Resistance to Leaf Spot Caused by *Cercosporidium personatum* in Wild *Arachis* Species

P. SUBRAHMANYAM, Plant Pathologist, J. P. MOSS, Principal Cytogeneticist, D. McDONALD, Principal Plant Pathologist, P. V. SUBBA RAO, Research Associate, Groundnut Improvement Program, and V. R. RAO, Botanist, Genetic Resources Unit, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru P.O., Andhra Pradesh 502 324, India

ABSTRACT

Subrahmanyam, P., Moss, J. P., McDonald, D., Subba Rao, P. V., and Rao, V. R. 1985. Resistance to leaf spot caused by *Cercosporidium personatum* in wild *Arachis* species. Plant Disease 69:951-954.

Ninety-six accessions of wild *Arachis* species were evaluated for reactions to the late leaf spot pathogen *Cercosporidium personatum*. Lesions were formed on leaflets of all accessions but were small and nonsporulating on all accessions of sections *Erectoides, Triseminalae, Extranervosae, Rhizomatosae,* and *Caulorhizae*. Species in section *Arachis* had lesions from 0.16 to 1 mm in diameter; 15 accessions had no sporulating lesions, and in the others, sporulation of lesions ranged from slight to extensive. Frequency of infection (number of lesions per square centimeter of leaf area) and percentage of defoliation varied greatly within each section and species.

The two leaf spot diseases of peanut (*Arachis hypogaea* L.) caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton are the most important diseases on a world scale (11,18). Losses in yield of about 10% attributable to leaf spots have been estimated in the United States despite the use of chemical control measures (11). In the semiarid tropics, peanut is grown almost entirely by small-scale farmers who can rarely afford to use chemical crop protection practices, and under these conditions, yield losses exceeding 50% are common (6). Screening for resistance to leaf spots has received considerable attention in recent years, and a number of resistant sources have been reported in cultivated peanut (2,8,9,13–15,18,22,23,26–28).

Wild *Arachis* species are potential sources of resistance to various peanut diseases, and in recent years, there has been considerable emphasis on screening wild *Arachis* species for resistance to leaf spots (1,3,4,7,12,16–19,28).

We report the results of a laboratory test where the components of resistance to *C. personatum* were determined for 96 accessions of wild *Arachis* species.

MATERIALS AND METHODS

All test entries were identified by collector and collector numbers, USDA Plant Inventory (PI) numbers, and ICRISAT (ICG) numbers because many species names in common use have not been validly published. Accessions of wild *Arachis* species (Table 1) were received mostly from the United States. Plants were grown outdoors in cylindrical concrete tanks 60 cm in diameter × 75 cm deep containing a mixture of soil, sand, and farmyard manure (3:3:1, v/v) at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India. Leaves were collected from each test entry at the end of the 1982 rainy season. Young, fully expanded leaves with no visible damage were excised through the pulvinus, washed in running tap water, and arranged with their petioles buried in a layer of sterilized sand in plastic seed trays 56 cm long × 25 cm wide × 5 cm deep (29). The sand was moistened with Hoagland's nutrient solution (10). For entries where the leaves were too small for convenient handling in this manner, a suitable stem piece with attached leaves was used. All entries were tested at the same time, and there were five replicates for each entry arranged in a randomized block design. Leaves of a *C. personatum*-susceptible peanut cultivar, TMV 2, were included as a control. Trays were covered with clear plastic sheets and placed in plant growth chambers (Percival Refrigeration & Mfg. Co., Boone, IA) at 25 C with a 12-hr photoperiod for 24 hr before inoculation.

Inoculum of *C. personatum* from a single lesion on a susceptible cultivar in the field was produced on detached leaves of TMV 2 in a growth chamber. Conidia were harvested with a cyclone spore collector (ERI Instrument Shop, Iowa State University, Ames), suspended in sterile distilled water containing Tween 80 (0.2 ml/1,000 ml of water), and adjusted to about 1×10^5 conidia per milliliter. Trays were removed from the growth chambers, and conidial suspensions were atomized onto the leaves. Trays were again covered with plastic sheets and placed in the growth chamber. Hoagland's nutrient solution was added as required. Disease development was assessed 30 days after inoculation, and the following components of resistance were evaluated:

Infection frequency. Total lesions on all leaves were counted with a stereomicroscope. Leaf area was measured with a leaf area meter (Hayashi Denkoh Co. Ltd., Tokyo, Japan). Infection frequency was expressed as number of lesions per square centimeter of leaf area.

Percentage of defoliation. Abscinded leaflets were counted for each replicated leaf and percentage of defoliation was calculated.

Lesion diameter. Five randomly selected lesions on each leaflet were measured with an ocular micrometer.

Sporulation. Lesions were examined under a stereomicroscope (×70) and the degree of *C. personatum* sporulation was scored visually on a five-point scale, where 1 = no or very few stromata, no sporulation; 2 = few stromata, some with slight sporulation; 3 = stromata over most of lesion, moderate sporulation; 4 = stromata on the entire lesion, moderate to profuse sporulation; and 5 = dense production of stromata with profuse sporulation (27).

RESULTS AND DISCUSSION

Reactions of the standard susceptible peanut cultivar and the wild *Arachis* species to *C. personatum* are presented in Table 1. The susceptible check cultivar showed 100% defoliation, indicating that the development of *C. personatum* was satisfactory for evaluating the reactions of wild *Arachis* species against the pathogen. Infection frequency varied from 0.9 to 82.3. Several wild *Arachis* species had a higher infection frequency than the susceptible peanut cultivar (Table 1). However, lesions were small and nonsporulating on all accessions of sections *Erectoides, Triseminalae, Extranervosae, Rhizomatosae*, and *Caulorhizae*. Fifteen accessions in section *Arachis* had no sporulating lesions, nine had sparse (sporulation index 1.2–3.0)

Submitted as Journal Article No. 473 by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Accepted for publication 25 March 1985.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

sporulation, and two sporulated profusely (sporulation index 5.0). Percentage of defoliation varied from 1 to 100. Most of the wild *Arachis* species in section *Arachis* showed a high percentage of defoliation, but a high proportion of entries in section *Rhizomatosae* showed no defoliation. Although all accessions of the same species are botanically similar, reactions to *C. personatum* varied markedly among accessions. For instance, one accession (K 7988) of *A. duranensis* had a low infection frequency (eight lesions per square centimeter of leaf area) and defoliation (35%), whereas the other accession (GKBSPSc 30077) of the same species had a high infection frequency (33.3 lesions per square centimeter of leaf area) and defoliation (100%). Similar variability was also observed among accessions of other species including *A. batizocoi, A. monticola, A. paraguariensis, A. villosulicarpa, A. hagenbeckii*, and *A. glabrata* (Table 1).

Abdou et al (1) screened a number of wild *Arachis* species for resistance to *Cercospora arachidicola* and *Cercosporidium personatum* under laboratory conditions and found several immune and highly resistant species in the sections *Arachis, Erectoides, Rhizomatosae*, and *Extranervosae*. None of the entries in our investigation was immune to *C. personatum*; however, the lesions were small and nonsporulating. Abdou et al (1) reported that three accessions of *A. villosulicarpa* were immune to *C. personatum* in the United States, but in our investigation, tiny, nonsporulating lesions of *C. personatum* were observed on two accessions of *A. villosulicarpa*. An unidentified species of *Arachis* (GKP

Table 1. Reactions of wild *Arachis* species to *Cercosporidium personatum*

Section Series Species	Collector initial and number or other identity[a]	Plant inventory number (PI)	ICRISAT peanut accession number (ICG)	Components of resistance to *C. personatum*			
				Infection frequency (lesions/cm^2)	Defoliation (%)	Lesion diameter (mm)	Sporulation index[b]
Arachis							
Annuae							
A. duranensis[c]	K 7988	219823	8123	8.0	35.0	0.49	1.8
A. duranensis[c]	GKPSPSc 30069	···	8201	13.3	75.0	0.46	1.0
A. duranensis[c]	GKBSPSc 30070	···	8202	13.7	70.0	0.84	2.0
A. duranensis[c]	SKBSPSc 30074	···	8957	6.2	60.0	0.90	2.8
A. duranensis[c]	GKBSPSc 30075	···	8205	13.9	93.9	0.84	1.0
A. duranensis[c]	GKBSPSc 30061	···	8196	18.3	91.1	0.55	1.0
A. duranensis[c]	GKBSPSc 30077	···	8207	33.3	100.0	0.51	1.0
A. batizocoi	GKBSPSc 30079	···	8209	28.5	80.0	0.36	1.4
A. batizocoi	GKBSPSc 30083	···	8211	14.8	50.0	0.33	1.0
A. batizocoi	GKBSPSc 30080	···	8958	18.9	95.0	0.43	1.2
A. batizocoi	GKBSPSc 30081	···	8210	9.7	55.0	0.46	1.0
A. spegazzinii[c]	GKP 10038	262133	8138	12.7	75.0	0.79	3.0
Arachis sp.	GK 30006	···	8190	8.6	62.3	0.28	1.0
Perennes							
A. correntina[c]	K 7830	262137	8133	15.9	5.0	0.23	1.0
A. stenosperma[c]	HLK 410	338280	8126	19.4	30.0	0.16	1.0
A. chacoense[c]	GKP 10602	276235	4983	17.4	32.6	0.26	1.0
A. helodes[c]	GK 30036	···	8955	16.6	35.0	0.38	1.0
Arachis sp.	Manfredi 5	···	8918	30.6	70.0	0.62	1.8
Arachis sp.	GK 30031	···	8952	23.3	60.0	0.47	2.2
Arachis sp.	GK 30035	···	8954	6.8	60.0	0.20	1.0
Arachis sp.	GK 30017	···	8194	16.5	70.0	0.64	2.0
Arachis sp.	GKBSPScZ 30085	···	8959	8.6	50.0	0.31	1.0
Arachis sp.	GKBSPSc 35001	···	8164	6.7	40.0	0.34	1.0
Arachis sp.	GKSSc 30093	···	8212	11.9	0.0	0.21	1.0
Amphiploides							
A. monticola	HLK 104	331338	8135	33.5	33.9	1.00	5.0
A. monticola	GKBSPSc 30063	···	8198	37.1	100.0	0.68	5.0
Erectoides							
Tetrafoliolatae							
A. paraguariensis	KCF 11462	···	8130	8.8	0.0	0.22	1.0
A. paraguariensis	GKPSc 30118	···	8214	6.7	60.0	0.36	1.0
A. paraguariensis	GKPSc 30109	···	8963	15.2	90.0	0.23	1.0
Arachis sp.	GKPSc 30126	···	8215	10.5	85.0	0.22	1.0
Arachis sp.	GKPSc 30134	···	8973	8.4	0.0	0.28	1.0
Arachis sp.	GK 30016	···	8948	5.5	15.0	0.25	1.0
Arachis sp.	GK 30007	···	8191	6.5	10.0	0.26	1.0
Arachis sp.	HLKHe 565-6	388398	8141	27.7	50.0	0.32	1.0
Procumbensae							
A. appressipila[c]	GKP 10002	···	8129	19.8	5.0	0.24	1.0
Arachis sp.	GKP 9990	261877	8127	21.8	20.0	0.29	1.0
Arachis sp.	GKP 9993	261878	8128	23.5	65.0	0.34	1.0
Arachis sp.	GK 30003	···	8945	37.2	60.0	0.28	1.0
Triseminalae							
A. pusilla	GKP 12922	338449	8131	12.0	25.0	0.45	1.0
Extranervosae							
A. villosulicarpa (2n = 20)	···	···	8142	4.0	33.6	0.47	1.0
A. villosulicarpa (2n = 40)	···	···	8143	8.7	99.9	0.31	1.0
Rhizomatosae							
Eurhizomatosae							
A. burkartii	A 52	261851	···	2.0	0.0	0.09	1.0
A. hagenbeckii	HLKO 349	338305	8922	82.3	93.9	0.49	1.0
A. hagenbeckii	HL 486	338267	8146	67.3	0.0	0.30	1.0
A. glabrata	HLKHe 552	338261	8149	11.2	0.0	0.35	1.0
A. glabrata	HLKHe 553	338262	8150	42.6	0.0	0.25	1.0
A. glabrata	HLKHe 560	338263	8151	32.7	0.0	0.19	1.0

(*continued on next page*)

10596, PI 276233) in the section *Rhizomatosae* was immune to both leaf spot pathogens in the United States (1) and India (28). In our investigation, however, the same accession developed numerous tiny nonsporulating lesions. Abdou et al (1) and Nevill (17) reported that *A. chacoense* was susceptible to *C. personatum* in the United States and Nigeria, respectively, but an accession of this species was resistant in India (28). Nevill (17) did not observe any *C. personatum* lesions on *A. stenosperma* (HLK 410) in Nigeria, but in our investigation, minute nonsporulating lesions developed on the same species.

These differences in disease reaction may be associated with variability of the pathogen; interaction between the host, pathogen, and environment; preinoculation environment; or incorrect identification of or variation within the host species. The differences may also be due to variation in methods of evaluation and in interpretation of results. Some of the previous observations were made on plants in field plots or on potted plants exposed to natural inoculum. This led to problems in identifying the agent or agents responsible for lesions on leaflets when the lesions did not have fructification. Hence we decided to use a laboratory screening technique in this study.

The reason for examining the reactions of wild *Arachis* species to *C. personatum* is that we hope to transfer many useful characters from them to the cultivated peanut, especially resistance to *C. arachidicola* and *C. personatum*. It is important to determine the reaction of each accession of each species to these

Table 1. (*continued from preceding page*)

Section Series Species	Collector initial and number or other identity[a]	Plant inventory number (PI)	ICRISAT peanut accession number (ICG)	Components of resistance to *C. personatum*			
				Infection frequency (lesions/cm^2)	Defoliation (%)	Lesion diameter (mm)	Sporulation index[b]
A. glabrata	HLKHe 571	338265	8153	49.0	0.0	0.23	1.0
A. glabrata	GKP 9827	262796	8935	34.0	0.0	0.25	1.0
A. glabrata	GKP 9830	262797	8936	16.4	20.0	0.30	1.0
A. glabrata	HL 489	338257	8147	50.1	5.0	0.25	1.0
A. glabrata	HL 489	338257	...	44.7	0.0	0.24	1.0
A. glabrata	GK 30020	...	8950	2.3	0.0	0.08	1.0
A. glabrata	...	231318	8178	75.7	0.0	0.26	1.0
A. glabrata	GKPSc 30116	...	8966	5.3	0.0	0.12	1.0
A. glabrata	GKPSc 30138	...	8975	2.2	0.0	0.08	1.0
A. glabrata	GKPSc 30120	...	8968	0.9	0.0	0.08	1.0
A. glabrata	GKPSc 30122	...	8969	1.6	0.0	0.08	1.0
A. glabrata	GKP 9649	262844	8165	16.4	0.0	0.17	1.0
A. glabrata	GKP 9834	262798	8170	70.4	0.0	0.48	1.0
A. glabrata	GKP 9882	262286	8171	78.6	15.0	0.31	1.0
A. glabrata	GKP 10596	276233	4984	49.4	35.0	0.22	1.0
A. glabrata	GKP 9893	...	8938	3.2	15.0	0.39	1.0
Arachis sp.	HLKHe 569	...	8924	3.7	0.0	0.08	1.0
Arachis sp.	GKPSc 30135	...	8974	6.8	0.0	0.12	1.0
Arachis sp.	GKPSc 30111	...	8964	5.2	5.0	0.08	1.0
Arachis sp.	GKPSc 30132	...	8972	8.1	0.0	0.15	1.0
Arachis sp.	HLO 333	338316	8145	37.4	0.0	0.21	1.0
Arachis sp.	HL 492	338284	8148	27.2	5.0	0.27	1.0
Arachis sp.	HLKHe 567	338299	8152	34.5	0.0	0.18	1.0
Arachis sp.	K 7934	201856	8154	53.4	15.0	0.68	1.0
Arachis sp.	GKP 9566	262812	8155	25.9	0.0	0.32	1.0
Arachis sp.	GKP 9567	262818	8156	43.9	0.0	0.21	1.0
Arachis sp.	GKP 9580	262825	8158	40.0	0.0	0.24	1.0
Arachis sp.	GKP 9592	262828	8159	64.8	15.0	0.22	1.0
Arachis sp.	GKP 9618	...	8160	48.7	0.0	0.22	1.0
Arachis sp.	GKP 9634	262836	8161	28.2	0.4	0.20	1.0
Arachis sp.	GKP 9645	262841	8162	67.7	20.0	0.27	1.0
Arachis sp.	GKP 9667	262848	8166	62.7	0.0	0.33	1.0
Arachis sp.	GKP 9797	262808	8933	38.9	10.0	0.18	1.0
Arachis sp.	GKP 9806	262792	8167	34.3	85.0	0.19	1.0
Arachis sp.	GKP 9813	262793	8168	32.6	0.0	0.35	1.0
Arachis sp.	GKP 9935	262301	8941	40.0	56.4	0.20	1.0
Arachis sp.	GKP 9553	262801	8925	16.2	10.0	0.26	1.0
Arachis sp.	GKP 10120 P1.1	276202	8943	22.8	0.0	0.39	1.0
Arachis sp.	GKP 9574	262820	8927	40.8	0.0	0.27	1.0
Arachis sp.	GKP 9921	262296	8939	39.6	100.0	0.22	1.0
Arachis sp.	GKP 10120 P1.2	276202	8944	63.4	69.4	0.24	1.0
Arachis sp.	(1960)	...	8172	42.6	35.0	0.30	1.0
Arachis sp.	2A5	...	8916	1.5	0.0	0.10	1.0
Arachis sp.[d]	Ex. Coimbatore	...	8903	3.1	0.0	0.09	1.0
Caulorhizae							
A. repens	210	...	8187	22.3	0.0	0.15	1.0
Not known							
Arachis sp.[c]	Ex. Dharwar	...	8189	36.1	10.0	0.38	1.0
Arachis sp.	2A2	...	8180	2.8	15.0	0.12	1.0
Arachis sp.	2A1	...	8179	1.0	0.0	0.13	1.0
Arachis sp.	2A7	...	8183	4.0	5.0	0.09	1.0
Control							
A. hypogaea	TMV 2	...	221	19.1	100.0	1.96	5.0
SE ±				12.64	22.82	0.087	0.16
C.V. (%)				52.50	84.80	28.200	13.80

[a] Collector names: A = Arriola, B = Banks, C = Coradin, F = Fugarazzo, G = Gregory, H = Hammons, He = Hemsy, K = Krapovickas, L = Langford, O = Ojeda, P = Pietrarelli, S = Simpson, Sc = Schinini, and Z = Zurita.

[b] Extent of sporulation scored on a five-point scale, where 1 = no sporulation and 5 = extensive sporulation.

[c] *Nomen nudum.*

[d] *Arachis* sp. received as *A. marginata* from Tamil Nadu Agriculture University, Coimbatore, India, is a Rhizomatous species.

[e] *Arachis* sp. received as *A. prostrata* from Tamil Nadu Agriculture University, Coimbatore, India, is yet to be identified.

important pathogens. Most attention is now concentrated on the species in section *Arachis* because these are cross-compatible with *A. hypogaea* (5,16, 20,21,24,25). It is evident that there is a considerable variation among the species in section *Arachis* in components of resistance to *C. personatum* examined in this study. The choice of parents from wild *Arachis* species for interspecific hybridization should be based on knowledge of components of resistance to *C. personatum*. For example, in spite of high infection frequency and defoliation, accessions with small non-sporulating lesions are also useful in developing peanut cultivars with resistance to *C. personatum*.

LITERATURE CITED

1. Abdou, Y. A.-M., Gregory, W. C., and Cooper, W. E. 1974. Sources and nature of resistance to *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curtis) Deighton in *Arachis* species. Peanut Sci. 1:6-11.
2. Coffelt, T. A., Porter, D. M., Smith, J. C., and Garren, K. H. 1977. Reaction of 45 peanut (*Arachis hypogaea* L.) lines to 5 fungal and insect pathogens. (Abstr.) Proc. Am. Peanut Res. Educ. Assoc. Inc. 9:33.
3. Company, M., Stalker, H. T., and Wynne, J. C. 1982. Cytology and leafspot resistance in *Arachis hypogaea* × wild species hybrids. Euphytica 31:885-893.
4. Foster, D. J., Stalker, H. T., Wynne, J. C., and Beute, M. K. 1981. Resistance of *Arachis hypogaea* L. and wild relatives to *Cercospora arachidicola* Hori. Oleagineux 36:139-143.
5. Gardner, M. E. B., and Stalker, H. T. 1983. Cytology and leafspot resistance of section *Arachis* amphiploids and their hybrids with *Arachis hypogaea*. Crop Sci. 23:1069-1074.
6. Gibbons, R. W. 1980. Peanut improvement research technology for semi-arid tropics. Pages 27-37 in: Proceedings of the International Symposium on Development and Transfer of Technology for Rainfed Agriculture and the SAT Farmer. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), Patancheru, A.P., India.
7. Gibbons, R. W., and Bailey, B. E. 1967. Resistance to *Cercospora arachidicola* in some species of *Arachis*. Rhodesia, Zambia, Malawi Agric. J. 5:57-59.
8. Gorbet, D. W., Shokes, F. M., and Norden, A. J. 1983. Relative value of certain plant introductions as parents in leafspot resistance breeding. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. Inc. 15:75.
9. Hassan, H. N., and Beute, M. K. 1977. Evaluation of resistance to Cercospora leafspots in peanut germplasm potentially useful in a breeding program. Peanut Sci. 4:78-83.
10. Hoagland, D. R., and Arnon, D. I. 1950. The water culture method for growing plants without soil. Calif. Agric. Exp. Circ. 347.
11. Jackson, C. R., and Bell, D. K. 1969. Diseases of peanut (groundnut) caused by fungi. Univ. Ga. Exp. Stn. Res. Bull. 56.
12. Melouk, H. A., and Banks, D. J. 1978. A method of screening peanut genotypes for resistance to Cercospora leafspot. Peanut Sci. 5:112-114.
13. Melouk, H. A., Banks, D. J., and Fanous, M. A. 1984. Assessment of resistance to *Cercospora arachidicola* in peanut genotypes in field plots. Plant Dis. 68:395-397.
14. Monasterios, T., Jackson, L. F., and Norden, A. J. 1978. Reaction of peanut *Arachis hypogaea* L. genotypes to two Cercospora leafspot diseases. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. Inc. 10:64.
15. Moraes, S. A., and Godoy, I. J. 1985. Diferentes neveis de resistencia a *Cercosporidium personatum* em genotipos de *Arachis hypogaea*. Summa Phytopathol. 11:74-86.
16. Moss, J. P. 1980. Wild species in the improvement of peanuts. Pages 525-535 in: Advances in Legume Science. R. J. Summerfield and A. H. Bunting, eds. Proc. Int. Legume Conf., Kew, England.
17. Nevill, D. J. 1979. An investigation of disease reaction to *Cercosporidium personatum* in *Arachis hypogaea*. Trop. Grain Legume Bull. 15:18-22.
18. Porter, D. M., Smith, D. H., and Rodriguez-Kabana, R. 1982. Peanut plant diseases. Pages 326-410 in: Peanut Science and Technology. H. E. Pattee and C. T. Young, eds. American Peanut Research and Education Society, Inc., Yoakum, TX.
19. Sharief, Y., Rawlings, J. O., and Gregory, W. C. 1978. Estimates of leafspot resistance in three interspecific hybrids of *Arachis*. Euphytica 27:741-751.
20. Simpson, C. E., Smith, D. H., Higgins, W. H., Woodard, K. E., Jr., and Higgins, D. L. 1983. Introgression of leafspot resistance into *Arachis hypogaea* L. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. Inc. 15:78.
21. Singh, A. K., Sastry, D. C., and Moss, J. P. 1980. Utilization of wild *Arachis* species at ICRISAT. Pages 82-90 in: Proceedings of the International Workshop on Groundnuts. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), Patancheru, A.P., India.
22. Smith, D. H. 1979. Disease resistance in peanuts. Pages 431-447 in: Biology and Breeding for Resistance to Arthropods and Pathogens in Agricultural Plants. M. K. Harris, ed. Proc. Int. Short Course in Host Plant Resistance. Texas A&M University, College Station.
23. Sowell, G., Smith, D. H., and Hammons, R. O. 1976. Resistance of peanut plant introductions to *Cercospora arachidicola*. Plant Dis. Rep. 60:494-498.
24. Stalker, H. T. 1984. Utilizing *Arachis cardenasii* as a source of Cercospora leafspot resistance for peanut improvement. Euphytica 33:529-538.
25. Stalker, H. T., and Wynne, J. C. 1979. Interspecific hybridization between cultivated and wild peanut species. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. Inc. 11:55.
26. Subrahmanyam, P., Hammons, R. O., Nigam, S. N., McDonald, D., Gibbons, R. W., Fan, M.-Y., and Yeh, W.-L. 1983. International cooperative screening for resistance of peanut to rust and late leafspot. Plant Dis. 67:1108-1111.
27. Subrahmanyam, P., McDonald, D., Gibbons, R. W., Nigam, S. N., and Nevill, D. J. 1982. Resistance to rust and late leafspot diseases in some genotypes of *Arachis hypogaea*. Peanut Sci. 9:6-10.
28. Subrahmanyam, P., Mehan, V. K., Nevill, D. J., and McDonald, D. 1980. Research on fungal diseases of peanut at ICRISAT. Pages 193-198 in: Proceedings of the International Workshop on Groundnuts. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), Patancheru, A.P., India.
29. Subrahmanyam, P., Moss, J. P., and Rao, V. R. 1983. Resistance to peanut rust in wild *Arachis* species. Plant Dis. 67:209-212.