No-Pesticide Preliminary Yield Trials in Peanut[1]

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ABSTRACT

Pest-resistant peanut (*Arachis hypogaea* L.) cultivars are critically important to reduce the increasing cost of production. Current pesticides used in the U.S. are effective but very expensive. The objective of this study was to evaluate several advanced Georgia breeding lines when grown without nematicides, fungicides, or insecticides. Preliminary yield trials without pesticides were conducted for 3 yr (1996-98) at the Univ. of Georgia, Coastal Plain Exp. Sta. under irrigation. However, preplant and occasionally post-applied herbicides were used for weed control. Thrips damage was noticeably uniform and severe early in the growing season each year, but plants seemingly recovered by midseason. Probably the most endemic diseases in the Southeast are both early and late leaf spots [*Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton, respectively] and tomato spotted wilt virus (TSWV). Results from replicated field tests strongly suggest that it would be economically feasible to significantly reduce pesticide cost by growing multiple pest-resistant advanced Georgia breeding lines as compared to the five check cultivars Florunner, GK-7, Southern Runner, Florida MDR 98, and Georgia Browne. However, dollar values were variable and low with no pesticides because of the overall reduction in yield. An alternative approach for greater net returns possibly may be achieved by only reducing currently recommended input costs rather than eliminating pesticides with pest resistant cultivars.

Key Words: *Arachis hypogaea* L., breeding lines, cultivars, disease resistance, economic analyses, groundnut, production costs.

The U.S. peanut (*Arachis hypogaea* L.) industry is influenced by global competition. For U.S. peanut growers to become more competitive in this world market, cost of production must be reduced while maintaining or improving quality.

Peanut production in the U.S. has become dependant upon numerous types of pesticides, including herbicides, nematicides, fungicides, insecticides, and miticides (11), which are highly effective but very expensive. Annually, pesticides contribute one of the largest input costs to U.S. peanut growers.

In Georgia, production cost varies from year to year, farm to farm, and field to field (8). The 1998 estimated total cost for irrigated peanut production with an expected yield of 3924 kg/ha was calculated to be $1715/ha, which includes both variable and fixed costs but excludes land and quota (5). Pesticides accounted for nearly 40% of this expense in material, fuel, maintenance, and labor.

Pest-resistant cultivars could reduce production cost by lowering or eliminating utilization of several pesticides. However, such genetic resistance needs to be carefully assessed in an overall pest, yield, and cost analysis to determine its potential impact. The objective of this study was to evaluate the performance of both multiple resistant and susceptible cultivars in comparison to the most promising advanced breeding lines from the Georgia peanut breeding program when grown without fungicides, insecticides, nematicides, or miticides.

Materials and Methods

During 1996, 12 advanced runner-type Georgia breeding lines were compared to two multiple resistant cultivars, Georgia Browne (2) and Southern Runner (6), and two susceptible cultivars, Florunner (9) and GK-7(1). During 1997-98, the best performing Georgia breeding lines from the previous year were re-evaluated and new lines were added along with another multiple resistant cultivar, Florida MDR 98 (7).

Each year, no-pesticide preliminary yield trials were conducted on a Tifton loamy sand soil type (fine-loamy, siliceous, thermic Plinthic Kandindult) at the agronomy research farm near the Univ. of Georgia, Coastal Plain Exp. Sta. A randomized complete block design was used each year with six replications. Plots consisted of two rows 6.1 m long × 1.8 m wide (0.8 m within and 1.0 m between adjacent plots). Seed were spaced approximately 6.1 cm apart within each row. Planting dates were 7 May 1996, 2 May 1997, and 24 April 1998. Production practices included fertilization and irrigation, but excluded all pesticides, except for preplant incorporated and post-applied herbicides as needed for weed control. Previous crop rotation involved following peanut in 1996, fallow in 1997, and cotton in 1998. Individual susceptible entries were harvested based upon plant deterioration due to above-ground disease severity; whereas, the more resistant entries were dug near optimum maturity based upon hull-scrape determinations from adjacent border plants (12).

Leaf spot (LS) ratings among all genotypes were made twice each season. Early LS rating was in mid-late August and involved primarily the early leaf spot pathogen (*Cercospora arachidicola* Hori); whereas the late LS rating was in mid-late September and involved primarily the late leaf spot pathogen [*Cercosporidium personatum* (Berk. & Curt.) Deighton]. A 1-9 visual canopy rating scale was used where 1 = immune and 9 = dead plants (10). In general, disease rating represents an overall relative genotypic assessment.

Tomato spotted wilt virus (TSWV) and total disease incidence were evaluated each season. The percentage of TSWV incidence was first evaluated at about midseason, and percentages of total disease incidence were scored prior to digging, which included TSWV as well as any soil-borne disease, primarily stem rot or white mold caused by *Sclero-*

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tium rolfsii Sacc. A disease hit equalled one or more infected plants in a 30-cm section of row.

After picking with a small-plot thresher, pods were dried with forced warm air to 6% moisture and then were hand-cleaned over a screen table before weighing. Dollar values were calculated from yield and grade based upon USDA-FSA-1014 peanut loan schedules for each crop year. As required by runner price support, the Georgia Browne cultivar was discounted $110/MT to reflect current marketing regulations. An economical analysis was conducted on the best year of 3 yr with regard to total gross dollar value returns. Total cost estimates included both variables and fixed cost, but excluded land and quota.

Data from each test were statistically analyzed by analysis of variance. Waller-Duncan's T-test (k-ratio = 100) was used for means separation.

Results and Discussion

Each year, several different advanced Georgia breeding lines were evaluated without pesticides, thus combined year comparisons were not possible. However, some genotypes were common across all 3 yr.

During 1996, the percentage of TSWV was not assessed, but total disease incidence ranged from a high of only 17% for Florunner to a low around 3-4% for GA 942509, GA 942510, and GA 942511 (Table 1). These advanced Georgia breeding lines were developed by the sequential selection method (4). In the early segregating F_2-F_4 generations, individual resistant plants were sequentially selected under heavy soil-borne disease pressure, heavy leaf spot disease pressure, and heavy TSWV pressure and without fungicide and insecticide applications. Leaf spots were the major yield limiting factors in 1996. The same three breeding lines also had the best early and late leaf spot ratings and among the highest pod yields and dollar values in 1996 (Table 1).

The small-seeded peanut cultivar Georgia Browne yielded significantly higher than GK-7, Florunner, and Southern Runner in 1996 when no pesticides were applied (Table 1). It also produced a significantly higher dollar value return in spite of the $110/MT penalty compared to the other runner check cultivars.

During 1997, the early maturing and leaf spot-tolerant Georgia breeding line, GA T-2844 (3), produced the highest yield and dollar values (Table 2). However, it was not significantly different from GA 931307, GA 942505, GA 942506, or GA 942511. The three sequential selections GA 942509, GA 942510, and GA942511 again had the lowest incidence of TSWV, total disease, and leaf spot ratings.

The resistant cultivars Southern Runner, Florida MDR 98, and Georgia Browne showed significantly better disease resistance than the susceptible cultivars Florunner and GK-7, but this was not reflected in yield or dollar values (Table 2). The reason for the poor performance between both the resistant and susceptible check cultivars could be due to other pathogens or an overall cumulative disease and insect effect. These results do suggest the importance of evaluating for total pest resistance in addition to specific diseases or insects.

During 1998, one new advanced Georgia breeding line, GA 962533 significantly out-performed the three sequential selections and the early maturing leaf spot-

Table 1. Disease assessment and performance evaluation among four peanut cultivars and 12 advanced Georgia breeding lines when grown without pesticides during 1996.[a]

Cultivar/ breeding line	Total disease	Early leaf spot rating	Late leaf spot rating[b]	Pod yield	Dollar value
	%	1-9[c]	1-9[c]	kg/ha	$/ha
GA 942506	8.8 b-e	5.3 d	6.5 de	2600 ab	1660 a
GA 942511	3.8 fg	2.0 j	3.2 h	2314 abc	1616 a
GA 942509	3.2 g	2.5 hij	3.3 h	2437 ab	1587 a
GA 942001	6.2 c-g	7.0 a	--	2528 ab	1556 ab
GA T-2844	10.5 bc	6.0 bc	--	2587 ab	1542 ab
GA 942503	6.2 c-g	5.8 cd	7.3 bc	2362 abc	1531 ab
Georgia Browne	5.5 efg	5.3 d	7.0 cd	2699 a	1497 ab
GA 931319	5.8 d-g	2.7 ghi	3.5 h	2146 bcd	1388 abc
GA 942510	3.0 g	2.2 ij	3.2 h	2136 bcd	1359 a-d
GA 942505	10.5 bc	5.3 d	6.7 de	2522 ab	1278 bcd
GK-7	10.0 bcd	6.3 bc	7.7 ab	1923 cd	1085 cde
Florunner	16.8 a	6.5 ab	8.0 a	1799 de	1070 de
GA 931320	8.0 b-f	3.2 f	4.2 g	1331 ef	907 ef
GA 942504	9.5 b-e	4.0 e	5.0 f	1315 f	838 ef
Southern Runner	5.5 efg	3.0 fgh	4.0 g	1173 f	807 ef
GA 931312	11.8 b	3.3 f	4.3 g	1133 f	671 f

[a]Within columns, means followed by the same letter are not significantly different at $P \leq 0.05$.

[b]Two early maturing advanced GA breeding lines (GA 942001 and GA T-2844) were dug prior to late leaf spot rating.

[c]1 to 9 scale, where 1 = immune and 9 = dead plants.

Table 2. Disease assessment and performance evaluation among five peanut cultivars and 11 advanced Georgia breeding lines when grown without pesticides during 1997.[a]

Cultivar/ breeding line	TSWV	Total disease	Early leaf spot rating	Late leaf spot rating[b]	Pod yield	Dollar value
	%	%	1-9[c]	1-9[c]	kg/ha	$/ha
GA T-2844	26.2 a	28.0 ab	4.2 ef	--	3716 a	2651 a
GA 942511	8.2 d	9.5 f	2.2 h	3.0 h	3564 ab	2549 ab
GA 942506	15.5 bc	15.8 def	4.5 de	6.2 c	3415 abc	2449 abc
GA 942505	11.8 cd	15.0 def	5.5 c	7.7 a	3395 abc	2411 a-d
GA 931307	17.5 bc	19.2 cd	3.8 f	5.0 d	3339 a-d	2367 a-d
GA 942503	16.2 bc	19.5 cd	6.3 b	8.0 a	3167 bcd	2313 b-e
GA 942001	18.8 b	24.5 bc	4.7 de	--	3112 cd	2167 c-f
GA 942009	17.0 bc	18.2 cd	7.2 a	8.0 a	3007 cde	2122 d-g
GA 942510	8.2 d	10.0 ef	2.2 h	3.2 gh	2905 def	2048 efg
GA 942509	7.0 d	9.5 f	2.3 h	3.5 fg	2559 fgh	1877 fgh
GA 942010	15.8 bc	16.2 def	6.8 ab	8.0 a	2646 efg	1851 gh
South. Runner	13.2 bcd	15.5 def	3.0 g	4.5 e	2191 hi	1612 hi
GK-7	29.5 a	33.0 a	5.3 c	7.2 b	2244 ghi	1581 hi
Georgia Browne	13.0 bcd	17.0 de	5.0 cd	6.2 c	2559 fgh	1536 i
Florunner	26.2 a	32.5 a	6.5 b	7.8 a	1997 i	1422 ij
Florida MDR 98	18.2 bc	19.2 cd	3.0 g	3.7 f	1530 j	1126 j

[a]Within columns, means followed by the same letter are not significantly different at $P \leq 0.05$.

[b]Two early-maturing advanced GA breeding lines (GA 942001 and GA T-2844) were dug prior to late leaf spot rating.

[c]1 to 9 scale, where 1 = immune and 9 = dead plants.

tolerant breeding line for both pod yield and dollar value (Table 3). Several other advanced breeding lines had TSWV and total disease percentages comparable to the three sequential selections GA 942509, GA 942510, and GA 942511; but these three Georgia breeding lines had the lowest late leaf spot ratings of all genotypes every year.

In both 1997 and 1998, the resistant check cultivars had significantly less disease incidence; but, with the exception of Georgia Browne, the resistant cultivars were not significantly different in yield from the susceptible cultivars (Table 3). Georgia Browne had significantly higher yield compared to all the other runner cultivars. However, because of the current USDA-imposed penalty on Georgia Browne, its higher yield only resulted in a significantly higher net return than the Florunner cultivar (Table 4).

An economical analyses was conducted on the 1998 data since this was the best year of the three with regard to total gross dollar value returns (Table 4). Total cost estimates for 1998 were based upon irrigated peanut production for Georgia (5) and were reduced by $479/ha without pesticides. Net returns for each of the check cultivars and advanced Georgia breeding lines had the same significant differences as the gross returns because of subtracting a constant amount from the total cost.

The highest net return of $2077/ha in this 3-yr study without pesticides was found with GA 962533 (Table 4). The sequentially selected breeding lines GA 942509, GA 942510, and GA 942511 and the early maturing breeding line GA T-2844 resulted in significantly higher net returns when compared to the resistant and susceptible runner-type cultivars Georgia Browne, GK-7, Florida MDR 98, Southern Runner, and Florunner. The performance of several multiple pest-resistant advanced Georgia peanut breeding lines suggests that it would be economically feasible to use such pest-resistant cultivars for reducing pesticide costs. However, there was considerable year-to-year variablility in yield and dollar values without any pesticides (Tables 1, 2, and 3). Pesticide rate studies are now needed to determine how few number of applications are still profitable.

In conclusion, several advanced Georgia breeding lines significantly outperformed five check cultivars during each of the 3-yr preliminary yield trials without any nematicides, fungicides, or insecticides. However, dollar value returns were variable and low with no pesticides because of the overall reduction in yield. An alternative approach to enhance the competitiveness of U.S. peanut producers with greater net return and more stability may possibly be achieved by only reducing pesticide rates rather than by completely eliminating pesticides when such multiple pest-resistant cultivars are commercially available. These results also show the importance of evaluating advanced peanut breeding lines for overall pest resistance, yield, and dollar values.

Table 3. Disease assessment and performance evaluation among five peanut cultivars and 11 advanced Georgia breeding lines when grown without pesticides during 1998.[a]

Cultivar/ breeding line	TSWV	Total disease	Early leaf spot rating	Late leaf spot rating[b]	Pod yield	Dollar value
	%	%	1-9[c]	1-9[c]	kg/ha	$/ha
GA 962533	7.0 e	18.8 gh	1.5 ef	4.0 d	4972 a	3313 a
GA 942509	14.2 cd	22.5 fgh	1.2 fg	2.3 f	3963 bc	2551 b
GA 942511	8.0 e	23.2 fgh	1.0 g	2.0 f	3460 de	2446 bc
GA 942510	9.5 de	14.5 h	1.2 fg	2.2 f	3584 b-e	2374 bcd
GA T-2844	20.0 b	34.2 cde	2.8 c	--	3733 bcd	2264 b-e
GA 962532	7.0 e	23.8 e-h	1.3 fg	4.2 cd	4743 a	2239 c-f
GA 962543	11.8 de	25.5 d-g	2.2 d	3.2 e	3200 ef	2173 c-g
GA 942506	10.0 de	35.5 cd	3.0 bc	4.7 bc	4025 b	2114 d-h
GA 962540	8.0 e	20.0 gh	2.0 d	3.3 e	2917 fg	2033 e-i
GA 962522	8.0 e	23.0 fgh	3.8 a	6.3 a	3531 b-e	2025 e-i
Georgia Browne	10.0 de	32.5 c-f	3.2 bc	5.0 b	3485 cde	1950 f-i
GK-7	18.2 bc	46.8 b	4.0 a	6.7 a	2855 fg	1885 ghi
Florida MDR 98	14.2 cd	27.0 d-g	1.8 de	3.2 e	2642 g	1840 hi
South. Runner	18.2 bc	38.2 bc	2.0 d	3.3 e	2625 g	1805 i
Florunner	30.5 a	60.8 a	3.3 b	6.2 a	2589 g	1449 j
GA 962539	8.0 e	22.5 fgh	2.0 d	3.0 e	2596 g	1404 j

[a]Within columns, means followed by the same letter are not significantly different at $P \leq 0.05$.

[b]Two early-maturing advanced GA breeding lines (GA 942001 and GA T-2844) were dug prior to late leaf spot rating.

[c]1 to 9 scale, where 1 = immune and 9 = dead plants.

Table 4. Economical analyses among five peanut cultivars and 11 advanced Georgia breeding lines when grown without pesticides during 1998.[a]

Cultivar/ breeding line	Gross return	Total cost[b]	Net return
	$/ha	$/ha	$/ha
GA 962533	3313 a	1236	2077 a
GA 942509	2551 b	1236	1315 b
GA 942511	2446 bc	1236	1210 bc
GA 942510	2374 bcd	1236	1138 bcd
GA T-2844	2264 b-e	1236	1028 b-e
GA 962532	2239 c-f	1236	1003 c-f
GA 962543	2173 c-g	1236	937 c-g
GA 942506	2114 d-h	1236	878 d-h
GA 962540	2033 e-i	1236	797 e-i
GA 962522	2025 e-i	1236	789 e-i
Georgia Browne	1950 f-i	1236	714 f-i
GK-7	1885 ghi	1236	649 ghi
Florida MDR 98	1840 hi	1236	604 hi
Southern Runner	1805 i	1236	569 i
Florunner	1449 j	1236	213 j
GA 962539	1404 j	1236	168 j

[a]Within columns, means followed by the same letter are not significantly different at $P \leq 0.05$.

[b]Total cost includes both variable and fixed cost, excluding land and quota.

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