Field Screening of Reciprocal Chico x Florigiant Peanut Populations for Resistance to Leafspot in Virginia[1]

T. A. Coffelt* and D. M. Porter[2]

ABSTRACT

Early and late leafspot of peanut (*Arachis hypogaea* L.), caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton, respectively, are disease problems of major significance throughout the world. Leafspot control strategies using fungicides can result in a 10% increase in production costs. Field screening tests were conducted in 1980 and 1981 to identify breeding lines with resistance to leafspot. Nine genotypes from a cross between Chico x Florigiant and the reciprocal cross were compared with Florigiant for relative susceptibility to the leafspot fungi. Variation in leafspot resistance, especially to *C. arachidicola*, was found in the peanut germplasm tested. High yielding genotypes with greater resistance to leafspot than Florigiant were identified. Differences in leafspot susceptiblity from reciprocal cross populations indicate that a cytoplasmic factor and additive genetic effects may control leafspot resistance.

Key Words: *Arachis hypogaea* L., groundnut, *Cercospora arachidicola*, *Cercosporidium personatum*, inheritance of resistance, cytoplasmic inheritance, plant germplasm, breeding, host-plant resistance.

Early and late leafspot, caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton, respectively, are major diseases of peanut (*Arachis hypogaea* L.) throughout the world. Porter *et al.* (14) and Smith (16) have recently reviewed the symptoms, disease cycle, epidemiology, and current control measures for the leafspot diseases. Yield loss of up to 50% is common in areas of the world where fungicides are not used (16). Use of fungicides to control leafspot usually increases production costs by 10%. Leafspot resistant cultivars are urgently needed because of 1) the rising costs of fungicides, 2) their effect on nontarget pathogens (12), 3) plant injury during application (13), and 4) environmental pollution.

Defoliation, even at low levels, reduces yield, while infection at low levels does not (16). Therefore, Gorbet *et al.* (7) proposed that the ultimate value of resistance or tolerance to leafspot in peanuts is the stabilization of pod yields achieved by minimizing yield losses while reducing fungicide use. Historically, resistant lines have been associated with low yields (9).

Several sources of resistance to leafspot have been identified in peanuts (1,2,4,5,6,7,8,11,15,17,18,19). These genotypes include both wild and cultivated *Arachis* spp. Some lines possess resistance to only one causal organism while others are resistance to both. The amount of resistance observed in these genotypes ranges from near immunity to susceptibility less than that of current cultivars. Characteristics positively correlated with leafspot resistance include riboflavin content of the seed and leaf characteristics, such as leaves with a thick palisade layer, dark green color, and small stomata (14). Abdou *et al.* (1) reported that germ tube growth was prevented in immune genotypes, and a barrier formed around the germ tube followed by deposition of a pectic substance after penetration of stomata in resistant genotypes. Foster *et al.* (5) and Walls *et al.* (19) reported resistance was due to an increased latent period, reduced lesion area, and/or reduced sporulation. Genetic studies

---

[1] Contribution from the U. S. Department of Agriculture, Agricultural Research Service, and the Tidewater Research Center, Research Division, Virginia Polytechnic Institute and State University, Suffolk, Virginia 23437. Mention of a specific commercial cultivar or chemical product does not constitute endorsement by the U. S. Department of Agriculture, Agricultural Research Service, or Virginia Polytechnic Institute and State University.

[2] Research Geneticist and Supervisory Research Plant Pathologist, respectively, U. S. Department of Agriculture, Agricultural Research Service, Tidewater Research Center, Suffolk, Virginia 23437.

have indicated that resistance is multifactorial with additive genetic effects (10,15). Some studies have shown that maternal effects and/or cytoplasmic factors may also be involved (10,15).

The objective of this study was to evaluate advanced generation selections from reciprocal cross populations for resistance to both leafspot fungi.

Table 1. Pedigree of genotypes used in two leafspot screening experiments at Suffolk, VA, in 1980 and 1981.

Entry	Pedigree
Florigiant	(Jenkins Jumbo x F230) x F334
VA 732813	Chico x Florigiant
VA 732815	Chico x Florigiant
VA 732816	Chico x Florigiant
VA 732817	Chico x Florigiant
VA 732818	Chico x Florigiant
VA 732827	Florigiant x Chico
VA 732829	Florigiant x Chico
VA 732832	Florigiant x Chico
VA 732834	Florigiant x Chico

Materials and Methods

Field screening tests for leafspot resistance were conducted at the Tidewater Research Center in Suffolk, VA, in 1980 and 1981. Soil types were a Nansemond fine sandy loam (coarse-loamy, siliceous, thermic Aquic Hapludult) and a Suffolk loamy sand (fine-loamy, siliceous, thermic Typic Hapludult) in 1980 and 1981, respectively. Plots were two rows, 1.8m wide and 6.1m long. A randomized complete block design with four replications was used in both years. Recommended production practices were followed in both experiments, except no fungicides were applied for leafspot control. Data were analyzed by analysis of variance methods and Duncan's new multiple range test.

In preliminary agronomic studies in 1979, six genotypes, including VA 732813, VA 732815, VA 732816, VA 732817, VA 732818, and VA 732827 were selected for leafspot resistance. These six genotypes, three additional genotypes (VA 732829, VA 732832, and VA 732834), and the cultivar Florigiant were evaluated for resistance to leafspot. These genotypes represent advanced generation selections from reciprocal cross populations (Table 1).

Disease incidence due to natural infection was determined near the end of the growing season by randomly selecting ten mainstems and lateral branches from within each plot. Measurements were made on the uppermost eight fully expanded leaves of each stem. Percentages of defoliation and infected leaflets and the number of lesions per leaflet were determined on 32 randomly picked leaflets. Pod yields and crop values were calculated in both years.

Results and Discussion

The primary causal organism for leafspot in this study was *C. arachidicola*, but low levels of *C. personatum* occurred late in the growing season. A significant genotypes x sampling date interaction was obtained for percentages of defoliations and infected leaflets; therefore data were analyzed by sampling date (Table 2).

Florigiant had significantly ($P<0.05$) more defoliation at both sampling dates in 1981 and the most defoliation in 1980 (Table 2). Environmental conditions, as indicated by rainfall, were more conducive to leafspot in 1981 than in 1980 (Table 3). Defoliation in 1980 may have been due more to drought than to leafspot, and thus artificially high when compared to 1981. Florigiant had significantly ($P<0.05$) higher percentages of defoliation, infected leaflets, and number of lesions per infected leaflet in 1981 on the main stem samples than the other genotypes. Florigiant also had a significantly higher defoliation score for the lateral branch samples in 1981 than the other genotypes.

It is interesting to compare the average reaction to leafspot of the nine experimental genotypes in this study with the ratings taken for their reaction to Sclerotinia blight, caused by *Sclerotinia minor* Jagger, in a previous study (3). The lines from the Chico x Florigiant cross are the most resistant to both diseases, while lines from the reciprocal cross are more susceptible. Florigiant had higher leafspot ratings than genotypes from either cross, but was intermediate for Sclerotinia blight resistance.

The differences between crosses are even clearer when

Table 2. Reaction of leaflets of the mainstems (MS) and lateral branches (LA) of nine peanut genotypes from reciprocal crosses and the Florigiant parent to leafspot fungi in 1980 and 1981.

	Defoliation (%)[1]			Leaflet Infection (%)			Lesions/leaflet		
Entry	1980-MS+LA	1981-MS	1981-LA	1980-MS+LA	1981-MS	1981-LA	1980-MS+LA	1981-MS	1981-LA
Florigiant	44.5 A[2]	25.3 A	76.5 A	78.3 A	88.0 A	99.8 A	4.8 A	5.8 A	7.5 A
VA 732813	36.0 ABC	8.0 D	15.5 D	18.0 BC	36.0 D	68.5 CDE	1.5 B	2.0 BC	3.0 BC
VA 732815	33.8 C	6.8 D	18.3 CD	17.3 BC	35.5 D	62.3 E	2.0 B	1.8 C	3.3 BC
VA 732816	34.3 BC	9.3 D	17.0 CD	5.8 D	42.3 CD	68.0 CDE	1.0 B	2.0 BC	3.3 BC
VA 732817	34.8 BC	10.5 CD	19.0 CD	11.5 CD	38.0 CD	65.0 DE	1.5 B	2.0 BC	3.5 BC
VA 732818	35.5 ABC	10.0 CD	20.0 CD	7.5 D	36.0 D	68.3 CDE	1.3 B	1.8 C	2.8 C
VA 732827	39.3 ABC	15.5 BC	39.0 B	13.0 BCD	58.3 B	89.8 AB	2.0 B	2.8 BC	6.5 A
VA 732829	43.8 AB	12.5 BCD	30.5 BCD	21.8 B	50.3 BC	86.0 ABC	2.3 B	2.8 BC	5.5 AB
VA 732832	38.5 ABC	11.8 BCD	32.8 BC	16.8 BC	57.0 B	78.0 BCDE	2.3 B	2.8 BC	5.0 ABC
VA 732834	39.8 ABC	17.0 B	40.5 B	22.0 B	57.8 B	84.3 ABCD	2.0 B	3.0 B	5.0 ABC

[1] Readings taken on 14 October 1980, 15 September 1981, and 24 September 1981, respectively. Leafspot was due primarily to C. arachidicola.

[2] Means within columns not followed by the same letter are significantly (P=0.05) different according to Duncan's New Multiple Range Test.

Table 3. Rainfall, planting dates, and number of growing days for 1980 and 1981 at Suffolk, Virginia.

Month	Rainfall (mm)			Planting/harvesting (Date)	
	Normal[1]	1980	1981	1980	1981
May	96	79	63	16	14
June	113	8	98		
July	154	70	98		
August	152	31	215		
September	108	25	84		28
October	86	46	---	15	
Total	709	259	558	152	137
Avg/month	118	43	112		

[1] Based on 50-year mean at Suffolk, Virginia.

the averages for the genotypes within each cross are compared to Florigiant (Table 4). The Chico x Florigiant lines had less defoliation, fewer infected leaflets, and fewer lesions per infected leaflet than either Florigiant or the Florigiant x Chico genotypes. These data suggest that a cytoplasmic factor may be involved in leafspot resistance of these genotypes. Maternal effects have been suggested in an earlier study (10), but they were only observed in the F_1 and not in the advanced generations, as in this study. In a study by Sharief *et al.* (15) differences between reciprocal crosses were noted in the F_2 but possible explanations for the differences were not discussed. Their results are particularly interesting since the parents (*A. chacoense* Krap. et Greg. *nom. nud.* and *A. cardenasii* Krap. et Greg. *nom. nud.*) are reported as resistant to *C. arachidicola* and *C. personatum*, respectively. The F_1's were both susceptible to *C. personatum*. The F_2's of the cross *A. cardenasii* x *A. chacoense* were suspectible to *C. personatum*, while the F_2's of the reciprocal cross were highly resistant to *C. personatum* (15). Thus, even though *A. chacoense* is susceptible to *C. personatum*, there appears to be a cytoplasmic factor(s) that, when combined with the resistance of *A. cardenasii*, gives a high level of resistance in the F_2 and possibly later generations. The occurence of a cytoplasmic factor(s) for resistance in a susceptible parent (Chico) was also observed in this study.

Table 4. Mean leafspot ratings, yield, and dollar value for two reciprocal cross peanut populations and Florigiant in 1980 and 1981.

Entry	Leafspot readings[1] Defoliation (%)	Leaflet infection (%)	Lesions/ leaflet (#)	Yield (kg/ha)	Value ($/ha)
Florigiant	48.8	88.7	6.0	3512	1636
Chico x Florigiant	20.6	38.7	2.2	3314	1515
Florigiant x Chico	30.1	52.9	3.5	3297	1447
LSD (0.05)	5.6	7.6	0.9	287	163

[1] Means of three readings taken on 14 October 1980 from mainstems and lateral branches, 15 September 1981 from mainstems, and 24 September 1981 from lateral branches.

Since Florigiant and Chico are both susceptible parents, resistance to leafspot in this study may be due to additive gene action. These results support previous studies which have suggested that resistance to leafspot is multifactorial with additive genetic effects (10,15).

Florigiant had a significantly ($P<0.05$) higher yield and value than the breeding lines in 1980 when leafspot was not severe and rainfall was limited (Tables 2, 3 and 5). In contrast, the breeding lines had a significantly higher yield and value than Florigiant in 1981 when leafspot was more severe and rainfall was adequate. In the combined analysis over years, few significant differences among genotypes were observed. However, based on 1980 and 1981 results, a significant year x genotype interaction was observed. Yields and values were significantly higher in 1981 than in 1980. The higher yield of Florigiant in 1980, when compared to the nine breeding lines, is probably more indicative of relative stability of yield under low rainfall than to the occurrence of leafspot. In contrast, the higher yield of the nine breeding lines in 1981 compared to Florigiant is probably due to the greater resistance to leafspot by these genotypes in the presence of adequate moisture for them to express their yield potential.

Table 5. Yield and dollar value/ha of nine peanut genotypes resulting from reciprocal crosses and the Florigiant parent in 1980 and 1981.

ENTRY	YIELD (kg/ha) 1980	1981	MEAN	VALUE ($/ha) 1980	1981	MEAN
Florigiant	3591 A[1]	3428 B	3512 A	1747 A	1522 C	1636 A
VA 732813	2930 BC	3845 A	3390 AB	1317 B	1816 AB	1567 AB
VA 732815	2696 BC	4202 A	3451 AB	1203 BC	1969 A	1586 A
VA 732816	2472 BC	4079 A	3276 AB	1050 BC	1913 AB	1483 ABC
VA 732817	2452 C	4079 A	3268 AB	1072 BC	1905 AB	1490 ABC
VA 732818	2452 C	3917 A	3186 AB	1030 BC	1873 AB	1450 ABC
VA 732827	2634 BC	4099 A	3369 AB	1117 BC	1905 AB	1512 ABC
VA 732829	2513 BC	3825 A	3170 B	1072 BC	1707 BC	1391 BC
VA 732832	2981 B	3876 A	3430 AB	1260 BC	1772 AB	1515 ABC
VA 732834	2584 BC	3855 A	3219 AB	1011 C	1735 ABC	1371 C

[1] Means within columns not followed by the same letter are significantly ($P=0.05$) different according to Duncan's New Multiple Range Test.

Results from these experiments show that variation in reaction to leafspot does exist in *A. hypogaea* germplasm. While many sources of resistance possess lower yield potential than current cultivars, genotypes with resistance and high yield potential are available. Results from reciprocal cross populations indicate a cytoplasmic factor(s) and additive genetic effects may determine leafspot resistance. In the near future, a combination of more resistant cultivars and fewer fungicide applications may be the most economical means of leafspot control for growers.

Literature Cited

1. Abdou, Y. A-M., W. C. Gregory, and W. E. Cooper. 1974. Sources and nature of resistance to *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Beck & Curtis) Deighton in *Arachis* species. Peanut Sci. 1:6-11.
2. Chahal, A. S., and R. S. Sandhu. 1972. Reaction of groundnut varieties against *Cercospora personata* and *C. arachidicola*. Plant Dis. Reptr. 56:601-603.
3. Coffelt, T. A., and D. M. Porter. 1982. Screening peanuts for resistance to Sclerotinia blight. Plant Dis. 66:385-387.
4. Coffelt, T. A., D. M. Porter, J. D. Smith, and K. H. Garren. 1977. Reaction of 45 peanut (*Arachis hypogaea* L.) lines to 5 fungal and insect pathogens. Proc. Am. Peanut Res. Educ. Assoc. 9:33. (Abstr.).
5. Foster, D. J., M. K. Beute, and J. C. Wynne. 1980. Spore production and latent period as mechanisms of resistance to *Cercospora arachidicola* in four peanut genotypes. Peanut Sci. 7:88-90.
6. Foster, D. J., J. C. Wynne, and M. K. Beute. 1980. Evaluation of detached leaf culture for screening peanuts for leafspot resistance. Peanut Sci. 7:98-100.

7. Gorbet, D. W., F. M. Shokes, and L. F. Jackson. 1982. Control of peanut leafspot with a combination of resistance and fungicide treatment. Peanut Sci. 9:87-90.
8. Hassan, H. M., and M. K. Beute. 1977. Evaluation of resistance to cercospora leafspot in peanut germplasm potentially useful in a breeding program. Peanut Sci. 4:78-83.
9. Higgins, B. B. 1956. Les maladies de l'arachide aux Etats-Unis. Oleagineux 11:213-230.
10. Kornegay, J. L., M. K. Beute, and J. C. Wynne. 1980. Inheritance of resistance to *Cercospora arachidicola* and *Cercosporidium personatum* in six virginia-type peanut lines. Peanut Sci. 7:4-9.
11. Melouk, H. A., D. J. Banks, and M. A. Fanous. 1984. Assessment of resistance to *Cercospora arachidicola* in peanut genotypes in field plots. Plant Dis. 68:395-397.
12. Porter, D. M. 1980. Increased severity of Sclerotinia blight in peanuts treated with captafol or chlorothalonil. Plant Dis. 64:394-395.
13. Porter, D. M., and N. L. Powell. 1978. Sclerotinia blight development in peanut vines injured by tractor tires. Peanut Sci. 5:87-90.
14. Porter, D. M., D. H. Smith, and R. Rodriguez-Kabana. 1982. Peanut plant diseases. pp. 326-410. *In* H. E. Pattee and C. T. Young (eds.) Peanut Science and Technology. Amer. Peanut Res. and Educ. Soc., Inc., Yoakum, TX.
15. Sharief, Y., J. O. Rawlings, and W. C. Gregory. 1978. Estimates of leafspot resistance in three interspecific hybrids of *Arachis*. Euphytica 217:741-751.
16. Smith, D. H. 1984. Foliar diseases—early and late leafspots. pp. 5-7. *In* D. M. Porter, D. H. Smith, and R. Rodriguez-Kabana (eds.) Compendium of Peanut Diseases. Am. Phytopath. Soc., St. Paul, MN.
17. Sowell, G., Jr., D. H. Smith, and R. O. Hammons. 1976. Resistance of peanut plant introductions to *Cercospora arachidicola*. Plant Dis. Reptr. 60:494-498.
18. Subrahmanyam, P., D. McDonald, R. W. Gibbons, S. N. Nigam, and D. J. Nevill. 1982. Resistance to rust and late leafspot diseases in some genotypes of *Arachis hypogaea*. Peanut Sci. 9:6-10.
19. Walls, S. B., J. C. Wynne, and M. K. Beute. 1985. Resistance to late leafspot peanut of progenies selected for resistance to early leafspot. Peanut Sci. 12:17-22.

Accepted August 2, 1986