Combination of Early Maturity and Leaf Spot Tolerance Within an Advanced Georgia Peanut Breeding Line[1]

W. D. Branch* and A. K. Culbreath[2]

ABSTRACT

In the past, genetic resistance to both early and late leaf spots [*Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton] has been found to be negatively or inversely correlated with early maturity in the cultivated peanut (*Arachis hypogaea* L.). For example, the late leaf spot resistant cultivar Southern Runner is approximately 2 wk later in maturity than the susceptible Florunner cultivar. Recently, an advanced runner-type breeding line (GA T-2844) has been developed by the Georgia peanut breeding program which combines early maturity and leaf spot tolerance. For the past 3 yr (1991-1993), GA T-2844 has been evaluated in replicated field tests without fungicides. Results show that GA T-2844 has on the average >30% yield advantage and a 30-d earlier maturity than Southern Runner. Leaf spot ratings also showed GA T-2844 to be intermediate between Southern Runner and Florunner. Such a combination of early maturity and leaf spot tolerance could significantly enhance U.S. peanut production by providing an environmentally safer and efficient alternative to costly pesticides not previously available among runner-type cultivars.

Key Words: *Arachis hypogaea* L., groundnut, disease resistance, *Mycosphaerella arachidis* Deighton, *Mycosphaerella berkeleyi* Jenk.

Throughout the world, both early (*Cercospora arachidicola* Hori) and/or late [*Cercosporidium personatum* (Berk. & Curt.) Deighton] leaf spot diseases are among the worst foliar diseases of the cultivated peanut (*Arachis hypogaea* L.). Estimated annual cost for leaf spot fungicide control in the Georgia peanut production region alone exceeds $35 million (4), and in years with environmental conditions conducive for leaf spot epidemics, significant losses to this devastating disease still occur.

An alternative to costly pesticides is natural host-plant resistance. However, genetic resistance to leaf spot in peanut has previously been reported to be negatively correlated with early maturity (9, 11, 13, 15, 17). For example, Southern Runner is a late leaf spot resistant cultivar (7) which is approximately 2 wk later in maturity than the susceptible Florunner cultivar, and PI 109839 is an early leaf spot resistant germplasm line (8) that is also about 2 wk later in maturity than Florunner. Late maturing leaf spot resistant Florida breeding lines were found to lag behind susceptible genotypes by 10-30 d in pod initiation (10).

High levels of leaf spot resistance have been found within the U.S. peanut germplasm collection (1, 18). However, the most resistant plant introductions also have late maturity and low yields in U.S. production areas. Past breeding efforts have been hampered by such a strong relationship between leaf spot resistance and late maturity.

A cultivar having disease resistance, early maturity, and high yield would present tremendous advantages for the whole peanut industry to remain globally competitive. One of the research thrusts of the Georgia peanut breeding program is development of cultivars with the best of these combinations. The purpose of this paper is to document recent progress made toward this objective.

Materials and Methods

During 1991-93, six advanced runner-type Georgia breeding lines were compared to three commercial U.S. check cultivars [Florunner (14), Southern Runner (7), and Georgia Browne (2)]. Based upon the hull-scrape method (19), the maturity of these genotypes relative to Florunner, when grown under ideal growing conditions, are as follows in south Georgia: Southern Runner = 2 wk later; Georgia Browne, GA T-2843, and GA T-2847 = 1 wk later; GA T-2845R and GA T-2846 = same; GA T-2742 = 1 wk earlier; and GA T-2844 = 2 wk earlier.

Yield tests were conducted on a Tifton loamy sand soil type (fine-loamy, siliceous, thermic Plinthic Kandiudult) at the agronomy research farm near the Georgia Coastal Plain Experiment Station. A randomized complete block design was used with six replications each year . Plots consisted of two rows 6.1-m long x 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 16 May 1991, 8 May 1992, and 3 May 1993. Standard cooperative extension service recommended production practices were followed throughout each growing season, except no fungicides were applied to control leaf spot diseases. 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 plots (Table 1).

Leaf spot disease ratings among all genotypes were made within 5 d prior to the first digging each year on a 1 to 9 visual canopy scale where 1 = very highly resistant, 2 = highly resistant, 3 = moderately resistant, 4 = slightly resistant, 5 = intermediate, 6 = slightly susceptible, 7 = moderately susceptible, 8 = highly susceptible, and 9 = very highly susceptible (16). In general, this disease rating represents an overall relative genotypic assessment. Lesions on several peanut leaflets were closely examined also for coloration as well as sporulation to determine which pathogens were

[1]Contribution from the Univ. of Georgia, College of Agric. and Environ. Sci. This research was supported by state and hatch funds with grants from the Georgia Peanut Commission and Georgia Seed Development Commission.

[2]Prof. and Assoc. Prof., Dept. of Crop and Soil Sciences and Plant Pathology, respectively, Coastal Plain Expt. Stn., Tifton, GA 31793-0748.
*Corresponding author.

Table 1. Three-year (1991-93) average number of days between planting and digging of three runner peanut cultivars and six advanced Georgia breeding lines under high leaf spot disease pressure.

Genotype	Mean no.
	d
Southern Runner	160
Georgia Browne	146
GA T-2845R	146
GA T-2846	146
GA T-2847	146
GA T-2843	145
Florunner	139
GA T-2742	136
GA T-2844	134

most prevalent at the time of each genotypic rating. After harvesting, peanut pods were dried and cleaned before weighing for yield. Data from each test were analyzed by analysis of variance, and Waller-Duncan's T-test (K-ratio=100) was used for mean separations.

A combination yield and disease rating index also was assessed for each genotype used in this study as previously described (3). The combined index involved grouping these nine genotypes into high, medium, or low categories for both yield performance and leaf spot resistance as determined by statistical mean separations from the combined ANOVA. This 3 x 3 classification results in an index from 1 to 9 where 1 = high yield performance combined with low disease rating (resistance) and 9 = low yield performance combined with high disease ratings (susceptible).

Results and Discussion

Late leaf spot was the predominant pathogen in the field plots evaluated during 1991 and 1992; however, early leaf spot was more prevalent in 1993. There was a significant genotype x environment interaction for both yield and leaf spot ratings; consequently, each year was analyzed separately.

Pod yield results were similar in 1991 and 1992 (Table 2). The earliest maturing genotype, Georgia breeding line GA T-2844, had the highest yield; but it was not significantly different from Georgia Browne and GA T-2847. Florunner and Southern Runner had the lowest yields and were significantly different from all other genotypes in 1991. GA T-2844 again had the best performance in 1993; although only significantly different from GA T-2846, GA T-2847, and Florunner. Overall, GA T-2844 resulted in the highest 3-yr average pod yield.

Because of heavy leaf spot disease pressure, the susceptible Florunner cultivar had severe defoliation and plant deterioration which contributed to its low yield performance. The reason for the low pod yields of Southern Runner during the first 2 yr is not readily apparent since the plants appeared to be more leaf spot resistant than other genotypes, and other diseases and pests were of minor influence in these tests.

Leaf spot canopy ratings were used to determine the level of resistance among genotypes (Table 3). Accordingly, Southern Runner had the lowest leaf spot ratings

Table 2. Pod yield performance of three runner peanut cultivars and six advanced Georgia breeding lines when grown without leaf spot fungicide.

Genotype	Pod yield[a]			
	1991	1992	1993	Mean
	kg/ha			
GA T-2844	4164 a	3556 ab	3424 a	3715
Georgia Browne	4040 ab	3654 a	2799 ab	3498
GA T-2847	3746 abc	3733 a	2487 bc	3322
GA T-2843	3348 c	3229 bc	3056 ab	3211
GA T-2845R	3474 bc	3124 cd	2951 ab	3183
GA T-2846	3512 bc	3036 cd	2145 cd	2898
GA T-2742	3478 bc	2222 f	2876 ab	2859
Southern Runner	2707 d	2551 ef	3108 ab	2789
Florunner	2553 d	2729 de	1813 d	2365
Mean	3447	3093	2740	3093

[a]Pod yield values within each column followed by the same letter are not significantly different at $P \leq 0.05$.

Table 3. Leaf spot rating of three runner peanut cultivars and six advanced Georgia breeding lines when grown without leaf spot fungicide.

Genotype	Leaf spot rating[a]			
	1991	1992	1993	Mean
GA T-2742	7.0 a	7.0 b	7.0 a	7.0
Florunner	7.7 a	8.0 a	4.3 d	6.7
GA T-2846	4.7 b	6.8 bc	5.3 bc	5.6
GA T-2847	4.7 b	5.8 ef	6.0 b	5.5
Georgia Browne	4.3 b	6.2 de	5.7 b	5.4
GA T-2843	7.0 a	6.5 cd	2.3 f	5.3
GA T-2844	4.7 b	6.5 cd	4.3 d	5.2
GA T-2845R	4.7 b	5.7 f	4.7 cd	5.0
Southern Runner	3.3 c	4.3 g	3.3 e	3.7
Mean	5.3	6.3	4.8	5.5

[a]Leaf spot ratings within each column followed by the same letter are not significantly different at $P \leq 0.05$, where 1 = immune and 9 = dead plants.

in 1991 and 1992 when late leaf spot predominated; however, GA T-2843 had the lowest rating in 1993 when early leaf spot was prevalent. Also in 1993, Florunner appeared to be more resistant to early than late leaf spot (Table 3). However, it produced significantly lower yield than all other cultivars and advanced Georgia breeding lines (Table 2). The reason for this is because leaf spot incidence increased substantially between the time of rating and digging for Florunner (4.3 vs. 8.0, respectively). Overall, Florunner and GA T-2742 were the most susceptible and the other genotypes were intermediate. Leaf spot ratings for the early maturing Georgia breeding line GA T-2844 were exactly halfway between the 3-yr average ratings for Southern Runner and Florunner. GA T-2844 and Georgia Browne also had the best combined yield performance and disease rating

index of 2, Southern Runner had an index of 4, GA T-2742 had an index of 6, Florunner was rated the worst with an index of 9, and all other genotypes received an index of 5.

GA T-2844 is approximately 1 mo earlier in maturity than the leaf spot resistant Southern Runner cultivar (Table 1), but it is very similar in maturity to the two currently available early maturing, runner-type peanut cultivars, Marc I (6) and its sister line Andru 93(5). GA T-2844 also has comparable yield, grade, and dollar values as Marc I and Andru 93 with a larger percentage of jumbo runner seed (21 vs. 12 and 9%, respectively) when grown in Georgia under a full season spray regime of leaf spot fungicide (unpublished data).

Results obtained from this study with GA T-2844 suggests that tolerance can be as beneficial as resistance to minimize the yield impact of leaf spot disease on peanut. The combination of tolerance to both leaf spot pathogens with early maturity, which is found in GA T-2844, is significant in several different ways. Although leaf spot resistance in GA T-2844 is not as great as in Southern Runner based on ratings from this study, the combination of tolerance with a shorter period of time for epidemics to develop may prove to be a valuable tool for an integrated pest management (IPM) program.

Over the past few years many commonly used pesticides in U.S. peanut production have undergone close scrutiny by EPA, and alternate farming systems are currently being evaluated to determine the feasibility of growing peanuts with fewer pesticides inputs (12). The performance of GA T-2844 without leaf spot fungicide during the entire growing season is encouraging, and its early maturity characteristic could act as an escape mechanism for other potential disease, insect, nematode, and/or virus problems.

In conclusion, the advanced Georgia breeding line GA T-2844 had an average of 30% greater yield advantage and a 30-d earlier maturity than the Southern Runner cultivar when grown without any leaf spot fungicide for 3 yr. Leaf spot ratings of GA T-2844 were intermediate between the resistant Southern Runner and the susceptible Florunner cultivars under these same no-fungicide test conditions. Although there is need for further improvement, significant progress has initially been made in the combination of early maturity, leaf spot tolerance, and high yield performance.

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Accepted 11 September 1995