Peanut Science (1983) 10:72-75

Agronomic Potential of Six Cylindrocladium Black Rot Resistant Peanut Lines[1]

T. A. Coffelt[2]

ABSTRACT

Six Cylindrocladium black rot (CBR) resistant peanut (*Arachis hypogaea* L.) lines (Spancross, Tamnut 74, NC 3033, VGP 1, GA 722105, and Toalson) and one susceptible line (Florigiant) were evaluated in field experiments for agronomic potential. All experiments (one each in 1976 and 1977 and two in 1978) were located in fields (sites) where CBR had previously occurred. The percentage of CBR symptomatic plants, yield per hectare, and market grade were measured at each site. In addition, the percentage of damaged roots and a visual rating of pod damage were determined at three sites (one in 1977 and two in 1978). Florigiant had a significantly higher yield and percentage of CBR symptomatic plants than the six CBR resistant lines. No significant differences occurred among the six resistant lines for percentage of CBR symptomatic plants. VGP 1 and GA 722105 had significantly lower yields than the other four resistant lines. These results indicate the low agronomic potential of the resistant lines.

Key Words: groundnut, *Cylindrocladium crotalariae*, *Calonectria crotalariae*, disease resistance, plant breeding, *Arachis hypogaea* L.

Cylindrocladium black rot (CBR) of peanuts (*Arachis hypogaea* L.), caused by *Calonectria crotalariae* (Loos) Bell & Sobers (*Cylindrocladium crotalariae* (Loos) Bell & Sobers) (1), was first reported in the Virginia-North Carolina peanut-growing area in 1970, and had reached epidemic proportions by 1975 (7). CBR is potentially one of the most damaging diseases of peanuts in the Virginia-North Carolina peanut-growing area. Sporadic occurrences of CBR since 1975 have been associated with winter temperatures preceding the peanut crop (13). Cold winter temperatures result in less CBR the following growing season.

Results from screening tests have been reviewed recently by Coffelt and Garren (6) and Hammons, et al. (11). More than 50 peanut genotypes have been identified as resistant to *C. crotalariae* (6, 11); however, the agronomic potential of the genotypes in Virginia has not been reported. Coffelt (5) reported differences in the susceptibility of roots and pods on the same plant to *C. crotalariae.*

Morton and Baxter (12) evaluated the agronomic potential of six susceptible peanut cultivars (Tifrun, GK 3, NC 6, Florunner, Florigiant, and Early Bunch) and one resistant germplasm line (NC 3033). They found that the susceptible cultivars yielded more than NC 3033, although NC 3033 had less CBR damage. Higher yields of GK 3 and Tifrun compared to Florunner or Florigiant were not associated with lower infection by *C. crotalariae.*

The objectives of this study were 1) to evaluate the agronomic potential of six peanut genotypes previously reported as resistant to *C. crotalariae* (5, 7, 9) compared to Florigiant, a susceptible cultivar; 2) to study the effect of CBR on market grade characteristics; and 3) to study the relationship between different rating systems for CBR damage.

Materials and Methods

Three spanish-type, *A. hypogaea* spp *fastigiata* var vulgaris Harz, cultivars (Spancross, Tamnut 74, and Toalson) and three small-seeded virginia-type, spp *hypogaea* var *hypogaea,* breeding lines (NC 3033, VGP 1, and GA 722105) that were classified as resistant in previous tests (5, 6, 7) were selected for yield and market grade studies. Florigiant (3), a large-seeded virginia-type cultivar grown on over 85 percent of the Vriginia-North Carolina peanut-growing area was

[1]Cooperative investigations of the Agricultural Research Service, U.S. Department of Agriculture, and the Virginia Polytechnic Institute and State University. Research was supported in part by ARS grant No. 12-14-7001-855.

[2]Research Geneticist, Agricultural Research Service, U.S. Department of Agriculture, Tidewater Research Center, Suffolk, Virginia 23437.

chosen as a susceptible check. Spancross (10), Tamnut 74 (14), Toalson (15), and Florigiant (3) are commercially available cultivars. NC 3033 (2) and VGP 1 (4) are germplasm lines released as sources of resistance to CBR. GA 722105 is an unreleased breeding line developed from a cross between Argentine and Early Runner.

All tests, one each in 1976 (site-1) and 1977 (site-2) and two in 1978 (sites 3 and 4), were located in fields where CBR had previously occurred. Soil types, rainfall, previous crop, and planting and harvesting dates are presented in Table 1 for the four sites. Early maturing lines (Spancross, Tamnut 74, and Toalson at all sites and GA 722105 at sites 1 and 2) were harvested about four weeks prior to the other lines (Florigiant, NC 3033, and VGP 1 at all sites and GA 722105 at sites 3 and 4) (Table 1). Recommended practices for producing peanuts in Virginia were followed at all sites. The percentage of CBR symptomatic plants per plot, yield per hectare, and market grade were determined at all sites. The percentage of damaged roots and a visual score of pod damage (5, 6) were determined at harvest for sites 2, 3 and 4. Pod damage was based on a visual score of one to three for each plot with one equal to 0-25 percent damaged pods and three equal to 75-100 percent damaged pods.

All measures were taken on two-row plots 1.8 m wide (.9 m between rows) and 6.1 m long arranged in a randomized complete block design with six replications. Data were analyzed by analysis of variance and Duncan's new Multiple Range Test. Linear regression and simple correlation coefficients were computed for percentage CBR symptomatic plants versus pod damage, root damage, yield, damaged kernels, and total sound mature kernels, and for pod damage versus root damage. Coefficients were calculated for the average of six replications for each line at each site, the average for each line over all replications and sites, and the average for each site over all replications and lines.

Results and Discussion

In the combined analyses over four sites, Florigiant had a significantly higher percentage of CBR symptomatic plants, percentage of root damage, and yield than the resistant lines (Tables 2 and 3). NC 3033 and Toalson had

Table 1. Soil type, previous crop, planting and harvesting dates, and rainfall at four sites.

Site	Soil Type	Previous Crop	Planting Date	Harvest Date: Early	Harvest Date: Late	Rainfall (cm): Early Harvest	Rainfall (cm): Late Harvest
1	Norfolk fine sandy loam	Corn	5/24/76	9/29/76	10/28/76	50.7	63.8
2	Craven fine sandy loam	Corn	5/11/77	9/06/77	10/06/77	32.5	40.0
3	Suffolk loamy sand	Corn	5/25/78	9/20/78	10/17/78	49.2	54.9
4	Eunola loamy fine sand	Corn	5/23/78	9/18/78	10/17/78	55.1	61.6

Table 2. Percent CBR symptomatic plants, percent damaged roots, and visual estimates of pod damage at four sites in Virginia in 1976-78.

Line	% CBR Symptomatic Plants					% Damaged Roots				Visual Pod Damage Score			
	Site-1	Site-2	Site-3	Site-4	Mean	Site-2	Site-3	Site-4	Mean	Site-2	Site-3	Site-4	Mean
Florigiant	31.2 a*	32.1 a	2.2 a	3.1 a	17.2 a	23.9 a	4.0 a	3.8 a	10.6 a	2.2 a	1.0 a	1.0 a	1.4 a
Spancross	10.4 b	24.7 ab	0.8 ab	0.0 b	9.0 b	1.1 b	1.0 b	0.2 b	0.8 b	1.7 ab	1.0 a	1.2 a	1.3 ab
Tamnut 74	15.9 b	21.6 ab	0.2 ab	0.2 b	9.5 b	2.9 b	0.0 b	0.0 b	1.0 b	1.5 ab	1.0 a	1.3 a	1.3 ab
NC 3033	14.1 b	17.1 b	0.8 ab	0.5 b	8.1 b	3.3 b	1.2 b	0.9 b	1.8 b	1.2 b	1.0 a	1.2 a	1.1 b
VGP 1	9.9 b	20.3 b	1.7 ab	1.4 b	8.3 b	8.8 b	1.0 b	2.2 ab	4.0 b	1.5 ab	1.2 a	1.0 a	1.2 ab
GA 722105	8.3 b	22.6 ab	0.0 b	0.3 b	7.8 b	7.7 b	0.0 b	0.5 b	2.7 b	2.0 a	1.0 a	1.0 a	1.3 ab
Toalson	7.9 b	18.7 b	1.3 ab	0.2 b	7.0 b	4.9 b	0.2 b	0.5 b	1.8 b	1.2 b	1.2 a	1.0 a	1.1 b
Mean	14.0 B	22.4 A	1.0 C	0.8 C		7.5 A	1.1 B	1.2 B		1.6 A	1.1 B	1.1 B	

* Means of lines within a column followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test. Site means within a disease rating followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Table 3. Yield and market grade of seven peanut lines at four sites in Virginia in 1976-78.

Line	Yield (kg/ha)					% Damaged Kernels					% Total Sound Mature Kernels				
	Site-1	Site-2	Site-3	Site-4	Mean	Site-1	Site-2	Site-3	Site-4	Mean	Site-1	Site-2	Site-3	Site-4	Mean
Florigiant	3568a*	3873a	4171a	3893a	3876a	2.2bc	0.7a	0.0a	0.8a	0.9b	60.3c	63.5b	68.3abc	70.0a	65.5a
Spancross	1926cd	2455b	4198a	3486ab	3017b	3.5b	0.0b	0.0a	0.5ab	1.0b	64.8ab	67.3a	70.8a	64.7b	66.9a
Tamnut 74	2171bcd	2482b	3860ab	3228b	2935b	1.4cd	0.0b	0.0a	0.0b	0.4c	65.5a	62.5b	68.8ab	65.0b	66.5a
NC 3033	2517b	2550b	3228c	3202b	2874b	6.3a	0.0b	0.2a	0.3ab	1.7a	44.9f	61.2bc	65.0cd	60.5c	57.9b
VGP 1	2225bcd	2510b	2706d	2612c	2513c	3.2b	0.2b	0.0a	0.0b	0.8b	54.0d	58.3cd	64.2d	59.3c	59.0b
GA 722105	1859d	2041b	3520bc	3202b	2656c	0.3d	0.0b	0.0a	0.0b	0.1c	50.7e	56.0de	66.2bcd	59.5c	58.1b
Toalson	2259bc	2483b	3704b	3168b	2903b	0.7d	0.0b	0.0a	0.0b	0.2c	62.8bc	54.8e	59.3e	55.5d	58.1b
Mean	2361 D	2628 C	3626 A	3255 B		2.5 A	0.1 B	0.0 B	0.2 B		57.6 D	60.5 C	66.1 A	62.1 B	

* Means of lines within a column followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test. Site means within a yield or market grade factor followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

significantly less pod damage than Florigiant (Table 2). No significant differences occurred among the resistant lines for percentage of CBR symptomatic plants, percentage of damaged roots, or visual pod damage score (Table 2). VGP 1 and GA 722105 yielded significantly less than the other resistant lines (Table 3).

The location means for all characters were significant at the P = .05 level (Tables 2 and 3). As has been pointed out in previous studies (5, 6, 7, 12), initial inoculum levels and environmental conditions both before and during the growing season greatly affect the amount of CBR. Colder winter temperatures than normal prior to the 1978 growing season probably account for the lower amount of CBR at sites 3 and 4 (6, 12, 13).

The site x line interaction for all characters was highly significant, as it has been reported previously (5, 6, 7). This may be due to genotype x environment interactions or to the presence of fungal races with different pathogenicity among the sites which affected the lines differently. Races of the pathogen have not been identified, but the possibility has been proposed (6, 9).

All correlation coefficients between root damage and percentage of CBR symptomatic plants were significant (Table 4). Site 2 was highest for both plants and roots, while sites 3 and 4 were lowest for percentage CBR symptomatic plants and roots (Table 2). This occurs because the above ground symptoms are based largely upon what is happening to the root system. Similar results have been reported (5, 6).

port the previous suggestion that root and pod resistance may be controlled by separate genetic mechanisms (5, 6). In breeding and screening for CBR resistance, pod damage as well as root and/or plant damage evaluations should be made so that plants with both pod and root resistance can be selected. Site 2 was the highest for both percentage of damaged roots and pod damage (Table 2).

The percentage of total sound mature kernels was significantly higher for Florigiant, Spancross, and Tamnut 74 than the other lines (Table 3). This might have resulted from the selection for superior grade and yield in the development of these cultivars, while these factors were not the major selection criteria for the breeding lines.

The coefficients of correlation for percentage total sound mature kernels with percentage of CBR symptomatic plants were not significant; however, they were negative for sites and replication (Table 4). Sites 1 and 2 were highest in percentage of CBR symptomatic plants and lowest in percentage of total sound mature kernels, while sites 3 and 4 were lowest in percentage of CBR symptomatic plants and highest in percentage of total sound mature kernels (Tables 2 and 3). Since CBR affects the fruiting structures of the plant, fewer total sound mature kernels would be expected from diseased plants.

In the combined analysis over all locations, NC 3033 had significantly more damaged kernels than the other lines, while Tamnut 74, GA 722105, and Toalson had

Table 4. Regression (b) and correlation (r) coefficients among CBR, yield, and market grade characteristics.

Characteristics		Lines within Sites[1]			Lines[2]			Sites[3]		
Y	X	n	b	r	n	b	r	n	b	r
% Damaged Roots	% CBR Symptomatic Plants	21	0.36**	0.72**	7	1.44**	0.89**	3	0.30*	0.99*
Visual Pod Damage Score	% CBR Symptomatic Plants	21	0.03**	0.86**	7	0.04*	0.80*	3	0.02**	0.99**
% Total Sound Mature Kernels	% CBR Symptomatic Plants	28	- 0.13	-0.23	7	0.70	0.56	4	- 0.22	-0.67
% Damaged Kernels	% CBR Symptomatic Plants	28	0.03	0.23	7	0.03	0.19	4	0.03	0.28
Yield (kg/ha)	% CBR Symptomatic Plants	28	-22.97	-0.34	7	115.71**	0.92**	4	-45.45	0.83
Visual Pod Damage Score	% Damaged Roots	21	0.05**	0.75**	7	0.02	0.53	3	0.08**	0.99**

*, ** Significant at the .05 and .01 levels, respectively.

[1] Lines within sites is the average of six replications for each line at each site.

[2] Lines is the average for each line over all replications and sites.

[3] Sites is the average for each site over all replications and lines.

Significant correlation coefficients for pod damage scores and percentage of CBR symptomatic plants were found (Table 4). Site 2 was the highest for both percentage of CBR symptomatic plants and for pod damage, while sites 3 and 4 were lowest (Table 2). These results are similar to previous reports (5, 6).

The coefficients of correlation for pod damage scores and percentages of root damage by lines was not significant (Table 4). However, these traits were significantly correlated when analyzed by site and replication (Table 4). Spancross, Tamnut 74, and GA 722105 had more pod damage than expected based on the amount of root damage, while VGP 1 had more root damage than expected based on the amount of pod damage. These results sup-

significantly less (Table 3). Commercially, none of the levels of damaged kernels would be unacceptable. The percentage of damaged kernels was not significantly correlated with the percentage of CBR symptomatic plants (Table 4).

Correlation coefficients by line for yield per hectare and percentage of CBR symptomatic plants was highly significant (Table 4). This is due to the high yields of Florigiant, even under high (30 percent infected plants) levels of CBR, and the extremely low yield potentials of the resistant lines in Virginia. Correlation coefficients by site and replication of yield per hectare and the percentage of CBR symptomatic plants resulted in negative correlations (Table 4). Sites 1 and 2 were highest in percentage of CBR infected plants and lowest in yield, while sites 3 and 4 were lowest in percentage of CBR infected plants and highest in yield (Tables 2 and 3).

Yields of Florigiant with greater than 30 percent infection (sites 1 and 2) are similar to those reported by Garren, et al. (8). However, the sites (3 and 4) with low percentages of symptomatic plants do not approach the over 4,500 kg/ha he observed with no infection.

The results in this study agree with those of Morton and Baxter (12), who found that six susceptible cultivars had higher yields than one resistant line (NC 3033). The low yield potentials of the six resistant lines in this study indicate the need for a breeding program to develop high yielding resistant cultivars. The six germplasm lines identified by Hammons, et al. (11) also have low yield potentials (Hammons, personal communication, and Coffelt, unpublished). While their low yield potentials prevent the resistant lines from being of immediate value to peanut growers, their high levels of resistance should be of value in developing high yielding CBR resistant cultivars.

Acknowledgements

The author acknowledges the assistance of J. L. Steele in statistical analysis of the data and C. H. Crowder for technical assistance.

Literature Cited

1. Bell, D. K., and E. K. Sobers. 1966. A peg, pod and root necrosis of peanuts caused by a species of *Calonectria*. Phytopathology 56:1361-1364.
2. Beute, M. K., J. C. Wynne, and D. A. Emery. 1976. Registration of NC 3033 peanut germplasm. Crop Sci. 16:887.
3. Carver, W. A. 1969. Registration of Florigiant peanuts. Crop Sci. 9:849-850.
4. Coffelt, T. A. 1980. Registration of VGP 1 peanut germplasm. Crop Sci. 20:419.
5. Coffelt, T. A. 1980. Reaction of Spanish-type peanut genotypes to Cylindrocladium black rot. Peanut Sci. 7:91-94.
6. Coffelt, T. A., and K. H. Garren. 1982. Screening for resistance to Cylindrocladium black rot in peanuts (*Arachis hypogaea* L.). Peanut Sci. 9:1-5.
7. Garren, K. H., and T. A. Coffelt. 1976. Reaction to Cylindrocladium black rot in Virginia-type peanut cultivars. Plant Dis. Reptr. 60:175-178.
8. Garren, K. H., M. K. Beute, and D. M. Porter. 1972. The Cylindrocladium black rot of peanut in Virginia and North Carolina. J. Amer. Peanut Res. Educ. Assoc., Inc. 4:67-71.
9. Hadley, B. A., M. K. Beute, and J. C. Wynne. 1979. Heritability of Cylindrocladium black rot resistance in peanuts. Peanut Sci. 6:51-54.
10. Hammons, R. O. 1970. Registration of Spancross peanuts. Crop Sci. 10:459.
11. Hammons, R. O., D. K. Bell, and E. K. Sobers. 1981. Evaluating peanuts for resistance to Cylindrocladium black rot. Peanut Sci. 8:117-120.
12. Morton, C. S., and L. W. Baxter. 1979. Response of selected peanut cultivars to Cylindrocladium black rot in South Carolina. Phytopathology 69:530.
13. Phipps, P. M., and M. K. Beute. 1979. Population dynamics of *Cylindrocladium crotalariae* microsclerotia in naturally-infested soil. Phytopathology 69:240-243.
14. Simpson, C. E., and O. D. Smith. 1975. Registration of Tamnut 74 peanut. Crop Sci. 15:603-604.
15. Simpson, C. E., O. D. Smith, and T. E. Boswell. 1979. Registration of Toalson peanut. Crop Sci. 19:742.

Accepted September 24, 1983