Resistance to Peanut Rust in Wild *Arachis* Species

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ABSTRACT

Subrahmanyam, P., Moss, J. P., and Rao, V. R. 1983. Resistance to peanut rust in wild *Arachis* species. Plant Disease 67:209-212.

Sixty-one accessions of wild species, representing five sections of the genus *Arachis,* were tested under field and laboratory conditions for reaction to peanut rust (*Puccinia arachidis*). Most of them were immune, six were highly resistant, and two were susceptible to the pathogen. Immunity to peanut rust occurred in all sections, but susceptibility occurred in only one of the five sections represented and in one species of a section of unknown affinity in the genus.

Rust caused by *Puccinia arachidis* Speg. is an important disease of peanut (*Arachis hypogaea* L.) on a world scale (2,7,22). Peanut rust can be controlled by certain fungicides (17), but these are not readily available to small-scale farmers in the semiarid tropics, and even if available, their use might not be economical under prevailing conditions. An alternative solution to chemical control is to provide farmers with seed of cultivars resistant to peanut rust.

In recent years, there has been intensive screening of peanut germ plasm for peanut rust resistance, and several lines with good resistance to rust have been found (3,4,7,9,16,19–21); however, these may still represent a narrow genetic base that could be improved by the discovery of additional genes for resistance to peanut rust. Wild species are a good source for widening the genetic base of cultivated plants.

The genus *Arachis,* which consists of 22 described and 40 or more species that have not been formally described and named (12), is confined to a region east of the Andes, south of the Amazon, and north of the La Plata River in South America. The genus has been subdivided into seven sections, some of which are further split into series (5). Wild *Arachis* species have been considered as possible sources of resistance to peanut rust; some species have been reported immune and some highly resistant (3,7,21). Cytogenetic research aimed at incorporating rust resistance and other useful characters from wild *Arachis* species into *A. hypogaea* is in progress in several research institutions (10,15,18).

A collection of wild *Arachis* species has been assembled at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India. This paper reports the results of screening some of these for resistance to peanut rust.

MATERIALS AND METHODS

Wild *Arachis* species. Accessions of wild *Arachis* species (Table 1) were received as seed or branch cuttings, mostly from North Carolina State University, Raleigh; University of Oklahoma, Stillwater; USDA-ARS, Crops Research Unit, Tifton, GA; and Texas A&M University, Research and Extension Centre, Stephenville, in the United States. Two accessions, ICG 8142 and ICG 8937, were received from Tamil Nadu Agricultural University, Coimbatore, India. ICG 8937 was received as *A. marginata,* but it is a rhizomatous species and thus is not *A. marginata.* Accessions are identified by collector and collector numbers, USDA Plant Introduction (PI) numbers, and ICRISAT (ICG) numbers. Many accessions have not yet been fully described.

Field screening. At least five plants of each accession were tested for their reaction to peanut rust under field conditions during the 1980 rainy season at ICRISAT. There were many rust-susceptible peanut germ plasm lines growing adjacent to the test material, and there was severe development of rust on all of them. The reactions of test entries were classified as follows: immune = no rust disease symptoms, highly resistant = very small necrotic lesions formed but no production of pustules or urediniospores, and susceptible = typical peanut rust pustules with urediniospores.

The test entries were again grown in the open in the 1981 rainy season in round concrete tanks (60 cm diam., 75 cm deep) containing a mixture of garden soil, sand, and farmyard manure (3:3:1, v/v/v). The leaves of each plant were carefully

Submitted as Journal Article No. 216 by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Accepted for publication 10 July 1982.

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.

0191-2917/83/02020904/$03.00/0

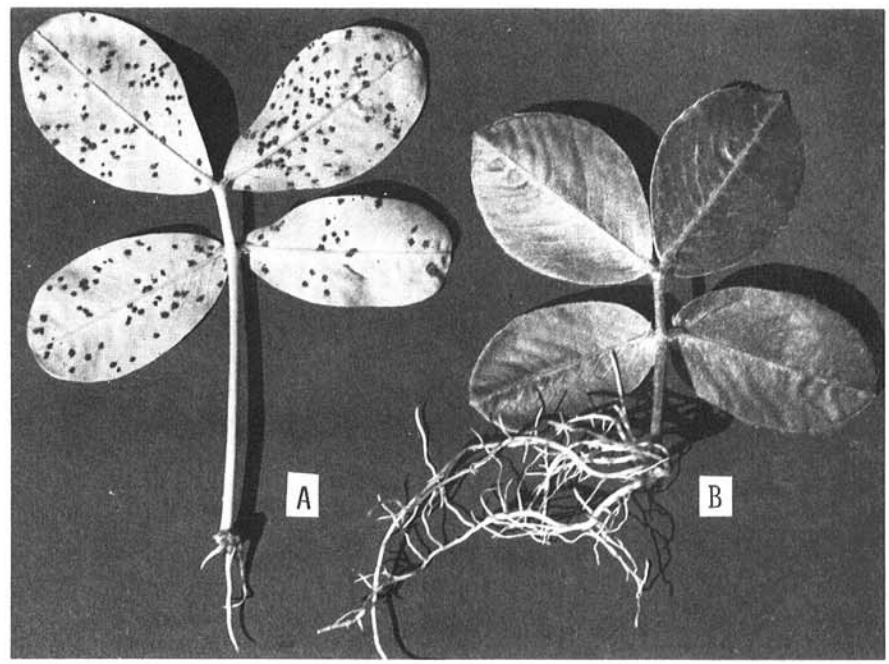

Fig. 1. *Arachis hypogaea* cv. TMV 2 showing susceptible reaction **(A)** and *A. batizocoi* (PI 298639) showing immune reaction **(B)** to *Puccinia arachidis.*

examined and scored as immune, highly resistant, or susceptible. Susceptible peanut cultivars grown in the same area developed severe rust symptoms.

Laboratory screening. Mature, undamaged leaves of each test entry were excised through the pulvinus, washed in running tap water, and arranged with their petioles buried in a layer of sterilized river sand in plastic seed trays (56 cm long × 25 cm wide × 5 cm deep). The sand was moistened with Hoagland's nutrient solution (8). Five leaves of each of four test entries and one rust-susceptible peanut cultivar, TMV 2, for a control, were placed in each tray. For entries where the leaves were too small for convenient handling in this manner, a suitable stem piece with leaves attached was used. Trays were covered with clear plastic sheets and placed in Percival plant growth chambers (Percival Co., Boone, IA), adjusted to 25 C and a 12-hr photoperiod, for 24 hr.

Inoculum of *P. arachidis* was multiplied on rooted, detached leaves of TMV 2. Urediniospores were collected with a cyclone spore collector (ERI Instrument Shop, Iowa State University of Science and Technology, Ames). Suspensions of urediniospores were prepared in sterile distilled water containing the wetting agent Tween 80 (0.2 ml/1,000 ml of water). The inoculum was adjusted to a concentration of approximately 100,000 urediniospores per milliliter.

Trays were removed from growth chambers, and spore suspensions were atomized over the leaves. Trays were again covered with the clear plastic sheet and replaced in the growth chamber. Hoagland's nutrient solution was added to the sand, as required, to maintain sufficient moisture for root growth and development of rust. The rooted, detached leaves were examined for rust reaction 20 and 40 days after inoculation. Entries were rated as immune, highly resistant, or susceptible to peanut rust.

RESULTS AND DISCUSSION

The *Arachis* species tested and their reactions to peanut rust in the laboratory-inoculation trial are shown in Table 1. Reactions to peanut rust in the laboratory were the same as those observed in the field. Evaluation of species for disease reaction was simpler in the laboratory than in the field, where the situation was complicated by attacks of *Leptosphaerulina crassiasca* Sechet., *Myrothecium roridum* Tode ex Fr. and *Colletotrichum* spp.

All leaves of the susceptible TMV 2 showed severe development of rust pustules (Fig. 1A). Most of the wild *Arachis* spp. were immune to peanut rust, with no recognizable symptoms of the disease appearing even after incubation for 40 days (Fig. 1B). Previous research with a limited number of wild *Arachis* spp. had shown that urediniospores

Table 1. Reaction of wild *Arachis* species to *Puccinia arachidis* in the laboratory-inoculation trial at ICRISAT, Hyderabad, India

Section Series Species	Collector initial and number or other identity[a]	Plant introduction number (PI)	ICRISAT groundnut accession number (ICG)	Synonyms[b]	Rust reaction[c]
Arachis					
Annuae					
A. batizocoi	K 9484	298639	8124	HLP 207/PI 338312	I
A. duranensis[d]	K 7988	219823	8123	···	I
A. spegazzinii[d]	GKP 10038	262133	8138 8139[f]	···	I
Perenne					
A. correntina[d]	HL 176	331194	4984	GKP 9584	I
A. correntina[d]	K 7987	262134	8134	PI 298635	I
A. correntina[d]	GKP 9530	262808	8132	···	I
A. correntina[d]	GKP 9531	262809	8140	GKP 9530/PI 262880	I
A. stenosperma[d]	HLK 410	338280	8126	HLK 411/PI 337309	HR
A. stenosperma[d]	HLK 408	338279	8125	HLK 409/PI 337308	HR
A. stenosperma[d]	HLK 409	337308	8137	HLK 408/PI 338279	HR
A. cardenasii[d]	GKP 10017	262141	8216	···	I
A. chacoense[d]	GKP 10602	276235	4983	···	I
A. villosa	···	210554	8144	···	I
Arachis sp.[e]	···	···	8918	Manfredi-5	I
Amphiploides					
A. monticola	HLK 104	331338	8135	PI 219824/PI 263393	S
Not known					
Arachis sp.	GK 30006	···	8190	···	I
Arachis sp.	GK 30011	···	8193	···	I
Arachis sp.	GK 30031	···	8952	···	HR
Arachis sp.	GK 30035	···	8954	···	HR
Erectoides					
Tetrafoliate					
A. apressipila[d]	GKP 10002	···	8129	···	I
A. paraguariensis	KCF 11462	···	8130	HLK 331/PI 337358	I
Arachis sp.	GKP 9990	261877	8127	···	I
Arachis sp.	GKP 9993	261878	8128	···	I
Triseminale					
A. pusilla	GKP 12922	338449	8131	···	I
Extranervosae					
A. villosulicarpa		···	8142	···	I
Rhizomatosae					
Eurhizomatosae					
A. hagenbeckii	HLKO 349	338305	8922	···	I
A. hagenbeckii	HL 486	338267	8146	361	I
A. glabrata	HLKHe 552	338261	8149	···	I
A. glabrata	HLKHe 553	338262	8150	···	I
A. glabrata	HLKHe 560	338263	8151	···	I
A. glabrata	HLKHe 571	338265	8153	···	I
A. glabrata	GKP 9827	262796	8935	···	I
A. glabrata	GKP 9830	262797	8936	···	I
A. glabrata	···	···	8902	···	I
Arachis sp.	HLO 333	338316	8145	···	I
Arachis sp.	HL 492	338284	8148	···	I
Arachis sp.	HLKHe 567	338299	8152	···	I
Arachis sp.	K 7934	201856	8154	PI 298638	I
Arachis sp.	GKP 9566	262812	8155	···	I
Arachis sp.	GKP 9567	262818	8156	···	I
Arachis sp.	GKP 9580	262825	8158	···	I
Arachis sp.	GKP 9591	262827	8929	···	I
Arachis sp.	GKP 9592	262828	8159	···	I
Arachis sp.	GKP 9618	···	8160	···	I
Arachis sp.	GKP 9634	262836	8161	···	I
Arachis sp.	GKP 9645	262841	8162	···	I
Arachis sp.	GKP 9649	262844	8165	···	I
Arachis sp.	GKP 9667	262848	8166	···	I
Arachis sp.	GKP 9797	262807	8933	···	I
Arachis sp.	GKP 9806	262792	8167	···	I
Arachis sp.	GKP 9813	262793	8168	···	I
Arachis sp.	GKP 9834	262798	8170	···	I
Arachis sp.	GKP 9882	262286	8171	···	I
Arachis sp.	GKP 9935	262301	8941	···	I
Arachis sp.	GKP 10596	276233	4984	···	I
Arachis sp.	···	···	8937	···	I
Arachis sp.	GKP 9893	···	···	···	HR

(continued on next page)

Table 1. (*continued from preceding page*)

Section Series Species	Collector initial and number or other identity[a]	Plant introduction number (PI)	ICRISAT groundnut accession number (ICG)	Synonyms[b]	Rust reaction[c]
Not known					
Arachis sp.	(1960)		8172	...	I
Arachis sp.	GKBSPSc30063		8198	...	S
Arachis sp.	GKBSPScZ 30085		8959	...	I
Arachis sp.	(2A5)		8916	...	I
Control					
A. hypogaea	cv. TMV 2		221	...	S

[a]Collector names; B = Banks, F = Fugarazzo, G = Gregory, H = Hammons, He = Hemsy, K = Krapovickas, L = Langford, O = Ojeda, P = Pietrarelli, S = Simpson, Sc = Schinini, Z = Zurita.
[b]Accessions that have been reported identical for taxonomic, morphological or other reasons.
[c]I (immune) = No rust disease symptoms; HR (highly resistant) = very small necrotic lesions formed but no production of pustules or uridiniospores; S (susceptible) = many typical peanut rust pustules with uridiniospores.
[d]*Nomen nudum*
[e]A hybrid between *A. correntina* and *A. villosa*.
[f]Accessions with small and large leaflets (ICG 8138, 8139, respectively) but have the same reaction to peanut rust.

Table 2. Previously reported rust reactions of some wild *Arachis* species

Section Species	Plant introduction number (PI)	Rust reaction[a]	Reference
Rhizomatosae			
A. glabrata	118457, 231318, 262287, 262141, 262801	Immune	3
A. glabrata[b]		Susceptible	1
Arachis			
A. monticola	263393	Resistant	3
	405933	Susceptible	7
A. nambyquarae[c]		Susceptible	23
Extranervosae			
A. villosulicarpa	336985	Immune	7
A. prostrata		Susceptible	23
A. marginata[d]		Susceptible	6

[a]Immune = no rust disease symptoms; resistant = very few, small weakly sporulating pustules; and susceptible = many typical peanut rust pustules with profuse sporulation.
[b]Specimens collected by W. A. Archer and A. Gehrt in Brazil, deposited in the National Fungus Herbarium, Plant Industry Station, Beltsville, MD, showed uredinia and telia of the peanut fungus, *Puccinia arachidis*.
[c]A form of *A. hypogaea* that is no longer considered a wild species.
[d]Specimens collected by A. M. Guarch in Uruguay showed peanut rust in the telial state only.

germinated normally on leaves of immune species and that germ tubes entered the leaves via the stomata, but that the germ tubes died without infecting the leaf tissues (11,21).

The accessions of *A. stenosperma* (HLK 410, HLK 408, and HLK 409—collected from the same locality) and *Arachis* sp. (GK 30031, GK 30035, and GKP 9893) showed only small necrotic lesions after inoculation, and no further rust development occurred. This is regarded as a hypersensitive reaction.

A. monticola (HLK 104) and *Arachis* sp. (GKBSPSc 30063) developed typical large, elevated urediniosori that showed profuse sporulation. Incubation period and infection frequency were similar to that of the rust-susceptible check cultivar, TMV 2.

Results of previous reports on the reaction of certain wild *Arachis* species to *P. arachidis* are summarized in Table 2; some of these *Arachis* species were also included in our investigation. Five accessions of *A. glabrata* were found immune in greenhouse inoculation trials with two isolates of *P. arachidis* from Texas and Puerto Rico (3); however, rust was observed on the same species collected in Brazil (1). In our tests, all accessions of *A. glabrata* were immune to rust. One accession of *A. monticola* (PI 263393) showed only small, weakly sporulating lesions (3); however, another accession (PI 405933) of the same species was killed by rust attack in the United States (7). In our investigation, the only accession of *A. monticola* tested was found susceptible. Some of these differences could be due to variation in the pathogen; to interaction between host, pathogen, and environment; or to confusion in identification of, or variation within, the host species. The latter is a possibility for *A. monticola* accessions because this species crosses freely with *A. hypogaea* and may not maintain its identity in collections. Bromfield and Cevario (3) give PI 262141 for *A. glabrata,* but Gregory et al (5) cite this PI number as *A. cardenasii* in section *Arachis*.

From Tables 1 and 2, it is evident that some of the wild *Arachis* species are immune or highly resistant to peanut rust and thus are important for interspecific hybridization to transfer resistance to the cultivated peanut. *Arachis hypogaea* can readily be crossed only with species in section *Arachis* (10,13). Hybrids have been produced between *A. hypogaea* and two accessions of wild *Arachis* in section *Rhizomatosae* by hormone treatments and embryo culture (13,14). Attempts are being made to use species that are resistant and immune to *P. arachidis* as practical sources of resistance to rust. They may have mechanisms of resistance to rust that are different from those in *A. hypogaea,* thus providing the possibility of combining the rust resistance of wild and cultivated species to give more effective and stable resistance in the cultivated peanut.

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