Comparison of Virginia-Type Peanut Cultivars and Interspecific Hybrid Derived Breeding Lines for Leaf Spot Resistance, Yield, and Grade

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ABSTRACT

Disease resistant cultivars with good quality are needed by U.S. peanut growers to lower production costs. In the Virginia-Carolina (V-C) production area, use of resistant cultivars to reduce leaf spots would be a cost-effective and environmentally safe alternative to chemical applications. Twenty-six interspecific hybrid derived breeding lines with 5 *Arachis* species in their pedigrees, six resistant *A. hypogaea* checks and 11 susceptible cultivars were evaluated for leaf spot resistance in field tests at the Peanut Belt Research Station in Lewiston, NC from 2004 to 2006 without leaf spot fungicides. Defoliation was rated on a 1–9 proportional scale with 1 = no defoliation (resistant) and a 9 = complete defoliation (susceptible). The mean defoliation score of the cultivars was 6.8±0.1 (range = 6.4 to 7.4), compared to 5.3±0.1 (range = 4.4 to 6.3) for the interspecific hybrid derived breeding lines. Some of the interspecific hybrid derived breeding lines showed levels of leaf spot resistance similar to the resistant *A. hypogaea* checks (mean = 4.3±0.2), suggesting that these breeding lines contain genes conditioning resistance to the leaf spots. The combined mean yield of the cultivars was 2709±103 kg/ha (range = 2296 kg/ha to 3070 kg/ha), whereas that of the interspecific hybrid derived breeding lines was 3169±119 kg/ha (range = 2467 kg/ha to 3767 kg/ha). Evaluation of selected grade characteristics showed that several interspecific hybrid derived breeding lines have grade similar to those of the commercial cultivars. Sixteen of the 26 interspecific hybrid derived breeding lines with five different diploid species in their pedigrees and NC 7, the commercial flavor standard for the V-C area, were also evaluated for sensory quality. No significant variation among test entries was found for the roasted peanut, sweet, or bitter sensory attributes. This suggests that high levels of leaf spot resistance can be combined with superior yield, grade and other quality factors and that some of these lines may become useful for commercial production in the V-C area.

Key Words: *Arachis hypogaea*, wild species, interspecific hybrid, disease resistance, yield, grade, flavor.

Peanut (*Arachis hypogaea* L.) is an important cash crop in the southeastern U.S. Peanut growers are demanding cultivars and management practices that reduce production costs so they can grow peanuts profitably to compete with imports. Peanut breeders have provided high yielding cultivars with good quality profiles for industry and consumer use. However, all of these cultivars are susceptible to one or more commonly occurring diseases. Few cultivars with multiple disease resistances are available, and none that has a sufficient level of leaf spot resistance to be grown without fungicide applications. Further, adverse weather conditions may delay timely sprays leading to heavy disease infestation that reduces yield and quality of peanuts. Thus, there is a need for high yielding, novel disease resistant peanut cultivars and progress in breeding for resistance has been slow due to the limited number of resistant genotypes available within the *A. hypogaea* germplasm. However, it is noteworthy that extensive work has been reported in developing leaf spot resistant runner cultivars using resistant plant introductions available within *A. hypogaea* gene pool (Branch, 2002; Gorbet and Shokes, 2002a and 2002b).

A potential source of disease resistance genes for peanut improvement is the wild species. The genus contains about 80 diploid ($2n = 2x = 20$), aneuploid ($2n = 2x = 18$) and tetraploid ($2n = 4x = 40$) species that have been grouped into nine botanical sections (Krapovickas and Gregory, 1994; Valls and Simpson, 2005) and *A. hypogaea* will only hybridize with species in section *Arachis*. Disease evaluations of section *Arachis* species revealed several with high levels of resistance to many important pathogens and pests (Lynch and Mack, 1995; Stalker and Moss, 1987; Stalker and Simpson, 1995). Although wild species of section *Arachis* have been suggested as sources of resistance genes since the 1960s (Smartt and Gregory, 1967), only two disease resistant, runner commercial cultivars have been released to-date from interspecific hybridization (Simpson and Starr,

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2001; Simpson *et al.*, 2003). A major reason for this slow and limited use of *Arachis* species for peanut improvement has been their ploidy level differences and genomic incompatibilities with *A. hypogaea* (Tallury *et al.*, 2005). Nonetheless, several tetraploid interspecific hybrid lines derived from *A. cardenasii* Krapov. & W.C. Gregory, *A. stenosperma* Krapov. & W.C. Gregory, *A. diogoi* Hoehne, *A. batizocoi* Krapov. & W.C. Gregory and *A. correntina* (Burkart) Krapov. & W.C. Gregory, have been developed in the NCSU peanut genetics program and 16 germplasm lines were released (Stalker and Beute, 1993; Stalker and Lynch, 2002; Stalker *et al.*, 2002a; Stalker *et al.*, 2002b; Isleib *et al.*, 2006a). These germplasm lines are publicly available and have high levels of resistances to early and late leaf spots (*Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton), root-knot nematode (*Meloidogyne arenaria* [Neal] Chitwood), tomato spotted wilt virus (TSWV), Sclerotinia blight (*S. minor* Jagger), Cylindrocladium black rot (CBR, *C. parasiticum* Crous, Wingfield & Alfenas), web blotch (*Phoma arachidicola*) and several insects, such as potato leafhopper (*Empoasca fabae* [Harris]), corn earworm (*Helicoverpa zea* [Boddie]), and lesser cornstalk borer (*Elasmopalpus lignosellus* [Zeller]). Several of these germplasm lines and other disease resistant selections have been hybridized with susceptible commercial cultivars and additional selections from the resulting progenies were evaluated in the present study (Table 1) for possible cultivar releases.

The overall goal of our research program is to develop peanut cultivars with resistance to the most common diseases in the V-C production area, which include early leaf spot (ELS), TSWV, Sclerotinia blight (SB) and CBR. The specific goals of the research reported in this paper are 1) to compare tetraploid, interspecific hybrid derived breeding lines with commercial peanut cultivars for their agronomic performance and leaf spot resistance, and 2) to evaluate the potential of tetraploid interspecific hybrid derived breeding lines for commercial cultivation in the V-C peanut production area.

Materials and Methods

Twenty-six tetraploid, interspecific hybrid derived breeding lines, six *A. hypogaea* lines resistant to early- and late leaf spots (resistant checks), and 11 commercial cultivars (susceptible checks) (Table 1) [NC 6 (Campbell *et al.*, 1977); NC 12C (Isleib *et al.*, 1997); Gregory (Isleib *et al.*, 1999); Perry (Isleib *et al.*, 2003); Brantley (Isleib *et al.*, 2006b); Phillips (Isleib *et al.*, 2006c); VA-C 92R (Mozingo *et al.*, 1994); VA 98R (Mozingo *et al.*, 2000); Wilson (Mozingo *et al.*, 2004); NC 7 (Wynne *et al.*, 1979) and NC-V11 (Wynne *et al.*, 1991)] were evaluated in field tests at the Peanut Belt Research Station in Lewiston, NC from 2004 to 2006. Experimental plots consisted of 2-rows each, 7.3 m long on 91 cm wide beds and 28 seeds/row were planted with 25 cm spacing. The plots were planted on 11 May in each of the 3 years. In each year the experimental design was a lattice with two replications, with a 10×10 simple square lattice in 2004 and 10×9 double rectangular lattices in 2005. The additional lines evaluated in these experiments (57 in 2004, 47 in 2005 and 2006) were experimental *A. hypogaea* lines from the N.C. State Univ. peanut-breeding project. Data on these experimental lines were not reported in this study (T.G. Isleib, unpublished data). Recommended management practices were followed during the growing of the crop but no fungicidal sprays were used to control leaf spots.

Defoliation ratings were recorded on plots on 2, 14, and 21 Sept. in 2004, on 21 and 27 Sept. in 2005, and on 9 and 21 Sept. in 2006, respectively. The severity of the disease was rated on a proportional scale from 1 = no defoliation (resistant) to 9 = complete defoliation (susceptible). The 3 yrs of data were combined to generate mean disease scores. Pod yield and grade were measured on all plots and combined to generate means. Analysis of variance was performed on defoliation scores, yields and grades. Means were adjusted for block effects in the incomplete block design if block effects were found to be significant by F-test. The means for the 43 entries from each year were used to perform an analysis of variance as if for a randomized complete block design using years as the blocking variable. Means were separated by t-tests. All analyses were performed using the general linear models procedure (PROC GLM) of the SAS statistical software package (SAS Institute, Inc. 2001).

Results and Discussion

Leaf spot evaluations. Significant variation among the 43 entries was observed ($P<0.05$) for both defoliation score and yield (Table 2). In 2004, the experimental plots showed higher incidence of ELS than in the other 2 yrs. Higher incidence of LLS was observed in the experimental plots in 2005 at Lewiston and both leaf spots were present in 2006. Although ELS has been the major disease in the V-

Table 1. Experimental material with their genetic background.

Identity	Pedigree
Interspecific Hybrid Derived Breeding Lines	
HTS 00-02	NC 7 /3/ 90 APS 47, NC 6 // PI 270806 / GP NC WS 4*
HTS 02-01	NC 6*2 // 4x Plot 18C Plant 2-2, PI 338280 (*A. stenosperma* HLK 410) / PI 276235 (*A. diogoi* GK 10602)
HTS 02-02	NC-V 11 // NC 6 / 82 F2LS 501-2 - F1-C (*A. cardenasii* GKP 10017)
HTS 02-03	PI 261942 (*A. hypogaea*) / PI 262141 (*A. cardenasii* GKP 10017)
HTS 02-04	NC 6*2 / 82 L F2LS 309-01 (*A. cardenasii* GKP 10017)
HTS 02-05	PI 298639 (*A. batizocoi* K 9484) / C2
HTS 02-06	NC Ac 18000 / PI 262881 (*A. correntina* GKP 9548)
HTS 02-07	NC 6 // F1 A, 82 F2LS 201-1 / 82 F2LS 215-1 (*A. cardenasii* GKP 10017)
HTS 02-08	NC 6 /3/ 90 APS 15, NC 6 // NC 3033 / GP NC WS 1
HTS 02-09	NC 6 /3/ 90 APS 25, NC 5 // PI 270806 / GP NC WS 4
HTS 02-10	NC 6 /3/ 90 APS 25, NC 5 // PI 270806 / GP NC WS 4
HTS 03-01	NC 6 /3/ 90 APS 20, NC 5 // PI 270806 / GP NC WS 4
SPT 04-01	Perry / GP NC WS 11
SPT 04-02	NC 12C / GP NC WS 15
SPT 04-03	NC 12C / GP NC WS 15
SPT 04-04	NC 12C / GP NC WS 15
SPT 04-05	NC 12C / GP NC WS 15
SPT 04-06	Southern Runner /4/ 95 LBCF4-139, NC 6 /3/ 90 APS 25, NC 5 // PI 270806 / GP NC WS 4
SPT 04-07	Southern Runner /4/ 95 LBCF4-139, NC 6 /3/ 90 APS 25, NC 5 // PI 270806 / GP NC WS 4
SPT 04-08	Southern Runner /4/ 95 LBCF4-139, NC 6 /3/ 90 APS 25, NC 5 // PI 270806 / GP NC WS 4
SPT 04-09	NC 12C / GP NC WS 13
SPT 04-10	NC 12C / GP NC WS 13
SPT 04-11	NC 12C / GP NC WS 13
SPT 04-12	NC 12C / GP NC WS 13
SPT 04-13	NC 12C / GP NC WS 13
SPT 04-14	NC 12C / GP NC WS 13
Resistant *A. hypogaea* Checks	**Susceptible *A. hypogaea* cultivars**
GP-NC 343	Brantley
Kanyoma	Gregory
PI 109839†	NC 12C
PI 121067	NC 6
PI 269685	NC 7
PI 270806	NC-V11
	Perry
	Phillips
	VA 98R
	VA-C 92R
	Wilson

*GP NC WS 1–15 have *A. cardenasii* (PI 262141, GKP 10017) in their pedigree
†Hammons *et al.* 1980

C production area, LLS also causes significant damage as was observed in 2005. Together, these two diseases can result in up to 50% yield losses to growers (Shew *et al.*, 1995). Cultivars with resistance to both diseases will greatly benefit the V-C peanut growers. As a group, the mean defoliation score of the cultivars was 6.8-±0.1 whereas the corresponding value for the resistant checks was 4.3±0.2 and for the interspecific hybrid breeding lines was 5.3±0.1, respectively. Thus, significant differences were observed for mean defoliation score (Table 2). Among the cultivars grown in the V-C area, the mean defoliation score ranged from 6.4 for the obsolete cultivar NC 6 to 7.4 for Wilson (Table 2). In the resistant *A. hypogaea* checks, the mean defoliation score varied from 3.0 in PI 269685 to 5.5 in Kanyoma. Correspondingly, the mean defoliation scores of the 26 interspecific hybrid derived breeding lines ranged from 4.4 in SPT 04-01 to 6.3 in SPT 04-13 and SPT 04-14. These three lines were derived from *A. cardenasii*. The line, HTS 02-01, derived from an amphidiploid of *A. stenosperma* × *A. diogoi*, had a mean defoliation score of 5.1, whereas, the *A. batizocoi* (HTS 02-05) and *A. correntina* (HTS 02-06) derivatives had mean defoliation scores of 5.9 and 5.0, respectively. Nine of the 26 interspecific hybrid breeding lines had mean defoliation scores of 5 or lower whereas the lowest mean defoliation score among the cultivars was a 6.4 for NC 6. Although a difference of 1.4 points or more in defoliation scores between the cultivars and the interspecific hybrid derived breeding lines may not seem significant, nevertheless, the leaf spot resistance levels observed in the interspecific hybrid derived breeding lines warrant further field evaluations for releases. In a study involving the components of resistance to late leaf spot and rust among 15 interspecific hybrid derivatives, Dwivedi *et al.* (2002) indicated that the disease score, which is primarily based on percentage defoliation, integrates all components of resistance and an optimum combination of these components results in lower defoliation scores. Thus, because of their lower defoliation scores, the interspecific hybrid derived breeding lines in this study may have accumulated an optimum combination of different components of resistance.

Currently, peanut growers use foliar application of fungicides to control leaf spots, usually beginning in early July and continuing until mid-Sept following a 14-d spray schedule or a weather based spray advisory. This requires five to six sprays during the crop season to control leaf spots with chemical costs of$371–494/ha. The interspecific hybrid derived breeding lines have high levels of leaf spot resistance even under heavy disease pressure, unlike some of the moderately leaf spot resistant V-C peanut cultivars which express severe defoliation symptoms under heavy disease pressure, and are a promising source for the development of leaf spot resistant cultivars for the V-C area.

Yield Evaluations. Although disease-resistant cultivars may reduce fungicidal sprays and lower production costs, the most important traits to a grower are the yield and grade because they determine the price and eventual profits. Large-seeded virginia type cultivars, such as Gregory, Perry, NC 12C, NC-V11, VA 98R and Wilson, dominate the V-C production area. In field tests conducted without chemical control of leaf spots, the mean yields ranged from 2296±313 kg/ha in NC 7 to 3070±363 kg/ha in Brantley, whereas 19 of the 26 interspecific hybrid derived breeding lines produced at least 3000 kg/ha without chemical control of leaf spots (Table 2). Of these, the highest yielding line, HTS 02-01 which is derived from the amphidiploid, [*A. hypogaea* × 4*x* (*A. stenosperma* × *A. diogoi*)] yielded 3767±365 kg/ha. Thus, the interspecific derived breeding lines yielded, on average, at least 300 kg more than the existing commercial cultivars with no fungicidal sprays (Table 2). As a result, a grower should be able to reduce or possibly eliminate the number of fungicidal sprays to control leaf spots and substantially lower production costs by reducing fuel and chemical costs.

Grade and Flavor Evaluations. Overall, the means of the selected grade characteristics of the interspecific breeding lines were slightly inferior to those of the cultivars (Table 2). For example, in the present study, Brantley had mean ELK content of 48.1% and SMK content of 68.3%. Among the interspecific hybrid derived breeding lines, the corresponding values for SPT 04-13 were 45.1 and 64.4%. Overall, 22 of the 26 interspecific hybrid derived breeding lines had ELK and SMK values similar to those of the cultivars (Table 2). Some of these lines exhibited values for jumbo pods, fancy pods and 100-seed weight similar to those of the cultivars (Table 2). Sixteen of the 26 interspecific hybrid derived breeding lines and NC 7, the commercial flavor standard for V-C area, were also evaluated for sensory quality. No significant variation among test entries and NC 7 was found for the roasted peanut, sweet, or bitter sensory attributes (Tallury *et al.*, 2008) indicating that the interspecific hybrid derived breeding lines did not exhibit flavor degradation, an important attribute if these lines are to be considered for cultivar release in the V-C area.

Conclusions

Currently grown cultivars in the V-C area produced less yield with more disease than the interspecific hybrid derived breeding lines. Many interspecific hybrid derived breeding lines yielded 3000 kg/ha without chemical control of leaf spots. This indicates that the interspecific hybrid derived breeding lines evaluated in this study have superior leaf spot resistance combined with high yield. Because the diploid *Arachis* species used in the pedigrees of the interspecific hybrid breeding lines have a broad range of disease resistances to several common pathogens and pests of peanut (Stalker and Moss, 1987), they may also be resistant to other diseases of peanut. These lines need to be evaluated in multiple environments in the V-C area

Table 2. Means of defoliation score, yield, and selected grade characteristics of susceptible cultivars, resistant *A. hypogaea* checks and tetraploid interspecific hybrid derived breeding lines evaluated at the Peanut Belt Res. Stn., Lewiston, NC from 2004–2006.

Identity	Defoliation Score	Pod yield	Jumbo pods	Fancy pods	Weight of 100 seeds	Extra large kernels	Sound mature kernels
		kg/ha	%	%	*g*	%	%
Cultivars							
NC 6	$6.4\pm0.5^{a-f}$	$2626\pm443^{b-f}$	$45.2\pm8.0^{a-e}$	$40.5\pm4.8^{a-j}$	$82.1\pm4.5^{a-e}$	$36.7\pm5.4^{b-g}$	$64.8\pm2.4^{a-h}$
NC 7	$6.5\pm0.4^{a-e}$	2296 ± 313^{f}	$52.2\pm6.5^{a-d}$	26.4 ± 3.9^{lm}	85.4 ± 3.6^{ab}	$42.5\pm4.4^{a-f}$	$66.8\pm2.0^{a-d}$
NC-V 11	$6.7\pm0.3^{a-d}$	$2823\pm276^{b-f}$	$19.6\pm6.5^{g-k}$	46.5 ± 3.9^{abc}	$78.3\pm3.6^{a-f}$	$31.9\pm4.4^{e-i}$	67.7 ± 2.0^{a}
NC 12C	$6.7\pm0.3^{a-d}$	$2771\pm248^{c-f}$	$49.9\pm6.5^{a-d}$	$31.2\pm3.9^{h-m}$	88.1 ± 3.6^{a}	45.5 ± 4.4^{abc}	67.6 ± 2.0^{a}
Gregory	7.1 ± 0.3^{abc}	2511 ± 276^{ef}	57.1 ± 6.5^{ab}	24.1 ± 3.9^{m}	87.8 ± 3.6^{a}	$43.7\pm4.4^{a-e}$	$65.6\pm2.0^{a-f}$
Perry	$6.7\pm0.3^{a-d}$	$2687\pm248^{c-f}$	54.7 ± 6.5^{abc}	$31.6\pm3.9^{g-m}$	87.7 ± 3.6^{a}	$37.4\pm4.4^{b-g}$	$65.3\pm2.0^{a-g}$
Phillips	$6.7\pm0.4^{a-e}$	$2628\pm363^{c-f}$	$36.1\pm8.0^{c-i}$	$41.5\pm4.8^{a-i}$	$79.2\pm4.5^{a-f}$	$43.3\pm5.4^{a-f}$	70.2 ± 2.4^{a}
Brantley	$6.6\pm0.4^{a-e}$	$3070\pm363^{a-f}$	$45.7\pm8.0^{a-e}$	$31.9\pm4.8^{f-m}$	88.2 ± 4.5^{a}	48.1 ± 5.4^{ab}	68.3 ± 2.4^{a}
VA-C 92R	7.3 ± 0.4^{ab}	$2926\pm365^{a-f}$	$35.6\pm6.5^{c-i}$	$33.5\pm3.9^{e-m}$	$82.0\pm3.6^{a-e}$	$33.8\pm4.4^{c-h}$	67.4 ± 2.0^{ab}
VA 98R	7.1 ± 0.4^{abc}	2534 ± 314^{ef}	$28.1\pm6.5^{e-j}$	$43.6\pm3.9^{a-f}$	$82.5\pm3.6^{a-d}$	$34.0\pm4.4^{c-h}$	$65.9\pm2.0^{a-f}$
Wilson	7.4 ± 0.4^{a}	$2724\pm365^{c-f}$	$36.5\pm6.5^{c-h}$	$34.0\pm3.9^{d-m}$	$81.9\pm3.6^{a-e}$	$32.6\pm4.4^{e-h}$	$65.0\pm2.0^{a-g}$
Mean	$\mathbf{6.8\pm0.1^{A}}$	$\mathbf{2709\pm103^{B}}$	$\mathbf{41.9\pm2.1^{A}}$	$\mathbf{37.3\pm2.0^{ns}}$	$\mathbf{83.9\pm1.2^{A}}$	$\mathbf{39.1\pm1.4^{A}}$	$\mathbf{66.8\pm0.6^{A}}$
Resistant checks							
GP-NC 343	$5.1\pm0.4^{i-m}$	3690 ± 310^{abc}	$20.4\pm8.0^{f-k}$	52.7 ± 4.8^{a}	$75.9\pm4.5^{a-g}$	$34.3\pm5.4^{b-h}$	$65.6\pm2.4^{a-g}$
Kanyoma	$5.5\pm0.5^{e-m}$	$3180\pm443^{a-f}$	55.4 ± 8.0^{abc}	23.1 ± 4.8^{m}	$82.4\pm4.5^{a-e}$	$38.7\pm5.4^{a-g}$	$61.4\pm2.4^{b-j}$
PI 109839	4.1 ± 0.5^{mn}	$2542\pm443^{c-f}$	12.4 ± 8.0^{jk}	5.2 ± 4.8^{n}	38.7 ± 4.5^{i}	6.7 ± 5.4^{k}	55.2 ± 2.4^{j}
PI 121067	3.1 ± 0.5^{n}	$3474\pm443^{a-e}$	$38.3\pm8.0^{b-g}$	48.9 ± 4.8^{ab}	$82.4\pm4.5^{a-e}$	52.0 ± 5.4^{a}	$65.2\pm2.4^{a-g}$
PI 269685	3.0 ± 0.5^{n}	3696 ± 443^{abc}	$37.2\pm8.0^{b-h}$	48.0 ± 4.8^{abc}	84.6 ± 4.5^{abc}	52.1 ± 5.4^{a}	$63.9\pm2.4^{a-h}$
PI 270806	$5.1\pm0.5^{f-m}$	$2878\pm443^{a-f}$	$24.4\pm8.0^{e-k}$	$46.3\pm4.8^{a-d}$	65.1 ± 4.5^{gh}	$29.8\pm5.4^{f-i}$	$59.2\pm2.4^{g-j}$
Mean	$\mathbf{4.3\pm0.2^{C}}$	$\mathbf{3254\pm189^{A}}$	$\mathbf{31.4\pm3.4^{B}}$	$\mathbf{35.0\pm1.3^{ns}}$	$\mathbf{71.5\pm1.9^{C}}$	$\mathbf{35.6\pm2.3^{AB}}$	$\mathbf{61.7\pm1.0^{C}}$
Interspecific breeding lines							
HTS 00-02	$4.9\pm0.4^{j-m}$	$2947\pm365^{a-f}$	$39.4\pm6.5^{b-f}$	$40.3\pm3.9^{b-j}$	$80.4\pm3.6^{a-f}$	$37.5\pm4.4^{b-g}$	$61.6\pm2.0^{c-i}$
HTS 02-01	$5.1\pm0.4^{h-m}$	3767 ± 365^{a}	$51.0\pm6.5^{a-d}$	$34.3\pm3.9^{d-m}$	83.4 ± 3.6^{abc}	$36.1\pm4.4^{b-g}$	$64.2\pm2.0^{a-h}$
HTS 02-02	$5.1\pm0.4^{g-m}$	$3490\pm365^{a-d}$	$49.2\pm6.5^{a-d}$	$31.3\pm3.9^{h-m}$	$78.7\pm3.6^{a-f}$	$33.0\pm4.4^{d-h}$	$60.1\pm2.0^{g-j}$
HTS 02-03	$5.6\pm0.4^{e-l}$	$3100\pm365^{a-f}$	$41.9\pm6.5^{b-e}$	$32.6\pm3.9^{g-m}$	$78.4\pm3.6^{a-f}$	$38.5\pm4.4^{a-g}$	$65.9\pm2.0^{a-f}$
HTS 02-04	$5.1\pm0.4^{i-m}$	$3324\pm365^{a-e}$	6.8 ± 6.5^{k}	24.5 ± 3.9^{m}	63.1 ± 3.6^{h}	15.6 ± 4.4^{jk}	$61.2\pm2.0^{e-j}$
HTS 02-05	$5.9\pm0.4^{d-k}$	2585 ± 365^{def}	$27.4\pm6.5^{e-j}$	48.2 ± 3.9^{ab}	$76.3\pm3.6^{b-g}$	$25.3\pm4.4^{g-j}$	$65.6\pm2.0^{a-g}$
HTS 02-06	$5.0\pm0.4^{i-m}$	3715 ± 365^{ab}	$27.0\pm6.5^{e-j}$	48.2 ± 3.9^{ab}	$82.2\pm3.6^{a-e}$	$42.8\pm4.4^{a-f}$	67.4 ± 2.0^{ab}
HTS 02-07	$5.3\pm0.4^{f-m}$	$3283\pm365^{a-e}$	$20.2\pm6.5^{g-k}$	$28.3\pm3.9^{j-m}$	$72.4\pm3.6^{d-h}$	19.7 ± 4.4^{ijk}	$64.7\pm2.0^{a-h}$
HTS 02-08	$5.0\pm0.4^{i-m}$	$3309\pm365^{a-e}$	57.3 ± 6.5^{ab}	27.5 ± 3.9^{klm}	$79.3\pm3.6^{a-f}$	$33.1\pm4.4^{c-h}$	58.9 ± 2.0^{hij}
HTS 02-09	$5.9\pm0.4^{d-k}$	2585 ± 365^{def}	$36.3\pm6.5^{c-h}$	$30.8\pm3.9^{i-m}$	70.2 ± 3.6^{fgh}	21.1 ± 4.4^{hij}	$60.9\pm2.0^{f-j}$
HTS 02-10	4.8 ± 0.4^{klm}	3668 ± 365^{abc}	$29.4\pm6.5^{e-j}$	47.6 ± 3.9^{abc}	$77.8\pm3.6^{a-f}$	$39.2\pm4.4^{a-f}$	$66.7\pm2.0^{a-e}$
HTS 03-01	$6.1\pm0.4^{d-i}$	$3009\pm365^{a-f}$	53.0 ± 6.5^{abc}	25.1 ± 3.9^{m}	85.1 ± 3.6^{ab}	$37.2\pm4.4^{b-g}$	$64.2\pm2.0^{a-h}$
SPT 04-01	4.4 ± 0.4^{m}	$2883\pm365^{a-f}$	$40.6\pm6.5^{b-f}$	$37.8\pm3.9^{b-k}$	$76.2\pm3.6^{b-g}$	21.4 ± 4.4^{hij}	57.1 ± 2.0^{ij}
SPT 04-02	$5.3\pm0.4^{f-m}$	$3044\pm365^{a-f}$	$18.7\pm6.5^{g-k}$	$41.2\pm3.9^{a-i}$	$72.7\pm3.6^{d-h}$	$35.5\pm4.4^{b-g}$	$66.5\pm2.0^{a-e}$
SPT 04-03	$5.3\pm0.4^{f-m}$	$3406\pm365^{a-e}$	$16.7\pm6.5^{h-k}$	$44.4\pm3.9^{a-e}$	$72.4\pm3.6^{d-h}$	$35.2\pm4.4^{b-g}$	67.0 ± 2.0^{abc}
SPT 04-04	4.9 ± 0.4^{klm}	$3178\pm365^{a-f}$	$17.4\pm6.5^{h-k}$	$43.7\pm3.9^{a-f}$	$74.5\pm3.6^{c-g}$	$37.5\pm4.4^{b-g}$	$66.5\pm2.0^{a-e}$
SPT 04-05	4.9 ± 0.4^{klm}	$3512\pm365^{a-d}$	15.5 ± 6.5^{ijk}	$42.4\pm3.9^{a-g}$	$72.2\pm3.6^{e-h}$	$33.1\pm4.4^{d-h}$	$65.1\pm2.0^{a-g}$
SPT 04-06	4.6 ± 0.4^{lm}	$3392\pm365^{a-e}$	60.8 ± 6.5^{a}	27.4 ± 3.9^{klm}	$77.7\pm3.6^{a-f}$	$39.3\pm4.4^{a-f}$	$65.6\pm2.0^{a-f}$
SPT 04-07	$5.2\pm0.4^{f-m}$	$3369\pm365^{a-e}$	$44.2\pm6.5^{a-e}$	$33.7\pm3.9^{e-m}$	$72.7\pm3.6^{d-h}$	$37.6\pm4.4^{b-g}$	$65.5\pm2.0^{a-g}$
SPT 04-08	4.6 ± 0.4^{lm}	$3374\pm365^{a-e}$	$40.4\pm6.5^{b-f}$	$36.1\pm3.9^{c-l}$	$74.7\pm3.6^{c-g}$	$37.1\pm4.4^{b-g}$	$65.5\pm2.0^{a-g}$
SPT 04-09	$6.0\pm0.4^{d-j}$	$3030\pm365^{a-f}$	$42.5\pm6.5^{a-e}$	$33.3\pm3.9^{f-m}$	85.6 ± 3.6^{ab}	$42.0\pm4.4^{a-f}$	$66.7\pm2.0^{a-e}$
SPT 04-10	$5.9\pm0.4^{d-k}$	$3313\pm365^{a-e}$	$34.0\pm6.5^{d-i}$	$37.0\pm3.9^{b-l}$	$81.1\pm3.6^{a-e}$	$37.2\pm4.4^{b-g}$	68.4 ± 2.0^{a}
SPT 04-11	$6.2\pm0.4^{c-h}$	$3113\pm365^{a-f}$	56.8 ± 6.5^{ab}	$28.6\pm3.9^{j-m}$	86.8 ± 3.6^{a}	$38.0\pm4.4^{b-g}$	$65.7\pm2.0^{a-f}$
SPT 04-12	4.6 ± 0.4^{lm}	2495 ± 365^{ef}	$38.0\pm6.5^{c-g}$	$42.1\pm3.9^{a-h}$	$78.9\pm3.6^{a-f}$	$40.0\pm4.4^{a-f}$	$61.8\pm2.0^{c-i}$
SPT 04-13	$6.3\pm0.4^{b-g}$	$2672\pm365^{c-f}$	$45.6\pm6.5^{a-e}$	$33.3\pm3.9^{f-m}$	$82.2\pm3.6^{a-e}$	$45.1\pm4.4^{a-d}$	$64.4\pm2.0^{a-h}$
SPT 04-14	$6.3\pm0.4^{b-f}$	2467 ± 365^{ef}	$25.5\pm6.5^{e-j}$	$44.1\pm3.9^{a-f}$	$77.2\pm3.6^{a-f}$	$39.3\pm4.4^{a-f}$	$61.4\pm2.0^{d-j}$
Mean	$\mathbf{5.3\pm0.1^{B}}$	$\mathbf{3169\pm119^{A}}$	$\mathbf{36.0\pm1.3^{B}}$	$\mathbf{36.3\pm0.8^{ns}}$	$\mathbf{77.4\pm0.7^{B}}$	$\mathbf{34.5\pm0.9^{B}}$	$\mathbf{64.2\pm0.4^{B}}$

^{A,B,C} Group means followed by the same capital Roman letter are not significantly different by t-test ($P<0.05$).

^{a,b,c} Entry means followed by the same lower-case Roman letter are not significantly different by t-test ($P<0.05$).

^{ns} Not significantly different by F-test.

before a recommendation for commercial use can be made.

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Literature Cited

Branch, W.D. 2002. Registration of 'Georgia-01R' peanut. Crop Sci. 42:1750-1751.

Campbell, W.V., D.A. Emery, and W.C. Gregory. 1971. Registration of GP-NC 343 peanut germplasm (Reg. No. GP 1). Crop Sci., 11-605.

Campbell, W.V., J.C. Wynne, D.A. Emery, and R.W. Mozingo. 1977. Registration of NC 6 peanuts (Reg. No. 20). Crop Sci. 17:346.

Dwivedi, S.L., S. Pande, J. Narayan Rao, and S.N. Nigam. 2002. Components of resistance to late leaf spot and rust among interspecific derivatives and their significance in a foliar disease resistance breeding in groundnut (*Arachis hypogaea* L.). Euphytica 125:81-88.

Gorbet, D.W. and F.M. Shokes. 2002a. Registration of 'C-99R' peanut. Crop Sci. 42:2207.

Gorbet, D.W. and F.M. Shokes. 2002b. Registration of 'Florida MDR 98' peanut. Crop Sci. 42:2207-2208.

Hammons, R.O., G. Sowell, Jr, and D.H. Smith. 1980. Registration of *Cercospora arachidicola*-resistant peanut germplasm (Reg. No. GP 10; PI 109839). Crop Sci. 20:292.

Isleib, T.G., P.W. Rice, J.E. Bailey, R.W. Mozingo, and H.E. Pattee. 1997. Registration of 'NC 12C' peanut. Crop Sci. 37:1976.

Isleib, T.G., P.W. Rice, R.W. Mozingo, II, J.E. Bailey, R.W. Mozingo, and H.E. Pattee. 2003. Registration of 'Perry' peanut. Crop Sci. 43:739-740.

Isleib, T.G., P.W. Rice, R.W. Mozingo, II, S.C. Copeland, J.B. Graeber, B.B. Shew, D.L. Smith, H.A. Melouk, and H.T. Stalker. 2006a. Registration of N96076L peanut germplasm. Crop Sci. 46:2329-2330.

Isleib, T.G., P.W. Rice, R.W. Mozingo, II, S.C. Copeland, J.B. Graeber, W.P. Novitzky, H.E. Pattee, T.H. Sanders, R.W. Mozingo, and D.L. Coker. 2006b. Registration of 'Brantley' peanut. Crop Sci. 46:2309-2311.

Isleib, T.G., P.W. Rice, R.W. Mozingo, II, S.C. Copeland, J.B. Graeber, H.E. Pattee, T.H. Sanders, R.W. Mozingo, and D.L. Coker. 2006c. Registration of 'Phillips' peanut. Crop Sci. 46:2308-2309.

Isleib, T.G., P.W. Rice, R.W. Mozingo, R.W. Mozingo, II, and H.E. Pattee. 1999. Registration of 'Gregory' peanut. Crop Sci. 39:1526.

Krapovickas, A. and W.C. Gregory. 1994. Taxonomy of the genus *Arachis* (Leguminosae). Bonplandia 8:1-186.

Lynch, R.E. and T.P. Mack. 1995. Biological and biotechnical advances for insect management in peanut, pp. 95-159. *In* H.E. Pattee and H.T. Stalker (eds.). Advances in Peanut Science. Amer. Peanut Res. Educ. Soc., Stillwater, OK.

Mozingo, R.W., T.A. Coffelt, and T.G. Isleib. 2000. Registration of VA 98R peanut. Crop Sci. 40:1202-1203.

Mozingo, R.W., T.A. Coffelt, C.W. Swann, and P.M. Phipps. 2004. Registration of 'Wilson' peanut. Crop Sci. 44:1017-1018.

Mozingo, R.W., J.C. Wynne, D.M. Porter, T.A. Coffelt, and T.G. Isleib. 1994. Registration of VA-C 92R peanut. Crop Sci. 34:539-540.

SAS Institute, Inc. 2001. SAS/STAT Software: Changes and Enhancements, Release 8.2. SAS Institute, Inc., Cary, NC. 332 pp.

Shew, B.B., M.K. Beute, and H.T. Stalker. 1995. Toward sustainable peanut production: Progress in breeding for resistance to foliar and soil borne pathogens of peanut. Plant Disease 79:1259-1261.

Simpson, C.E. and J.L. Starr. 2001. Registration of 'COAN' peanut. Crop Sci. 41:918.

Simpson, C.E., J.L. Starr, G.T. Church, M.D. Burow, and A.H. Paterson. 2003. Registration of 'NemaTAM' peanut. Crop Sci. 43:1561.

Smartt, J. and W.C. Gregory. 1967. Interspecific cross-compatibility between the cultivated peanut *Arachis hypogaea* L. and other members of the genus *Arachis*. Oléagineux 22:455-459.

Stalker, H.T. and M.K. Beute. 1993. Registration of four interspecific peanut germplasm lines resistant to *Cercospora arachidicola*. Crop Sci. 33:1117.

Stalker, H.T., M.K. Beute, B.B. Shew, and K.R. Barker. 2002a. Registration of two root-knot nematode-resistant peanut germplasm lines. Crop Sci. 42:312-313.

Stalker, H.T., M.K. Beute, B.B. Shew, and T.G. Isleib. 2002b. Registration of five leafspot-resistant peanut germplasm lines. Crop Sci. 42:314-316.

Stalker, H.T. and R.E. Lynch. 2002. Registration of four insect-resistant peanut germplasm lines. Crop Sci. 42:313-314.

Stalker, H.T. and J.P. Moss. 1987. Speciation, cytogenetics, and utilization of *Arachis* species. Adv. Agronomy. 41:1-40.

Stalker, H.T. and C.E. Simpson. 1995. Genetic resources in *Arachis*, pp. 14-53. *In* H.E. Pattee and H.T. Stalker (eds.). Advances in Peanut Science. Amer. Peanut Res. Educ. Soc., Stillwater, OK.

Tallury, S.P., K.W. Hilu, S.R. Milla, S.A. Friend, M. Alsaghir, H.T. Stalker, and D. Quandt. 2005. Genomic affinities in *Arachis* section Arachis (Fabaceae): Molecular and cytogenetic evidence. Theor. Appl. Genet. 111:1229-1237.

Tallury, S.P., H.E. Pattee, T.G. Isleib, and H.T. Stalker. 2008. Flavor profiles of wild species-derived peanut breeding lines. Peanut Sci. 35:81-85.

Valls, J.F.M. and C.E. Simpson. 2005. New species of *Arachis* from Brazil, Paraguay, and Bolivia. Bonplandia 14:1-2.

Wynne, J.C., T.A. Coffelt, R.W. Mozingo, and W.F. Anderson. 1991. Registration of 'NC-V11' peanut. Crop Sci. 31:484-485.

Wynne, J.C., R.W. Mozingo, and D.A. Emery. 1979. Registration of NC 7 peanut (Reg. No. 22). Crop Sci. 19:563.