Combination of Disease Resistance, Drought Tolerance, and Dollar Value among Runner and Virginia-Type Peanut Cultivars in Georgia.

W. D. Branch[a]* and S. M. Fletcher[b]

ABSTRACT

With increasing production cost, southeast U.S. peanut (*Arachis hypogaea* L.) growers are continually seeking to lower inputs to enhance economical return and sustainability of their farming operation. Utilization of peanut cultivars with the best combination of disease resistance, drought tolerance, and greatest dollar value return would be beneficial. Fifteen peanut cultivars were evaluated for 5-years (2011–15) and seventeen cultivars were evaluated for 4-years (2012–15) with minimum inputs and without irrigation at two locations in Georgia. Each year, minimum inputs for disease control included only three fungicide sprays at recommended rates on a 28 d schedule beginning 37 d after planting. No insecticide, nematocides, miticides, or irrigation were applied during the growing seasons each year. 'Georgia-06G', 'Georgia-12Y', 'Georgia-13M', 'Georgia-14N', and Florida-EP '113' had the lowest TSWV and total disease incidence (disease resistance) among the ten runner-type cultivars for both Georgia locations; whereas, 'Bailey', 'Georgia-08V', and 'Georgia-11J' had the least disease incidence among the five virginia-type cultivars. Similarly, Georgia-13M, Georgia-06G, and Georgia-12Y had the greatest gross dollar value return per hectare (drought tolerance) among the runner-types; whereas, Georgia-08V and Georgia-11J had the greatest dollar values per hectare among the virginia-type cultivars at both Georgia locations in this four and five-year study, respectively.

Key Words: *Arachis hypogaea* L., groundnut, disease resistance, drought tolerance, runner-type, virginia-type, dollar values.

In the southeast U.S., the most important and endemic foliar diseases of peanut (*Arachis hypogaea* L.) are tomato spotted wilt caused by *Tomato spotted wilt virus* (TSWV), early leafspot caused by *Cercospora arachidicola* Hori, and late leafspot caused by *Cercosporidium personatum* (Bert & Curt.) Deighton, respectively (Branch and Culbreath, 2013). The primary control for TSWV is resistant cultivars; whereas, fungicides are routinely used for leafspot and soilborne disease control. However, the total number of fungicide spray applications can vary from four to seven during a typical growing season depending upon low or high risk assessment of each field and specific fungicide recommendations (Kemerait *et al.,* 2016.)

Irrigation and pesticides currently used in peanut production are very effective, but also expensive. During 2015, total cost for irrigated production in Georgia with an expected peanut pod yield of 5269 kg/ha was estimated at $2,388/ha, which includes both variable and fixed costs but excludes land and return to management (Smith and Smith, 2015). These values compare with $1,797/ha estimated total cost for nonirrigated or dryland peanut production in Georgia with an expected yield of 3811 kg/ha. Thus, irrigation adds $591/ha to peanut production cost and pesticides accounted for approximately 40% of the total expense in material, fuel, maintenance, and labor. Consequently, Georgia peanut growers are seeking disease resistant and drought tolerant cultivars to substantially lower overall production cost in order to maintain relative economical return and enhance the sustainability of their farming operation.

The objective of this research was to evaluate the performance of runner and virginia-type peanut cultivars with minimum inputs and without irrigation. Drought tolerance has been defined as, "the ability of one genotype to be more productive with a given amount of soil moisture than another genotype" (Quizenberry, 1982). Since gross dollar values combine yield and grade, it was also considered an index criterion for assessing peanut genotypic performance under water-limiting environments when production cost is identical for each genotype in the experiment.

Materials and Methods

Fifteen runner and virginia-type peanut cultivars were evaluated for five-years (2011-15); whereas, seventeen runner and virginia-type culti-

[a]Professor, Department of Crop and Soil Sciences, University of Georgia, Coastal Plain Experiment Station, 2360 Rainwater Road, Tifton, GA 31793.

[b]Professor Emeritus, Department of Agricultural and Applied Economics, University of Georgia, Georgia Experiment Station, Griffin, GA 30223.

*Corresponding author: Tel.: 229 386 3561; Fax: 229 386 7293 *Email address:* wdbranch@uga.edu (W.D. Branch).

Table 1. Five-year and two-location average monthly rainfall distribution during the peanut growing season in Georgia, 2011-15.

Year	Loc.	Rainfall (mm)							7- Month
		Apr.	May	June	July	Aug.	Sept.	Oct.	Total
2011	Tifton	37.6	1.5	61.5	115.3	116.1	138.7	115.8	586.5
2012	Tifton	35.0	88.9	109.5	80.5	249.7	55.6	42.9	662.2
2013	Tifton	89.4	54.9	241.6	161.0	167.6	51.6	1.3	767.3
2014	Tifton	232.7	148.6	50.8	77.7	77.2	124.7	41.1	752.9
2015	Tifton	96.8	18.5	149.4	156.7	151.4	51.8	17.8	642.4
Long-Term Avg: (1923 – 2014)		97.3	82.8	116.6	134.1	122.7	92.5	57.4	703.3
2011	Plains	60.7	1.0	33.0	205.2	43.2	100.8	37.6	481.6
2012	Plains	57.2	34.5	88.6	99.3	57.9	92.5	38.1	468.1
2013	Plains	122.7	64.8	163.1	210.3	188.5	64.8	10.2	824.2
2014	Plains	239.5	55.1	35.3	95.8	29.0	109.0	70.4	634.0
2015	Plains	169.4	47.0	47.0	133.6	186.2	174.5	45.7	803.4
Long-Term Avg: (1923 – 2014)		87.6	78.7	116.1	133.9	103.9	85.1	58.4	663.7

vars were evaluated for four-years (2012-2015). Each year, field tests were used to evaluate cultivars for TSWV and total disease incidence, and gross dollar value, and were conducted on a Tifton loamy sand soil type (fine-loamy, siliceous, thermic Plinthic Kandiudult) at the Gibbs Research Farm (latitude: 31.43°N and longitude: -83.59°W) near the Coastal Plain Experiment Station in Tifton and on a Greenville sandy clay loam soil type (clayey, kaolinitic, thermic Rhodic Kandiudult) at the Southwest Georgia Research and Education Center (latitude: 32.04°N and longitude: -84.37°W) near Plains, GA. At both locations, land preparation was the same, moldboard plowing and then bedding, prior to planting each year. Plots consisted of two rows spaced 1.8 m apart by 6.1 m long. At Tifton, planting dates were 11 April 2011, 9 April 2012, 10 April 2013, 4 April 2014, and 9 April 2015. At Plains, planting dates were 20 April 2011, 25 April 2012, 23 April 2013, 28 April 2014, and 5 May 2015.

Each test involved minimum inputs without irrigation. Three fungicide applications (tebuconazole plus chlorothalonil at 221 and 1,262 g a.i./ha, respectively) were included during each growing season beginning 37 d after planting and then applied at 28 d intervals. On-site rainfall was recorded monthly and compared to the long-term average for each location obtained from the Georgia automated environmental monitoring network (Flitcroft, 2015). These field tests were in a three-year crop rotation following corn (*Zea mays* L.) and cotton (*Gossypium hirsutum* L.). Individual entries were dug near optimum maturity based upon the hull-scrape method determined from adjacent border rows (Williams and Drexler, 1981).

Incidence of TSWV was first assessed at midseason approximately 70 d after planting, when TSWV is usually the only disease. Percentages of total disease were also scored prior to digging, which included primarily TSWV and any soilborne disease. A disease hit equaled one or more diseased plants in a 30.5 cm section of row (Rodriguez-Kabana *et al*., 1975).

After digging with a two-row digger and threshing with a plot combine, pods were dried with forced warm air to 6% moisture. Pod samples were then hand-cleaned over a screen table before weighing for yield determinations. Market grades were determined according to federal state inspection service procedures for runner and virginia-type peanut, respectively (USDA-AMS, 1998). Gross dollar values were calculated from yield and grade based upon USDA-Farm Service Agency (FSA) peanut loan schedules for each crop year.

The experimental design was a randomized complete block with five replications. Data from each individual test was combined across years by location subjected to analysis of variances. Waller-Duncan's T-test (k-ratio = 100) was used for mean separation of significant differences ($P \leq 0.05$).

Results and Discusson

Total rainfall during the five growing seasons at both Georgia locations were below the long-term (91 yr) average for three out of the five years (Table 1). Likewise, approximately half of all monthly rainfall during the five growing seasons at both locations was also below the long-term average.

Table 2. Five-year average TSWV incidence of 15 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2011-15.[a]

	Georgia Locations:	
Cultivar	Tifton	Plains
runner-types:	(%)	
FloRun '107'	6.9 b*	7.0 ab
Florida-07	6.1 bc	6.4 bc
Tifguard	4.4 de	3.8 def
Georgia Greener	4.1 def	3.4 efg
Georgia-09B	4.2 def	3.2 efg
Georgia-07W	3.4 d-g	2.7 efg
Georgia-13M	3.1 efg	2.5 efg
Georgia-14N	2.9 fg	2.6 efg
Georgia-12Y	3.0 efg	2.3 fg
Georgia-06G	2.1 g	2.1 g
virginia-types:		
CHAMPS	9.2 a	8.0 a
Florida Fancy	6.8 b	7.2 ab
Georgia-11J	6.3 b	3.9 de
Georgia-08V	4.7 cd	5.2 cd
Bailey	4.7 cd	3.4 efg

*Within columns, means followed by the same letter are not significantly different at P ≤0.05.

[a]TSWV ratings were made at midseason each year.

Table 3. Five-year average total disease incidence of 15 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2011-15.[a]

	Georgia Locations:	
Cultivar	Tifton	Plains
runner-types:	(%)	
FloRun '107'	21.0 ab*	26.3 a
Florida-07	19.5 bc	18.6 b
Georgia-09B	16.8 cde	17.3 bc
Tifguard	14.8 d-g	14.8 cde
Georgia Greener	13.8 e-h	14.0 cde
Georgia-07W	12.5 f-i	12.5 de
Georgia-14N	12.0 f-i	12.0 ef
Georgia-06G	8.9 i	12.2 def
Georgia-13M	11.0 hi	8.7 fg
Georgia-12Y	11.2 ghi	7.4 g
virginia-types:		
Florida Fancy	24.1 a	26.8 a
CHAMPS	23.9 a	26.6 a
Georgia-08V	18.0 bcd	18.7 b
Georgia-11J	15.3 def	15.8 bcd
Bailey	14.8 d-g	13.0 de

*Within columns, means followed by the same letter are not significantly different at P ≤0.05.

[a]Total disease ratings were made prior to harvest each year.

Even during the higher rainfall seasons (2013 and 2014 at Tifton and 2013 and 2015 at Plains), there were at least two or more months where drought stress was a major limiting factor.

Leafspot was not severe until 2015, when rainfall was twice the long-term average at Plains during September (Table 1). Even with good rotation, environmental conditions were very favorable particularly for late leafspot development at this location in 2015. Significant cultivar differences (P ≤ 0.05) were observed among both runner and virginia-type cultivars for late leafspot on a visual rating scale of 0-9, where 0 = no leafspot and 9 = died defoliated plants. Overall, 'Georgia-08V' (Branch, 2009) had the highest late leafspot rating of 8.6 and 'CHAMPS' (Mozingo *et al.*, 2006) was second highest at 8.2; whereas, 'Georgia-12Y' (Branch, 2013) had the lowest late leafspot rating of 4.8 followed by 'Bailey' (Isleib *et al.*, 2011), 'Tifguard' (Holbrook *et al.,* 2008) and 'Georgia-11J' (Branch, 2012) at 5.6, respectively.

Significant differences were also observed among the 15 peanut cultivars for five-year average TSWV incidence at midseason (Table 2). 'Georgia-06G' (Branch, 2007) had the lowest percent TSWV incidence among both runner and virginia-type peanut cultivars. However, it was not different from the runner-type cultivars Georgia-12Y, 'Georgia-14N' (Branch and Brenneman, 2015), 'Georgia-13M' (Branch, 2014), and 'Georgia-07W' (Branch and Brenneman, 2008) at both locations; whereas, Bailey had the lowest TSWV among the viriginia-type cultivars at both Georgia locations. However, Bailey was not different from Georgia-08V at Tifton or Georgia-11J at Plains for TSWV incidence.

Significant differences were also observed among the peanut cultivars for five-year average total disease incidence prior to harvest (Table 3). Georgia-12Y, Georgia-13M, and Georgia-06G had the lowest percent of total disease incidence among runner-type cultivars; whereas, Bailey had the lowest total disease among the virginia-type cultivars at both locations. However, it was not different from Georgia-08V and Georgia-11J at Tifton and Georgia-11J at Plains.

Likewise, significant differences were observed among these same 15 peanut cultivars for five-year average gross dollar value returns (Table 4). Georgia-13M had the greatest dollar value at the two Georgia locations among both runner and virginia-type cultivars. However, it was not greater than Georgia-06G at Tifton, and Georgia-06G and Georgia-12Y at Plains. Georgia-08V had the greatest dollar value among the virginia-type cultivars at Tifton; but Georgia-11J had the greatest dollar value at Plains. However at the Plains location, Georgia-11J was not different from Georgia-08V.

Table 4. Five-year average gross dollar value return of 15 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2011-15.

Cultivar	Georgia Locations: Tifton	Georgia Locations: Plains
runner-types:	($/ha)	
Georgia-13M	1895 a*	1843 a
Georgia-06G	1814 ab	1757 ab
Georgia-12Y	1744 bcd	1749 ab
Georgia-07W	1782 bc	1698 bc
Georgia Greener	1688 cde	1665 bcd
Florida-07	1648 def	1648 bcd
FloRun '107'	1628 efg	1601 cd
Georgia-14N	1579 efg	1628 bcd
Georgia-09B	1651 def	1539 def
Tifguard	1525 gh	1591 cde
virginia-types:		
Georgia-08V	1767 bc	1572 c-f
Georgia-11J	1557 fgh	1641 bcd
Bailey	1576 efg	1433 f
Florida Fancy	1458 h	1455 ef
CHAMPS	1520 gh	1171 g

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

Two additional runner-type cultivars (TUFRunner '727' and Florida-EP '113') were included in the four-year averages (2012–15). Similarly, significant differences were observed for four-year average TSWV incidence (Table 5). Florida-EP '113' had the lowest percent TSWV incidence among both runner and virginia-types which agrees with another study involving Florida-EP '113" (McKinsey and Tillman, 2017); whereas, TUFRunner '727' had among the highest percent TSWV incidence. However, Florida-EP '113' was not different from Georgia-06G and Georgia-12Y at Tifton; and several other cultivars at Plains in TSWV incidence.

Significant differences were also observed among these 17 peanut cultivars for four-year average total disease incidence (Table 6). Georgia-12Y, Georgia-13M, Florida-EP '113', Georgia-06G, Georgia-14N, and Georgia-07W had the lowest total disease incidence among runner-types; whereas, Bailey, Georgia-11J, and Georgia-08V had the lowest total disease incidence among virginia-types at both Georgia locations.

Likewise, significant differences were found among these 17 peanut cultivars for four-year average gross dollar values (Table 7). Georgia-13M again had the greatest dollar value among both runner and virginia-type cultivars. However, it was not greater than Georgia-06G and Georgia-12Y at the Plains location. Georgia-08V had the greatest dollar value at the Tifton location; whereas,

Table 5. Four-year average TSWV incidence of 17 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2012-15.[a]

Cultivar	Georgia Locations: Tifton	Georgia Locations: Plains
runner-types:	(%)	
TUFRunner '727'	10.2 a*	8.5 a
FloRun '107'	7.4 b	8.4 a
Florida-07	6.5 b	7.2 ab
Tifguard	4.2 cde	4.1 cde
Georgia Greener	4.1 de	4.1 cde
Georgia-09B	4.2 cde	3.8 def
Georgia-07W	3.9 def	3.4 def
Georgia-13M	2.9 def	3.1 def
Georgia-14N	3.0 def	2.6 ef
Georgia-12Y	2.4 efg	2.8 ef
Georgia-06G	2.0 fg	2.5 ef
Florida-EP '113'	0.9 g	2.1 f
virginia-types:		
CHAMPS	9.4 a	9.1 a
Florida Fancy	6.8 b	8.2 a
Georgia-11J	6.1 bc	4.8 cd
Georgia-08V	4.5 cd	6.0 bc
Bailey	4.5 cd	4.0 def

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

[a]TSWV ratings were made at midseason each year.

Table 6. Four-year average total disease incidence of 17 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2012-15.[a]

Cultivar	Georgia Locations: Tifton	Georgia Locations: Plains
runner-types:	(%)	
TUFRunner '727'	30.0 a*	31.0 a
FloRun '107'	22.6 bcd	30.5 a
Florida-07	19.9 cde	21.0 b
Georgia-09B	17.9 d-g	18.8 bc
Tifguard	15.6 e-h	14.4 c-f
Georgia Greener	14.6 f-i	14.9 cde
Georgia-07W	13.1 g-j	14.1 def
Georgia-14N	12.4 hij	12.6 efg
Georgia-06G	8.5 j	14.0 def
Florida-EP '113'	10.8 ij	11.1 efg
Georgia-13M	11.5 hij	9.9 fg
Georgia-12Y	10.9 hij	8.5 g
virginia-types:		
Florida Fancy	25.0 b	30.0 a
CHAMPS	24.5 bc	30.2 a
Georgia-08V	18.2 def	20.0 b
Georgia-11J	15.0 f-i	17.5 bcd
Bailey	15.6 e-h	14.5 cde

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

[a]Total disease ratings were made prior to harvest each year.

Table 7. Four-year average gross dollar value return of 17 peanut cultivars when grown with minimum-inputs and without irrigation at two locations in Georgia, 2012-15.

	Georgia Locations:	
Cultivar	Tifton	Plains
runner-types:	($/ha)	
Georgia-13M	2090 a*	1950 a
Georgia-06G	1942 b	1848 ab
Georgia-12Y	1885 bcd	1856 ab
Georgia-07W	1905 bc	1752 bcd
Georgia Greener	1789 cde	1720 bcd
Florida-07	1754 def	1715 bcd
Georgia-09B	1801 cde	1623 de
FloRun '107'	1769 de	1643 cde
Georgia-14N	1707 ef	1693 bcd
TUFRunner '727'	1688 efg	1698 bcd
Tifguard	1628 fg	1628 cde
Florida-EP '113'	1277 h	1339 f
virginia-types:		
Georgia-08V	1915 bc	1636 cde
Georgia-11J	1727 ef	1791 abc
Bailey	1678 efg	1497 ef
Florida Fancy	1572 g	1525 e
CHAMPS	1631 fg	1159 g

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

Georgia-11J and Georgia-08V had the greatest dollar values among the virginia-type cultivars at the Plains location.

The high-oleic, small-seeded, runner-type peanut cultivar Georgia-13M had the highest dollar values at the two Georgia locations for both the four and five-years (Tables 4 and 7). The results from this study would suggest that Georgia-13M, Georgia-06G, and Georgia-12Y each have better combined disease resistance and drought tolerance than the other runner and virginia-type cultivars which agrees with a previous report for Georgia-06G having the greater dollar value return in both maximum and minimum tests (Branch and Fletcher, 2010). Performance of these three cultivars when grown with minimum-inputs and without irrigation should have major potential impact for dryland peanut production, and demonstrates significant improvement in cultivar development over an earlier report by Branch and Fletcher (2004).

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