Assessment of Resistance to *Cercospora arachidicola* in Peanut Genotypes in Field Plots

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ABSTRACT

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Reactions to early leaf spot, caused by *Cercospora arachidicola*, were evaluated at Perkins, OK, in 1981 on 151 peanut entries representing genotypes of cultivated *Arachis hypogaea*, wild species of *Arachis*, and hybrids. Plants were grown in single-row, 3-m plots that were irrigated weekly (2.5–3 cm); leaf spot was evaluated 115–120 days after planting. A subjective scale index of 1–5 (low to high response) was used to describe each of the following criteria: 1) amount of leaf necrosis, 2) degree of sporulation of *C. arachidicola*, and 3) leaf defoliation. A leaf spot reaction index (LSRI) for each entry was obtained as the product of the leaf necrosis and sporulation indices, where the lowest and highest values of the LSRI were 1 and 25, respectively. The Kruskal-Wallis one-way analysis of variance by ranks and multiple-comparison test were used to test the equality of the effects of genotypes on these criteria. The Spearman rank correlation for each pair of criteria was calculated for each genotype. Significant positive correlations between LSRI and defoliation and between amount of leaf necrosis and defoliation were obtained for all genotypes. Information obtained from this statistical analysis is useful for evaluating resistance of peanut entries to *C. arachidicola* in field plots on a yearly basis.

Early leaf spot of peanut (*Arachis hypogaea* L.), caused by *Cercospora arachidicola* Hori, is a disease of universal economic importance. The disease is characterized by the appearance of leaf defoliation and necrotic lesions on leaves, petioles, and stems. On susceptible peanut genotypes, *C. arachidicola* produces abundant conidia on mature lesions (7,8). Fungicides have provided the best control (2,18,19); however, the high cost of fungicides and the development of fungicide-tolerant strains of *C. arachidicola* (4,13,20) reduce their usefulness for management of this disease.

Resistant germ plasm of peanut to *C. arachidicola* has been identified (1,3,8,10,21). Greenhouse procedures to screen, identify, and evaluate resistance in the peanut germ plasm are useful in initial selection (11,14); however, assessment of resistance under field conditions is necessary in the final decision on selections. In this paper, criteria to assess resistance to *C. arachidicola* in the peanut germ plasm in small field plots are presented and discussed.

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MATERIALS AND METHODS

One hundred fifty-one entries were included in this study, representing 103, 23, and 25 peanut genotypes of cultivated *A. hypogaea*, wild *Arachis* species, and hybrids, respectively. Entries were planted in 3-m, single-row plots with 3.3-m centers. Spreader rows of the *C. arachidicola*-susceptible cultivar Pronto were planted alternately with plot rows and as border rows. The cultivated peanut entries were planted at the rate of 15 seeds per plot. All wild and hybrid entries were propagated from shoot-tip cuttings and transplanted in the field. Depending on the success of rooting, five to 10 rooted cuttings from each entry were planted in each plot. Entries were randomized throughout the field. Plots were fertilized 2 wk after planting with NH_4NO_3 (34% N) at the rate of 50 kg N/ha and sprinkle-irrigated weekly (2.5–3 cm) throughout the growing season.

Five of the cultivated entries were of Spanish and runner peanut types known to be susceptible to *C. arachidicola*. The other cultivated entries were obtained from collections from various expeditions to South America sponsored by the International Board of Plant Genetics Resources, FAO, Rome, Italy. Wild peanut entries represented genotypes in the sections Arachis, Rhizomatosae, and Erectoides. Hybrid entries represented crosses of wild × wild and cultivated × wild genotypes.

Severity of leaf spot on peanut entries was evaluated 115–120 days after planting. The amount of leaf spot (LS) and amount of leaf defoliation (DL) were recorded. For each variable, a subjective scale of 1–5 (low to high response) was used as an index to describe the variables, where 1 = no leaf spot or defoliation present, 2 = trace to 5% of total leaf area covered with lesions or defoliated, 3 = >5 to <10% of leaf area with lesions or defoliated, 4 = 10 to <25% of leaf area with lesions or defoliated, and 5 = >25% of leaf area covered with lesions or defoliated.

In addition to these variables, degree of sporulation (SS) of *C. arachidicola* on leaves was determined. Eight leaflets with dark brown lesions were randomly collected from each plot and incubated at 100% relative humidity under continuous light (800 lux) for 96 hr at 25 ± 1 (8). All lesions of the sample were examined stereoscopically, and a scale of 1–5 was used to describe the degree of sporulation

Table 1. Index values and ranks of amount of leaf spot (LS), sporulation of *Cercospora arachidicola* (SS), defoliation (DL), and leaf spot reaction index (LSRI) for some peanut entries in the 1981 leaf spot disease nursery

Entry[a]	Index[b]				Ranks[c]			
	LS	SS	DL	LSRI	LS	SS	DL	LSRI
Cultigen (*Arachis hypogaea* L.)								
Pronto	5	5	5	25	147.0	131.0	142	148.0
Comet	5	5	5	25	147.0	131.0	142	148.0
Tamnut 74	5	5	5	25	147.0	131.0	142	148.0
Florunner	5	5	5	25	147.0	131.0	142	148.0
Toalson	5	5	5	25	147.0	131.0	142	148.0
PI 109839	3	5	4	15	96.5	131.0	101	119.0
PI 468251 (BPZ 56)	2	3	3	6	44.5	24.5	52	32.0
PI 468253 (BPZ 58)	2	3	4	6	44.5	24.5	101	32.0
PI 468293 (BPZ 96)	2	3	3	6	44.5	24.5	52	32.0
PI 468295 (BPZ 98y)[d]	2	4	4	8	44.5	72.5	101	47.0
PI 475871 (GKSPSc 224)	2	4	4	8	44.5	72.5	101	47.0
PI 476029 (SPA 417)	2	3	3	6	44.5	24.5	52	32.0
PI 476034 (SPA 422)	2	3	3	6	44.5	24.5	52	32.0
Wild species								
A. batizocoi Krap. et Greg. (PI 298639) K9484	3	1	4	3	96.5	6.0	101	15.5
A. sp.[e] (PI 276233) GK 10596C	1	1	1	1	10.0	6.0	3	2.5
A. chacoense[f] (PI 276235) GKP 10602	2	1	2	2	44.5	6.0	20	8.5
A. stenosperma[f] (PI 338280) HLK 410	1	4	2	4	10.0	72.5	20	22.0
A. diogoi Hoehne (PI 468142) GK 30005	1	4	2	4	10.0	72.5	20	22.0
A. helodes Mart. ex Hoehne (PI 468146) GK 30031	1	3	2	3	10.0	24.5	20	15.5
A. villosulicarpa Hoehne[g] (PI 263394)	2	1	2	2	44.5	6.0	20	8.5
A. regonii Krap. et Greg.[h] (PI 262142) GKP 10034	2	1	3	2	44.5	6.0	52	8.5
Hybrids (F_1)								
A. stenosperma × *A. cardenasii*[f] (PI 262141) GKP 10017	2	1	2	2	44.5	6.0	20	8.5
A. hypogaea (Chico) × *A. chacoense*[i]	2	5	3	10	44.5	131.0	52	69.0
A. hypogaea (Peruvian) × *A. chacoense*	2	4	3	8	44.5	72.5	52	47.0
A. duranesis[f] (PI 219823) K 7988 × *A. chacoense*[i]	1	3	2	3	44.5	72.5	3	47.0
A. spegazzinii (PI 263133) GKP 10038 × *A. chacoense*[i]	2	4	2	8	44.5	72.5	20	47.0
A. stenosperma × *A. chacoense*	1	5	2	5	10.0	131.0	20	26.5

[a] All are members of the *Arachis* section except where otherwise noted. Accessions are mostly from various South American expeditions. Collector initials are as follows: A = V. O. Arriola, B = D. J. Banks, G = W. C. Gregory, H = R. O. Hammons, K = A. Krapovickas, L = W. R. Langford, P = J. Pietrarelli, S = C. E. Simpson, Sc = A. Schinini, and Z = H. Zurita.

[b] LS = amount of leaf spot rated on a scale of 1–5, where 1 = no lesions, 2 = trace to 5%, 3 = >5 to <10%, 4 = >10 to <25%, and 5 = >25% total leaf area covered with lesions; SS = degree of sporulation on a scale of 1–5, where 1 = no sporulation, 2 = trace to 5%, 3 = >5 to <10%, 4 = >10 to <25%, and 5 = >25% of all stomata sporulated; DL = amount of leaf defoliation rated on a scale of 1–5, where 1 = no defoliation, 2 = trace to 5%, 3 = >5 to <10%, 4 = >10 to <25%, and 5 = >25% total leaf area defoliated; LSRI = leafspot reaction index, which is the product of LS and SS indices.

[c] Based on 151 entries.

[d] A yellow-flowered selection.

[e] Section Rhizomatosae.

[f] Krap. et Greg. nom. nud.

[g] Section Extranervosae.

[h] Section Erectoides.

[i] A white-flowered selection.

Table 2. Rank means of amount of leaf spot (LS), sporulation of *C. arachidicola* (SS), defoliation (DL), and leaf spot reaction index (LSRI) in peanut genotypes of cultivated, wild, and hybrid entries

Genotype	No. of entries	Rank means			
		LS	SS	DL	LSRI
Cultivated	103	96.54 a[z]	82.24 a	98.10 a	96.04 a
Wild	23	30.26 b	30.98 b	30.39 b	19.72 c
Hybrid	25	33.40 b	91.70 a	26.92 b	45.22 b

[z] Means with a common letter in each variable were not significantly different at 15% experimentwise error rate. Critical values for comparing rank means between cultivated and wild; cultivated and hybrid; wild and hybrid entries were 19.77, 19.11, and 24.77, respectively.

on all stromata, where 1 = no sporulation, 2 = trace to 5%, 3 = >5 to <10%, 4 = >10 to <25%, and 5 = >25%. Percentage was estimated by observing the number of sporulating stromata in relation to total stromata present on all lesions. A leaf spot reaction index (LSRI) was developed by multiplying the indices of LS and SS, where the lowest value of LSRI was 1 and the highest was 25.

Nonparametric methods of statistical analysis (5) were used because of the scale of measurement of the variables (ordinal scale) and because of their general applicability. The Kruskal-Wallis test (5), which is a nonparametric analog to one-way analysis of variance, and a multiple-comparison test were used to test the equality of the effects of genotypes on the criteria listed before. Critical values to compare rank means between genotypes were calculated as described by Dunn (6), using an experimentwise error rate of 15%. Also, Spearman rank correlation for each pair of criteria was computed for each genotype (5).

RESULTS AND DISCUSSION

Table 1 contains index values and ranks of LS, SS, DL, and LSRI for some of the 151 peanut entries in the 1981 leaf spot disease nursery. Resistance to *C. rachidicola* was found in the wild species of the genus *Arachis*, which supports previous findings (1,8). The presence of useful levels of resistance was found in seven newly discovered cultivated peanut entries, PI 468251 (BPZ 56), PI 468253 (BPZ 58), PI 468293 (BPZ 96), PI 468295 (BPZ 98y), PI 475871 (GKSPSc 224), PI 476029 (SPA 417), and PI 476034 (SPA 422).

Rank means of LS, DL, and LSRI in the cultivated peanut entries were significantly higher (15% experimentwise error rate) than those in the wild and hybrid entries (Table 2). Rank means of SS in the cultivated and hybrid entries were significantly higher from those of the wild peanut entries (Table 2). Spearman rank correlation for each pair of the variables is presented in Table 3. Positive and significant correlations were obtained between each pair of variables in the cultivated genotype and when pooled over the genotypes. Also, positive and significant correlations were obtained between LS and DL, LS and LSRI, SS and LSRI, and LSRI and DL in the wild and hybrid entries (Table 3).

Other investigators (9,12,15–17) did not use sporulation as a parameter in determining the severity of leaf spot reaction on peanut in field plots; however, sporulation of *C. arachidicola* represents an important parameter for screening peanut genotypes for resistance to leaf spot (7,8). Sporulation of *C. arachidicola* is epidemiologically important in selecting for resistance because poor sporulation of a pathogen may reduce the apparent infection rate (*r*) or

Table 3. Spearman rank correlation between amount of leaf spot (LS), sporulation of *C. arachidicola* (SS), defoliation (DL), and leaf spot reaction index (LSRI) in peanut genotypes of cultivated, wild, and hybrids

Genotype	No. of entries	Correlation coefficients between LS and SS	LS and DL	LS and LSRI	SS and DL	SS and LSRI	LSRI and DL
Cultivated	103	0.45 (<0.001)[a]	0.80 (<0.001)	0.93 (<0.001)	0.38 (<0.001)	0.72 (<0.001)	0.74 (<0.001)
Wild	23	−0.09 (0.670)	0.70 (<0.001)	0.40 (0.088)	0.16 (0.473)	0.88 (0.088)	0.42 (0.044)
Hybrid	25	0.30 (0.139)	0.46 (0.019)	0.75 (<0.001)	0.42 (0.035)	0.82 (<0.001)	0.54 (0.005)
Pooled	151	0.35 (<0.001)	0.77 (<0.001)	0.87 (<0.001)	0.34 (<0.001)	0.70 (<0.001)	0.69 (<0.001)

[a] Probabilities associated with correlation coefficients.

the rate of disease increase (22) under field conditions. Therefore, the LSRI as defined in this paper could be a useful and practical index for consideration in selecting for resistance to the early leaf spot pathogen in peanut germ plasm, providing that sporulation assessment is made at same time that a susceptible genotype has actively sporulating lesions for comparison.

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