctonia solani* Kuhn, also occurred on pods but was not considered serious enough to warrant evaluation.

The relative incidence of *S. rolfsii* on some cultivars varied from year to year, while others were quite consistent (Table 1). The coefficients of rank correlation among test years, as developed by Spearman and described by Snedecor (21), ranged from r=0.60 to 0.62 (P=.01). Among runner entries, disease incidence in TxAG-3 was consistently low, while Okrun was among the most susceptible. Breeding lines such as Tx855228 and Tx833829 were not different from TxAG-3 during any of the three years. The incidence of disease in Tx835829 and Southern Runner was variable, perhaps as a result of chance, or from pathagen activation at a particularly sensitive plant growth stage. Each of these two entries were among the best in one or more years, and the poorest in other years. The low average disease incidence in Southern Runner, compared to cultivars such as Florunner and Okrun, is in agreement with the reports of Arnold et al. (2), Brenneman et al. (7), and Jacobi and Backman (12). Variations in relative entry performance were also noted by Branch and Csinos (6); hence, their conclusion that multiple-year evaluations were necessary for reliable genotypic assessments in Georgia.

For spanish entries, the range in disease incidence was comparable to that in runner types. Disease incidence in Tx855138 was consistently low, but was statistically better (p=.05) than Tamnut 74 only in 1988. Other entries, such as Tx855125 and Tx855106, had consistently high disease incidence. Variation in relative rank of spanish entries was not so apparent as in runner entries.

The lack of disease on pods from the random samples indicated that many of the diseased pods were lost at digging due to diseased pegs (Table 2). Significantly less disease was observed on the harvested pods in 1988 than in 1987 and 1989. Ratings suggested less disease than was indicated by disease loci counts; however, when plot sampes were dug, some infected pods dropped from the vine. Comparativetly high pod disease ratings were noted for runner types such as Okrun, Florunner, Tx835829, Tx835820, and Tx835841.

As a group, disease incidence in spanish types was slightly more than in runner. The average number of disease loci per 6.7 m of row for spanish was 10.1 compared to 8.4 for runner (Table 1). Pod disease ratings for the four Florunner/PI 365553 runner selections averaged 1.8 compared to 1.6 for the five PI 365553/Tamnut 74 lines (Table 2). The wide range in number of loci, in both runner and spanish lines selected for Pythium pod rot resistance, concurs with our earlier observation that resistance to S.

Table 2. Pod disease ratings for 17 peanut breeding lines and cultivars at Yoakum, TX, 1987-1989.

Market type Entry	Pod disease[1] 1987	1988	1989	Mean
RUNNER				
TX AG-3	1.2 c[2]	1.0 b-e	2.5 a-c	1.6
Tx855228	2.0 bc	1.0 b-e	2.2 a-c	1.8
Tx833829	1.7 bc	0.8 b-e	2.4 a-c	1.6
Southern Runner	1.8 c-f	0.5 e	2.2 a-c	1.5
Tx835829	2.6 ab	1.4 ab	2.4 a-c	2.1
Tx835820	1.4 c	1.5 ab	2.9 ab	1.9
Tx833841	1.7 bc	0.7 c-e	1.6 cd	1.3
VP8140	...	0.9 b-e	2.0 b-d	1.5
Florunner	3.2 a	0.9 b-e	2.6 ab	2.2
Tx835841	1.8 bc	1.4 a c	2.3 a-c	1.9
Okrun	1.8 bc	1.8 a	3.2 a	2.3
SPANISH				
Tx855138	1.2 c	0.7 de	1.2 d	1.1
Tamnut 74	1.9 bc	1.1 b-e	2.5 a-c	1.8
Tx855155	1.6 bc	1.0 b-e	2.2 a-c	1.6
Tx855143	2.0 bc	1.3 a-d	2.1 b-d	1.8
Tx855106	1.8 bc	1.0 b-e	2.4 a-c	1.7
Tx855125	1.9 bc	0.7 c-e	2.4 a-c	1.7
Average	1.9 A	1.1 B	2.3 A	

[1]Rating index: 0=no disease, 10=completely diseased.

[2]Entry means within each column, and yearly averages within the last row followed by the same letter are not different (P=.05) according to Duncan's Multiple Range Test.

rolfsii and *P. myriotylum* are not a result of the same defensive mechanisms (20). The coincidental resistance to both pathogens by TxAG-3 adds attraction to its use as a parent.

Yields varied among years with the highest average occurring in 1987 when disease was the lightest. Coefficients of correlation for disease incidence (hits) and yield were negative but not significant (P=.05) in all years (Table 3).

The average yield of Tx833841 was higher than the other entries, and was the highest yielding entry each year of the study. The yields of this line were 40-95% better than Okrun, Southern Runner, Florunner, and Tamnut 74 (Table 3). Southern Runner and Florunner produced virtually identical yields, but Southern Runner provided a 35% reduction in disease severity as compared with Florunner. Southern Runner generally matures later than Florunner and may have yielded higher if digging had been delayed. Among spanish genotypes, Tx855138 was the highest yielding entry, and was statistically (p=.05) better than Tamnut 74 each year of the test. The yields of Tx855138 ranged from 32 to 253% of those of Tamnut 74. Averaged over years, four out of six of the spanish lines were superior in yield to Tamnut 74.

Peanut grade was highest in 1987 when disease was less of

Table 3. Pod yields for 17 peanut breeding lines and cultivars at Yoakum, TX, 1987-1989.

Market type Entry	Pod Yield (kg/ha) 1987	1988	1989	Mean
RUNNER				
TX AG-3	2552 d-g[1]	1647 i	1415 e-g	1871
Tx855228	3750 ab	2698 b-e	2173 b-d	2805
Tx833829	3572 a-c	2165 e-i	1380 e-g	2372
Southern Runner	2992 c-e	3104 ab	1856 c-e	2651
Tx835829	2349 e-g	2425 c-f	2301 a c	2358
Tx835820	3782 ab	2715 b-e	2173 b-d	2890
Tx833841	3990 a	3409 a	2735 a	3378
VP8140	...	2314 c-h	2324 a-c	2319
Florunner	3574 a-c	2730 b-d	1713 de	2672
Tx835841	2056 bc	2795 bc	1736 de	2196
Okrun	2113 fg	3000 ab	2151 b-d	2421
SPANISH				
Tx855138	3249 a-d	2360 c-g	2511 ab	2702
Tamnut 74	2442 e-g	1782 hi	989 g	1738
Tx855155	2508 d-g	1824 g-i	1172 fg	1835
Tx855143	2845 c-f	1949 f-i	1654 d-f	2149
Tx855106	2662 d-g	2097 f-i	1433 e-g	2064
Tx855125	3072 b-e	2203 d-h	1731 de	2335
Average	2696 A	2475 B	1752 C	

[1]Entry means within each column, and yearly averages within the last row followed by the same letter are not different (P=.05) according to Duncan's Multiple Range Test.

Table 4. Total sound mature kernels for 17 peanut breeding lines and cultivars at Yoakum, TX, 1987-1989.

Market type Entry	% TSMK 1987	1988	1989	Mean
RUNNER				
TX AG-3	72.5 a-c[1]	61.5 e	55.8 h	63.3
Tx855228	75.5 a	66.2 b-d	64.3 c-f	68.6
Tx833829	69.3 bc	56.2 f	56.8 gh	60.8
Southern Runner	74.0 a	69.7 a-c	72.8 a	72.2
Tx835829	62.3 d	63.7 de	56.3 gh	60.8
Tx835820	74.8 a	69.0 a-c	61.5 ef	68.4
Tx833841	72.5 a-c	70.5 ab	70.3 ab	71.1
VP8140	...	66.5 b-d	62.8 d-f	64.7
Florunner	73.5 ab	69.7 a-c	69.0 a-c	70.7
Tx835841	63.5 d	63.7 de	62.8 d-f	63.3
Okrun	74.3 a	70.5 ab	68.5 a-c	71.1
SPANISH				
Tx855138	68.5 c	63.2 de	65.0 c-f	65.6
Tamnut 74	69.3 bc	65.2 c-e	60.8 fg	65.1
Tx855155	75.5 a	69.0 a-c	66.5 b-e	70.3
Tx855143	75.3 a	71.7 a	69.3 a-c	72.3
Tx855106	74.5 a	70.5 ab	65.3 b-f	70.1
Tx855125	76.5 a	73.0 a	67.5 b-d	72.3
Average	71.9 A	67.1 B	64.2 C	

[1]Entry means within each column, and yearly averages within the last row followed by the same letter are not different (P=.05) according to Duncan's Multiple Range Test.

a problem (Table 4). Southern Runner, Okrun, Florunner, and Tx833841 resulted in grades > 70% among runner entries while Tx855155, Tx855143, Tx855106, and Tx855125 were higher among spanish entries, when averaged over test years. The four above mentioned spanish entries provided to 6 to 7% increase in grade compared with Tamnut 74.

TxAG-3 had significantly lower grades in two of three years. In previous work by Smith *et al.* (20), they attributed the low grade of TxAG-3 to premature digging and thick shells. This line was one of the longest duration entries in the test and would have benefitted from a delay in digging.

These results indicate the potential of several breeding lines for use under heavy southern blight disease pressure. Not only was the disease incidence less with several of the genotypes but the yield potential was better than some of the commonly used commercial varieties.

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