# Resistance of Wild *Arachis* Species to Late Leaf Spot and Rust in Greenhouse Trials

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**ABSTRACT**

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Seventy-four accessions of wild *Arachis* species along with a susceptible line TMV 2 belonging to *A. hypogaea* were evaluated for resistance to late leaf spot and rust under greenhouse environment. The experiment was conducted twice to confirm the resistance of the accessions. Percentage of leaf area damaged and disease score on a 1 to 9 scale for late leaf spot and rust were recorded for all accessions in both experiments. Additionally, percentage of defoliation was recorded for late leaf spot. One accession, ICG 8190, of *A. hoehnei* and one accession, ICG 13199, of *A. duranensis* were asymptomatic to late leaf spot in both experiments. In addition, 26 accessions were classified as resistant, 10 accessions were moderately resistant, and the remaining 36 accessions exhibited a susceptible reaction to late leaf spot. Only one accession, ICG 8954 of *A. kuhlmannii,* remained asymptomatic to rust in both experiments. All other accessions, except ICG 8206 of *A. ipaensis*, ICG 8197, ICG 8198, ICG 11549, and ICG 13178 of *A. monticola*, and ICG 13171 of *A. stenosperma* were classified as highly resistant to rust. Four accessions of *A. monticola* were susceptible to late leaf spot and rust.

Late leaf spot (LLS) caused by *Phaeoisariopsis personata* ((Berk. & M.A. Curtis) Arx) = *Cercosporidium personatum* ((Berk. & M.A. Curtis) Deighton) and rust caused by *Puccinia arachidis* Speg. are economically important diseases of cultivated peanut, *Arachis hypogaea* L. (called groundnut in much of the world), throughout the world (3,9,11,26). In most areas, both diseases occur together, but the incidence and severity of each disease vary with environment, location, and cultivar. Both diseases cause yield losses over 50% if susceptible cultivars are not protected with chemicals (2,14,20,26). Although effective chemical control methods are available, their applications are limited because of high costs and possible existence of fungicide-tolerant strains of the pathogens (5,12). Hence disease-resistant cultivars are the best way to control these diseases (13,17).

*Arachis* spp. have been screened successfully for resistance to late leaf spot and rust by many workers. A number of resistant sources have been reported in cultivated peanuts (1,10,15,22,23), but high levels of resistance to these diseases are not available. Wild *Arachis* species have been considered as potential sources of resistance to various diseases of groundnut (8,19,21). In recent years, wild *Arachis* species have been screened for late leaf spot and rust resistance. High levels of resistance have been identified (1,7,15,18,22). The world collection of wild *Arachis* species is available at the Genetic Resources Unit (GRU) of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. Species compatible for crosses with *A. hypogaea* were screened for resistance to these diseases. This paper reports the results of screening of these wild *Arachis* species for resistance to late leaf spot and rust.

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## MATERIALS AND METHODS

**Wild *Arachis* species.** Seventy-four wild *Arachis* species belonging to *A. duranensis* (44 accessions), *A. stenosperma* (8 accessions), *A. monticola* (4 accessions), *A. cardenasii* (3 accessions), *A. batizogaea, A. hoehnei, A. kuhlmannii* (2 accessions each), *A. benensis, A. chiquitana, A. decora, A. ipaensis, A. kempff-Mercadoi, A. kretschmeri, A. magna, A. valida, A. villosa* (1 accession each), and a susceptible check TMV 2 belonging to *A. hypogaea* L. were screened separately for resistance to late leaf spot and rust. These trials were conducted in the greenhouse during the 1998 and 1999 rainy seasons at ICRISAT.

**Greenhouse screening.** Five seeds of each accession were sown in 15-cm-diameter plastic pots containing autoclaved Alfisol and manure (4:1). Three healthy plants were retained in each pot after germination. The experiment was arranged on greenhouse benches in a randomized complete block design with three replications. When plants were 35 days old, one set of plants was inoculated with a spore suspension of *P. personata* and another set with *P. arachidis* using an atomizer. Inocula of *P. personata* and *P. arachidis* were maintained separately on the incubated, inoculated detached leaves of the cultivar TMV 2 in a Percival plant growth chamber using a temperature of 23°C and a 12-h photoperiod. Conidia of *P. personata* and urediniospores of *P. arachidis* were harvested with a cyclone spore collector. The concentration of the inoculum of *P. personata* was 20,000 conidia per milliliter and of *P. arachidis* was 20,000 urediniospores per milliliter. A few drops of the surfactant Tween 80 (polyoxyethylene sorbitan mono-oleate) were added. Immediately after inoculation, plants were placed in a dew chamber (6) at 23°C to ensure wetness of the leaf surface during the night. Plants were removed from the dew chamber the next morning and returned to the greenhouse during the day. The alternating wet (16 h) and dry (8 h) period treatments (4) were repeated for 10 days. Plants were then held in the greenhouse until the end of the experiment. Care was taken to avoid cross-contamination between the two test pathogens. The experiment was terminated 50 days after inoculation. The minimum and maximum temperatures in the greenhouse during the period of the experiment were 18 to 24°C and 26 to 32°C in both years.

Two healthy and fully expanded quadrifoliate leaves on the main stem of each plant and two plants in each pot (each replication) were labeled for assessing percentage of leaf area infected. Percentage of defoliation also was recorded for late leaf spot. The leaf area damaged by late leaf spot and rust was assessed by comparing each leaf with standard diagrams depicting leaves with known percentages of leaf area affected (10). The number of defoliated leaflets of the labeled leaves on the main stem were counted at each assessment. Percentage of defoliation was calculated based on total and defoliated leaflets. Disease assessment was scored on a 1 to 9 rating scale based on the whole plants in each pot (replication). Data were collected at 5-day intervals from 10 days after inoculation. Maximum disease incidence was

observed 20 days after inoculation for late leaf spot and 40 days after inoculation for rust; hence these assessments were used for analysis and interpretations.

**Data analysis.** Data of all the parameters for each disease were analyzed using restricted maximum likelihood (REML) analysis (16) assuming accessions effects as fixed. Wald test, which follows an approximate chi-square distribution, was used to test the overall significance of differences among accessions at a 5% level of significance. Least significant difference (LSD) at the 5% level of significance was used to test differences among accessions. All computations were carried out using Genstat 5 statistical package.

## RESULTS

**Late leaf spot.** *Percentage of leaf area damage.* Accessions differed significantly ($P < 0.001$) for percentage of leaf area damaged by late leaf spot. Damage was significantly less on accessions than on the susceptible cultivar TMV 2 in both experiments (Table 1). Two accessions, ICG 8190 belonging to *A. hoehnei*, and ICG 13199 belonging to *A. duranensis*, had no leaf area damaged in either experiment. Twenty-four accessions from *A. duranensis,* six accessions from *A. stenosperma*, and one accession each of *A. batizogaea* (ICG 13208), *A. benensis* (ICG 11551), *A. cardenasii* (ICG 8216), *A. chiquitana* (ICG 11560), *A. decora* (ICG 14939), *A. ipaensis* (ICG 8206), *A. kempff-Mercadoi* (ICG 8959), *A. kretschmeri* (ICG 8191), *A. kuhlmannii* (ICG 8954), *A. magna* (ICG 8960), *A. valida* (ICG 11548), and *A. villosa* (ICG 8144) had <3% leaf area damaged (Table 1). Eleven accessions from *A. duranensis,* two accessions from *A. stenosperma* (ICG 13173, ICG 13233), and one accession from *A. kuhlmannii* (ICG 15144) had >3 to 5% mean leaf area damaged. Other accessions had >5% leaf area damaged in both experiments. All four accessions, ICG 8197, ICG 8198, ICG 11549, and ICG 13178, of *A. monticola* had >5% leaf area damaged in both experiments (Table 1).

*Percentage of defoliation.* Highly significant differences ($P < 0.001$) in defoliation were observed among the *Arachis* accessions in both experiments. Percentage of defoliation was significantly greater for the susceptible TMV 2 than for most of the *Arachis* accessions (Table 1). A few accessions of *A. batizogaea, A. cardenasii*, *A. duranensis,* and *A. monticola* had a greater amount of defoliation at 20 days after inoculation than the susceptible cultivar TMV 2. Two accessions, ICG 13161 and ICG 13199, of *A. duranensis*; both accessions, ICG 8954 and ICG 15144, of *A. kuhlmannii*; two accessions, ICG 8137 and ICG 8906, of *A. stenosperma*; and one accession each of *A. cardenasii* (ICG 8216), *A. decora* (ICG 14939), *A. hoehnei* (ICG 8190), *A. ipaensis* (ICG 8206), *A. kempff-Mercadoi* (ICG 8959), *A. magna* (ICG 8960), and *A. valida* (ICG 11548) were not defoliated. Only one accession, ICG 11551, of *A. benensis*; six accessions, ICG 8138, ICG 8196, ICG 11555, ICG 13202, ICG 13205, and ICG 13242, of *A.*

**Table 1.** Percentage of leaf area damaged, percentage of defoliation, and disease score on a 1 to 9 rating scale of wild *Arachis* species to late leaf spot caused by *Phaeoisariopsis personata* in the greenhouse environment during 1998 and 1999 at ICRISAT**,** India

| ICRISAT accession (ICG No.) | *Arachis* species | Leaf area damage (%)[a] | | Defoliation (%)[b] | | Disease score[c] | |
|---|---|---|---|---|---|---|---|
| | | 1998 | 1999 | 1998 | 1999 | 1998 | 1999 |
| 8123 | *A. duranensis* | 5.0 | 5.5 | 62.5 | 50.0 | 4.7 | 4.7 |
| 8125 | *A. stenosperma* | 0.7 | 1.2 | 8.3 | 0.0 | 2.0 | 2.3 |
| 8137 | *A. stenosperma* | 1.5 | 0.4 | 0.0 | 0.0 | 2.0 | 1.7 |
| 8138 | *A. duranensis* | 0.7 | 2.0 | 0.0 | 20.8 | 2.0 | 3.3 |
| 8139 | *A. duranensis* | 5.4 | 2.1 | 42.3 | 20.8 | 4.0 | 3.0 |
| 8144 | *A. villosa* | 1.6 | NT[d] | 28.0 | NT | 3.0 | NT |
| 8190 | *A. hoehnei* | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| 8191 | *A. kretschmeri* | 1.6 | 2.8 | 51.7 | 41.7 | 4.7 | 5.0 |
| 8195 | *A. duranensis* | 5.9 | 4.7 | 75.0 | 83.3 | 5.3 | 6.0 |
| 8196 | *A. duranensis* | 1.5 | 0.6 | 0.0 | 20.8 | 2.3 | 2.3 |
| 8197 | *A. monticola* | 9.2 | 11.7 | 66.7 | 63.5 | 5.3 | 5.3 |
| 8198 | *A. monticola* | 10.1 | 9.5 | 83.3 | 95.8 | 8.0 | 6.7 |
| 8199 | *A. duranensis* | 3.3 | 1.3 | 50.0 | 50.0 | 5.0 | 5.3 |
| 8200 | *A. duranensis* | 5.9 | 4.9 | 91.7 | 75.0 | 6.0 | 5.0 |
| 8201 | *A. duranensis* | 2.0 | 2.0 | 100.0 | 87.5 | 6.0 | 6.0 |
| 8202 | *A. duranensis* | 4.0 | 4.5 | 79.2 | 79.2 | 5.7 | 5.3 |
| 8204 | *A. duranensis* | 1.6 | 1.8 | 66.7 | 70.8 | 5.0 | 6.0 |
| 8205 | *A. duranensis* | 1.0 | 2.8 | 95.8 | 66.7 | 5.7 | 5.3 |
| 8206 | *A. ipaensis* | 0.7 | 0.9 | 0.0 | 0.0 | 2.0 | 2.0 |
| 8216 | *A. cardenasii* | 0.9 | 0.9 | 0.0 | 0.0 | 2.0 | 2.0 |
| 8901 | *A. batizogaea* | 5.0 | 6.2 | 100.0 | 91.7 | 6.7 | 6.3 |
| 8906 | *A. stenosperma* | 0.8 | 0.3 | 0.0 | 0.0 | 2.0 | 1.3 |
| 8954 | *A. kuhlmannii* | 0.7 | 0.4 | 0.0 | 0.0 | 2.0 | 1.7 |
| 8957 | *A. duranensis* | 0.0 | 0.7 | 100.0 | 91.7 | 6.0 | 5.3 |
| 8959 | *A. kempff-Mercadoi* | 0.4 | 0.7 | 0.0 | 0.0 | 1.7 | 1.7 |
| 8960 | *A. magna* | 0.6 | 1.7 | 0.0 | 0.0 | 2.0 | 2.0 |
| 11548 | *A. valida* | 1.1 | 1.0 | 0.0 | 0.0 | 2.0 | 2.0 |
| 11549 | *A. monticola* | 11.3 | 6.0 | 83.3 | 100.0 | 7.3 | 6.7 |
| 11550 | *A. duranensis* | 1.0 | 2.2 | 62.5 | 40.0 | 4.3 | 4.0 |
| 11551 | *A. benensis* | 1.6 | 0.2 | 29.2 | 0.0 | 2.0 | 1.0 |
| 11552 | *A. duranensis* | 5.4 | 2.1 | 50.3 | 50.0 | 5.0 | 4.7 |

(*continued on next page*)

[a] Percent leaf area damage was assessed by comparing each leaf with diagrams (10) depicting leaves with known percentages of leaf area affected.
[b] Percent defoliation was calculated based on total and defoliated leaflets of the tagged leaves.
[c] Scale 1 to 9: 1 = no disease, all leaves healthy; 2 = lesions present largely on lower leaves, no defoliation; 3 = lesions present largely on lower leaves, very few on middle leaves, defoliation on some leaflets evident on lower leaves; 4 = lesions on lower and middle leaves but severe on lower leaves; 5 = lesions present on all lower and middle leaves, over 50% defoliation of lower leaves; 6 = severe lesions on lower and middle leaves, lesions present but less severe on top leaves, extensive defoliation of lower leaves, defoliation of some leaflets evident on middle leaves; 7 = lesion on all leaves but less severe on top leaves, defoliation of all lower and some middle leaves evident; 8 = defoliation of all lower and middle leaves, severe lesions on top leaves, some defoliation of top leaves evident; and 9 = almost all leaves defoliated leaving bare stems, some leaflets may remain, but show severe leaf spots.
[d] Not tested.
[e] LSD = least significant difference.

*duranensis*; one accession each of *A. hoehnei* (ICG 14867) and *A. batizogaea* (ICG 13208); and five accessions, ICG 8125, ICG 13171, ICG 13233, ICG 14868, and ICG 14872, of *A. stenosperma* had as much as 25% defoliation in both experiments. Other accessions had >25% defoliation in both experiments (Table 1).

*Disease score on a 1 to 9 scale.* Accessions differed significantly ($P < 0.001$) for disease score. Disease score was significantly less on accessions than on the susceptible cultivar TMV 2 in both experiments (Table 1). Two accessions, ICG 8190 of *A. hoehnei* and ICG 13199 of *A. duranensis,* were asymptomatic in both experiments. Seven accessions from *A. duranensis,* seven accessions from *A. stenosperma*, both accessions of *A. kuhlmannii* (ICG 8954 and ICG 15144), and one accession each of *A. batizogaea* (ICG 13208), *A. benensis* (ICG 11551), *A. cardenasii* (ICG 8216), *A. decora* (ICG 14939), *A. hoehnei* (ICG 14867), *A. ipaensis* (ICG 8206), *A. kempff-Mercadoi* (ICG 8959), *A. magna* (ICG 8960), *A. valida* (ICG 11548), and *A. villosa* (ICG 8144) had <3 rating on a 1 to 9 point rating scale in both the experiments. Eleven accessions from *A. duranensis* and one accession each of *A. chiquitana* (ICG 11560) and *A. kretschmeri* ( ICG 8191) showed >3 to 5 rating on a 1 to 9 point rating scale (Table 1). Other accessions had ratings >5 in both experiments. Again, all four accessions of *A. monticola* had rating >5 in both experiments (Table 1).

**Rust.** *Percentage leaf area damage.* Accessions differed significantly ($P < 0.001$) for percentage of leaf area damaged by rust. Damage was significantly less on all accessions than on the susceptible cultivar TMV 2 in both experiments (Table 2). One accession of *A. kuhlmannii* (ICG 8954) had no leaf area damaged in either experiment. One accession each of *A. ipaensis* (ICG 8206) and *A. stenosperma* (ICG 13171), and all four accessions of *A. monticola* (ICG 8197, ICG 8198, ICG 11549, and ICG 13178) had significantly more leaf area damaged (>10%) than the rest of the accessions. Other accessions had <3% mean leaf area damaged in both experiments (Table 2).

*Disease score on a 1 to 9 scale.* Highly significant differences ($P < 0.001$) in disease score were observed among the *Arachis* accessions in both experiments. The disease score was significantly greater for the susceptible cultivar TMV 2 than for most of the *Arachis* accessions (Table 2). All four accessions (ICG 8197, ICG 8198, ICG 11549, and ICG 13178) of *A. monticola,* one accession (ICG 8206) of *A. ipaensis,* and one accession (ICG 13171) of *A stenosperma* had ratings >5 in both experiments. Other accessions had rating <3 (Table 2).

## DISCUSSION

The susceptible cultivar TMV 2 had very high and uniform percentage of leaf

**Table 1.** (*continued*)

| ICRISAT accession (ICG No.) | *Arachis* species | Leaf area damage (%)[a] 1998 | Leaf area damage (%)[a] 1999 | Defoliation (%)[b] 1998 | Defoliation (%)[b] 1999 | Disease score[c] 1998 | Disease score[c] 1999 |
|---|---|---|---|---|---|---|---|
| 11553 | *A. duranensis* | 10.1 | 7.7 | 75.0 | 66.7 | 5.7 | 5.3 |
| 11554 | *A. duranensis* | 7.9 | 5.7 | 66.7 | 45.8 | 5.3 | 6.0 |
| 11555 | *A. duranensis* | 1.2 | 0.7 | 12.5 | 0.0 | 3.0 | 2.0 |
| 11558 | *A. cardenasii* | 5.8 | 7.0 | 100.0 | 87.5 | 6.0 | 5.3 |
| 11560 | *A. chiquitana* | 1.9 | 3.5 | 56.7 | 45.8 | 3.0 | 3.7 |
| 11566 | *A. cardenasii* | 6.8 | 5.0 | 95.8 | 54.2 | 6.0 | 5.3 |
| 12162 | *A. duranensis* | 5.5 | 2.4 | 75.0 | 79.2 | 5.7 | 5.0 |
| 13161 | *A. duranensis* | 1.0 | 0.5 | 0.0 | 0.0 | 2.3 | 2.0 |
| 13171 | *A. stenosperma* | 1.9 | 0.9 | 4.2 | 0.0 | 2.0 | 2.0 |
| 13173 | *A. stenosperma* | 4.7 | 4.6 | 83.3 | 50.0 | 6.0 | 5.3 |
| 13174 | *A. duranensis* | 5.8 | 5.7 | 100.0 | 62.5 | 6.0 | 5.3 |
| 13175 | *A. duranensis* | 4.5 | 4.2 | 45.8 | 45.8 | 3.3 | 3.3 |
| 13176 | *A. duranensis* | 3.8 | 3.8 | 62.5 | 100.0 | 5.0 | 6.3 |
| 13178 | *A. monticola* | 18.2 | 7.2 | 75.0 | 100.0 | 5.7 | 5.7 |
| 13183 | *A. duranensis* | 2.0 | 3.7 | 58.3 | 83.3 | 6.0 | 5.3 |
| 13184 | *A. duranensis* | 6.8 | 4.8 | 91.7 | 91.2 | 5.3 | 5.3 |
| 13185 | *A. duranensis* | 2.4 | 2.7 | 30.5 | 20.8 | 3.3 | 2.7 |
| 13186 | *A. duranensis* | 0.7 | 2.2 | 50.0 | 66.7 | 5.0 | 5.0 |
| 13189 | *A. duranensis* | 2.3 | 2.0 | 66.7 | 70.8 | 5.0 | 6.0 |
| 13190 | *A. duranensis* | 4.9 | 3.3 | 100.0 | 91.6 | 5.3 | 5.3 |
| 13191 | *A. duranensis* | 5.0 | 3.2 | 100.0 | 58.3 | 5.0 | 6.0 |
| 13192 | *A. duranensis* | 4.1 | 5.0 | 62.5 | 79.2 | 5.7 | 6.0 |
| 13194 | *A. duranensis* | 0.0 | 2.8 | 100.0 | 75.2 | 5.0 | 6.0 |
| 13195 | *A. duranensis* | 2.7 | 0.9 | 40.0 | 62.5 | 4.3 | 3.5 |
| 13197 | *A. duranensis* | 0.0 | 0.7 | 100.0 | 62.5 | 5.0 | 6.0 |
| 13199 | *A. duranensis* | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| 13200 | *A. duranensis* | 0.0 | 1.7 | 100.0 | 75.0 | 6.0 | 5.0 |
| 13201 | *A. duranensis* | 0.0 | 2.7 | 100.0 | 75.0 | 5.7 | 5.3 |
| 13202 | *A. duranensis* | 0.0 | 1.8 | 25.0 | 22.2 | 3.0 | 3.3 |
| 13203 | *A. duranensis* | 1.4 | 2.5 | 45.8 | 66.7 | 3.3 | 4.0 |
| 13205 | *A. duranensis* | 0.0 | 0.7 | 12.5 | 8.3 | 2.0 | 2.3 |
| 13206 | *A. duranensis* | 4.0 | 3.5 | 95.8 | 66.7 | 5.7 | 5.3 |
| 13207 | *A. duranensis* | 0.8 | 1.7 | 40.8 | 62.5 | 4.7 | 4.5 |
| 13208 | *A. batizogaea* | 1.0 | 1.1 | 12.5 | 4.2 | 2.3 | 2.0 |
| 13217 | *A. duranensis* | 4.1 | 3.0 | 100.0 | 75.0 | 5.0 | 5.7 |
| 13233 | *A. stenosperma* | 4.0 | 3.2 | 25.0 | 0.0 | 3.0 | 1.3 |
| 13242 | *A. duranensis* | 0.0 | 1.2 | 12.5 | 0.0 | 3.0 | 2.0 |
| 14867 | *A. hoehnei* | 5.5 | NT | 12.5 | NT | 3.0 | NT |
| 14868 | *A. stenosperma* | 0.9 | NT | 22.5 | NT | 3.0 | NT |
| 14872 | *A. stenosperma* | 0.8 | 1.3 | 28.3 | 12.5 | 3.3 | 2.5 |
| 14939 | *A. decora* | 2.4 | NT | 0.0 | NT | 2.0 | NT |
| 15144 | *A. kuhlmannii* | 4.7 | NT | 0.0 | NT | 3.0 | NT |
| 15179 | *A. duranensis* | 7.7 | NT | 75.0 | NT | 5.0 | NT |
| TMV 2 | Susceptible check | 19.7 | 24.7 | 83.3 | 95.7 | 8.0 | 8.3 |
| LSD (0.05)[e] | | 3.1 | 48.4 | 27.1 | 25.9 | 0.89 | 1.1 |

area damaged by late leaf spot and rust. This cultivar also had a high degree of defoliation caused by late leaf spot; thus the development of both diseases was satisfactory for evaluating wild *Arachis* species for their reactions. Several accessions had significantly ($P < 0.001$) less late leaf spot and rust than the susceptible cultivar TMV 2. Abdou et al. (1) and Subrahmanyam et al. (24,25) also reported several resistant sources in wild *Arachis* species to these pathogens. Although accessions were from the same species, reactions to late leaf spot and rust varied markedly. For instance, the percentage of leaf area damaged and percentage of defoliation by late leaf spot was zero in one accession (ICG 13199) of *A. duranensis* and was very high in another accession (ICG 13174) of *A. duranensis*. Similar variability was observed among the accessions of other species. These results confirmed earlier findings of Subrahmanyam et al. (24). These differences in disease reaction may be due to genetic variation within the species. Some accessions were defoliated soon after infection when minute nonsporulating lesions developed (23). In the present study, defoliation due to late leaf spot in some of the accessions may be regarded as a hypersensitive reaction that does not allow the fungus to sporulate and perpetuate in the diseased leaves.

For a reliable evaluation of late leaf spot and rust resistance, it is important not to rely on any one variable (10). Hence, the accessions that had <3% leaf area damage, <25% defoliation, and a rating of <3 were considered to be resistant to late leaf spot. Those with leaf area damage <3% and ratings <3 were considered to be resistant to rust. Two accessions, ICG 13199 of *A. duranensis* and ICG 8190 of *A. hoehnei,* had asymptomatic reactions to late leaf spot but were highly resistant to rust, whereas accession ICG 8954 of *A. kuhlmannii* had an asymptomatic reaction to rust but was highly resistant to late leaf spot. Subrahmanyam et al. (24,25) reported that ICG 8190 and ICG 8954 were highly resistant to rust and late leaf spot. Of the 74 accessions tested for late leaf spot, two remained asymptomatic, 26 were resistant, 10 were moderately resistant, and 36 were susceptible. Of the 74 accessions tested for rust, one, ICG 8954 of *A. kuhlmannii,* had an asymptomatic reaction and all other accessions except ICG 8206 of *A. ipaensis*, ICG 8197, ICG 8198, ICG 11549, and ICG 13178 of *A. monticola*, and ICG 13171 of *A. stenosperma* had high levels of resistance. However, one accession, ICG 13171, of *A. stenosperma* and the one accession ICG 8206 of *A. ipaensis,* which were susceptible to rust, had high levels of resistance to late leaf spot in both experiments. All 28 accessions that were asymptomatic and resistant to late leaf spot were also resistant to rust, indicating that resistance to multiple pathogens exists in these accessions. Four accessions of *A. monticola* were susceptible to late leaf spot and rust in both experiments. Subrahmanyam et al. (24) also reported that only one accession, ICG 8198 of *A. monticola*, was susceptible to late leaf spot. The purpose of examining the reaction of wild *Arachis* species to *P. personata* and *P. arachidis* is that we hope to transfer several useful traits from these species to cultivated peanut, especially resistance to *P. personata*. Therefore, it is pertinent to evaluate the reaction of each accession of each species to these pathogens. Most attention is focused now on the species in *Arachis* that are cross-compatible with *A. hypogaea* (15). Several wild *Arachis* species are either asymptomatic or highly resistant to late leaf spot and rust, and hence could be important for interspecific hybridization to incorporate higher levels of resistance to these diseases to cultivated peanuts than is currently available.

**Table 2.** Percentage of leaf area damage and disease score on a 1 to 9 rating scale of wild *Arachis* species to rust caused by *Puccinia arachidis* in the greenhouse environment in 1998 and 1999 at ICRISAT, India

| ICRISAT accession | | Leaf area damage (%)[a] | | Disease score[b] | |
|---|---|---|---|---|---|
| (ICG No.) | *Arachis* species | 1998 | 1999 | 1998 | 1999 |
| 8123 | *A. duranensis* | 0.5 | 0.4 | 2.0 | 2.0 |
| 8125 | *A. stenosperma* | 2.5 | 2.2 | 4.0 | 3.0 |
| 8137 | *A. stenosperma* | 1.0 | 0.6 | 2.0 | 2.0 |
| 8138 | *A. duranensis* | 0.7 | 0.6 | 2.0 | 2.0 |
| 8139 | *A. duranensis* | 1.1 | 0.6 | 2.0 | 2.0 |
| 8144 | *A. villosa* | 2.5 | NT[c] | 3.0 | NT |
| 8190 | *A. hoehnei* | 0.4 | 0.0 | 2.0 | 1.0 |
| 8191 | *A. kretschmeri* | 1.2 | 0.2 | 2.0 | 2.0 |
| 8195 | *A. duranensis* | 1.4 | 0.4 | 2.0 | 2.0 |
| 8196 | *A. duranensis* | 1.0 | 0.4 | 2.0 | 2.0 |
| 8197 | *A. monticola* | 10.7 | 16.5 | 6.0 | 6.7 |
| 8198 | *A. monticola* | 12.6 | 20.0 | 6.7 | 7.0 |
| 8199 | *A. duranensis* | 2.0 | 0.0 | 2.0 | 1.0 |
| 8200 | *A. duranensis* | 0.6 | 0.8 | 2.0 | 2.0 |
| 8201 | *A. duranensis* | 1.3 | 0.3 | 2.0 | 1.7 |
| 8202 | *A. duranensis* | 0.8 | 0.2 | 2.0 | 1.7 |
| 8204 | *A. duranensis* | 1.0 | 0.3 | 2.0 | 2.0 |
| 8205 | *A. duranensis* | 3.0 | 1.1 | 3.0 | 2.0 |
| 8206 | *A. ipaensis* | 12.2 | 17.5 | 6.0 | 7.0 |
| 8216 | *A. cardenasii* | 0.8 | 0.9 | 2.0 | 2.0 |
| 8901 | *A. batizogaea* | 0.3 | 2.4 | 2.0 | 3.0 |
| 8906 | *A. stenosperma* | 1.1 | 1.0 | 3.0 | 2.0 |
| 8954 | *A. kuhlmannii* | 0.0 | 0.0 | 1.0 | 1.0 |
| 8957 | *A. duranensis* | 3.7 | 0.7 | 2.7 | 2.0 |
| 8959 | *A. kempff-Mercadoi* | 1.0 | 0.4 | 2.0 | 2.0 |
| 8960 | *A. magna* | 0.5 | 0.9 | 2.0 | 2.0 |
| 11548 | *A. valida* | 0.7 | 0.4 | 2.0 | 2.0 |
| 11549 | *A. monticola* | 31.6 | 56.5 | 7.0 | 7.7 |
| 11550 | *A. duranensis* | 0.9 | 0.0 | 2.0 | 1.0 |
| 11551 | *A. benensis* | 0.5 | 0.4 | 2.0 | 2.0 |
| 11552 | *A. duranensis* | 1.0 | 1.3 | 2.0 | 2.0 |

(*continued on next page*)

[a] Percent leaf area damage was assessed by comparing each leaf with diagrams (10) depicting leaves with known percentages of leaf area affected.

[b] Scale 1 to 9: 1 = no disease, all leaves healthy; 2 = few, very small pustules on some older leaves; 3 = few pustules, mainly on older leaves, some ruptured, poor sporulation; 4 = pustules small or large, mostly on lower and middle leaves, disease evident; 5 = many pustules, mostly on lower and middle leaves, yellowing and necrosis of some lower and middle leaves, moderately sporulating; 6 = as rating 5 but pustules heavily sporulating; 7 = pustules all over the plant, lower and middle leaves withering; 8 = as rating 7 but withering is severe; and 9 = plants severely affected, 50 to 100% leaves withering.

[c] Not tested.

[d] LSD = least significant difference.

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**Table 2.** (*continued*)

| ICRISAT accession (ICG No.) | *Arachis* species | Leaf area damage (%)[a] | | Disease score[b] | |
|---|---|---|---|---|---|
| | | 1998 | 1999 | 1998 | 1999 |
| 11553 | *A. duranensis* | 0.6 | 0.9 | 2.0 | 1.7 |
| 11554 | *A. duranensis* | 1.6 | 0.2 | 2.0 | 1.3 |
| 11555 | *A. duranensis* | 0.5 | 2.0 | 2.0 | 2.0 |
| 11558 | *A. cardenasii* | 3.0 | 1.0 | 3.0 | 2.0 |
| 11560 | *A. chiquitana* | 1.7 | 3.0 | 2.7 | 2.3 |
| 11566 | *A. cardenasii* | 0.3 | 1.4 | 2.0 | 2.0 |
| 12162 | *A. duranensis* | 1.1 | 0.6 | 2.0 | 2.0 |
| 13161 | *A. duranensis* | 1.2 | 0.3 | 2.0 | 1.7 |
| 13171 | *A. stenosperma* | 19.3 | 15.0 | 5.7 | 5.3 |
| 13173 | *A. stenosperma* | 0.7 | 1.1 | 2.0 | 2.0 |
| 13174 | *A. duranensis* | 4.3 | 0.2 | 3.0 | 1.7 |
| 13175 | *A. duranensis* | 1.7 | 0.4 | 2.0 | 2.0 |
| 13176 | *A. duranensis* | 1.3 | 0.4 | 2.0 | 2.0 |
| 13178 | *A. monticola* | 10.0 | 16.0 | 6.0 | 7.0 |
| 13183 | *A. duranensis* | 0.5 | 0.0 | 2.0 | 1.0 |
| 13184 | *A. duranensis* | 0.2 | 0.0 | 2.0 | 1.0 |
| 13185 | *A. duranensis* | 0.7 | 0.0 | 2.0 | 1.0 |
| 13186 | *A. duranensis* | 0.6 | 0.9 | 2.0 | 1.7 |
| 13189 | *A. duranensis* | 1.2 | 0.7 | 2.0 | 1.7 |
| 13190 | *A. duranensis* | 0.8 | 0.4 | 2.0 | 2.0 |
| 13191 | *A. duranensis* | 2.0 | 1.3 | 2.0 | 1.7 |
| 13192 | *A. duranensis* | 1.2 | 1.7 | 2.0 | 2.0 |
| 13194 | *A. duranensis* | 3.8 | 1.4 | 3.0 | 2.0 |
| 13195 | *A. duranensis* | 0.8 | 2.4 | 2.0 | 2.0 |
| 13197 | *A. duranensis* | 0.0 | 0.9 | 1.0 | 1.7 |
| 13199 | *A. duranensis* | 5.2 | 0.0 | 3.0 | 1.0 |
| 13200 | *A. duranensis* | 4.0 | 0.0 | 2.7 | 1.0 |
| 13201 | *A. duranensis* | 4.0 | 2.0 | 2.7 | 2.0 |
| 13202 | *A. duranensis* | 4.3 | 0.0 | 2.7 | 1.0 |
| 13203 | *A. duranensis* | 0.9 | 1.1 | 2.0 | 2.0 |
| 13205 | *A. duranensis* | 0.9 | NT | 2.0 | NT |
| 13206 | *A. duranensis* | 2.5 | 0.9 | 3.0 | 2.0 |
| 13207 | *A. duranensis* | 1.7 | 0.0 | 2.0 | 1.0 |
| 13208 | *A. batizogaea* | 0.6 | 0.4 | 2.0 | 1.7 |
| 13217 | *A. duranensis* | 2.0 | 0.0 | 2.0 | 1.0 |
| 13233 | *A. stenosperma* | 1.5 | 0.9 | 2.0 | 2.0 |
| 13242 | *A. duranensis* | 3.3 | 2.9 | 2.7 | 2.7 |
| 14867 | *A. hoehnei* | 1.2 | NT | 2.0 | NT |
| 14868 | *A. stenosperma* | 3.5 | NT | 2.7 | NT |
| 14872 | *A. stenosperma* | 0.0 | 1.8 | 1.0 | 3.0 |
| 14939 | *A. decora* | 1.2 | NT | 2.0 | NT |
| 15144 | *A. kuhlmannii* | 2.3 | NT | 2.0 | NT |
| 15179 | *A. duranensis* | 3.7 | NT | 3.0 | NT |
| TMV 2 | Susceptible check | 35.7 | 64.2 | 8.0 | 8.0 |
| LSD (0.05)[d] | | 3.8 | 6.6 | 0.6 | 0.6 |


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