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Resistance to Peanut Stunt Virus in Cultivated and Wild *Arachis* Species

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ABSTRACT

Approximately 4000 lines (cultivars, introductions, breeding lines, and radiation-induced mutants) of cultivated peanuts (*Arachis hypogaea* L.) were tested for resistance to peanut stunt virus (PSV), and all were susceptible to PSV infection. Twenty-one lines were less severely damaged than the others. In addition, 90 collections of wild *Arachis* species including 55 members of section *Rhizomatosae*, 17 of *Arachis*, 16 of *Erectoides*, and one each of *Caulorhizae* and *Extranervosae* were tested. Several collections in sections *Arachis*, *Caulorhizae*, *Erectoides* and *Rhizomatosae* were highly resistant to PSV. Collections of *A. duranensis*, *A. villosa*, and a hybrid derivative of *A. villosa*-*A. correntina* have the most immediate potential for utilization. The reactions of a few F_1 hybrids of *Arachis* species indicated that resistance to peanut stunt virus is not conditioned by a single dominant gene. Resistance of wild species could be used to develop resistant cultivars.

Key Words: Groundnut, *Arachis hypogaea*, peanut stunt virus.

When the peanut stunt virus disease was first observed in North Carolina and Virginia, it was regarded as a serious threat to peanut (*Arachis hypogaea* L.) production in that region. Almost total destruction of the crop occurred in severely affected portions of some fields (2, 6).

Although peanut stunt virus (PSV) can infect many species of leguminous and solanaceous plants, as well as a few species in other plant families (5, 7), the virus seems to persist almost exclusively in white clover (*Trifolium repens* L.) in North Carolina. Other species (*Trifolium pratense* L., *Pueraria thunbergiana* (Seib. & Zucc.) Benth, *Solanum carolinense* L., and species of *Lespedeza* and *Vicia*) are sometimes naturally infected with PSV but are not important sources of inoculum. If PSV strains which are better adapted to other hosts should develop, the disease could become a serious problem. Introduction of PSV into countries with existing host plants could result in serious PSV epidemics. Also, PSV could assume greater importantance in areas more favorable for secondary spread of the virus. As part of a program to find effective control measures for this disease, cultivated peanuts and wild *Arachis* species were screened for resistance to PSV.

Materials and Methods

The lines of cultivated peanuts and wild species (Tables 1, 2) tested were primarily those in the large collection of cultivars, breeding lines, introductions, and radiation-induced mutants maintained at North Carolina State University. Additionally, some lines of cultivated peanuts and collections of wild *Arachis* species were obtained from the United States Department of Agriculture.

Table 1. Wild *Arachis* collections without symptoms or virus recovery during two tests for peanut stunt virus.

No.	Collection no. or species name	Collector[a]	Section	PI number
1.	9571	GKP	Rhizomatosae	262818
2.	9610B	GKP	"	262832
3.	9806	GKP	"	262792
4.	9813	GKP	"	262793
5.	9827	GKP	"	262796
6.	9921	GKP	"	262296
7.	*A. glabrata*-B_1	--	"	--
8.	1960 #98	--	"	--
9.	9644	GKP	"	262840
10.	9649	GKP	"	262844
11.	9822	GKP	"	262795
12.	9922	GKP	"	262297
13.	9925	GKP	"	262299
14.	9935	GKP	"	262301
15.	10105	GKP	"	276200
16.	10596	GK	"	276233
17.	210	--	"	261851/261876
18.	1960 #3	--	"	--
19.	1960 #8	--	"	--
20.	1960 #100	--	"	--
21.	7988	K	Arachis	--
22.	9553	GKP	Rhizomatosae	262801
23.	9564	GKP	"	262811
24.	9568	GKP	"	262815
25.	9569	GKP	"	262816
26.	9570	GKP	"	262817
27.	9574	GKP	"	262820
28.	9576	GKP	"	262822
29.	9580	GKP	"	262825
30.	9587	GKP	"	262826
31.	9591	GKP	"	262827
32.	9618	GKP	"	262833
33.	9634	GKP	"	262836
34.	9764	GKP	Erectoides	262859
35.	9797	GKP	Rhizomatosae	262807
36.	9815	GKP	"	262794
37.	9893	GKP	"	262287
38.	9966	GKP	"	262306
39.	10120	GKP	"	276202
40.	10543	GK	Erectoides	276209
41.	10550	GK	Rhizomatosae	--
42.	10566	GK	"	276223
43.	10573	GK	Erectoides	276225
44.	10580	GK	"	276229
45.	10598	--	Arachis	276234
46.	22585	B	"	298636
47.	Manfredi #5	--	"	--
48.	*A. repens*	--	Caulorhizae	--

[a]Abbreviation of collectors' names: B = Burkart, G = Gregory, H = Hammons, K = Krapovickas, P = Pietrarelli.

To evaluate resistance to PSV, young seedlings or cuttings were inoculated one to three times with juice from infected beans, cowpeas, or peanuts extracted in 0.05M phosphate buffer (pH 7.5) containing 0.01M sodium diethyldithiocarbamate. Inoculum containing 1 g of 600 mesh Carborundum per 100 ml of buffered plant extracts was applied to plants with an artist's airbrush or with a cotton swab. Plants with symptoms 6 weeks after inoculation were discarded. Plants without symptoms were pruned and fertilized to regenerate new growth. Plants with symptoms on the new foliage were then discarded and the remaining symptomless plants were re-inoculated. After an additional 6 weeks, plants without symptoms were serologically tested for the presence of the virus or by inoculation of beans or cowpeas with juice extracted from these plants. If PSV was not detected, cuttings were made from the plants and inoculation was repeated on new cuttings.

Some lines that were not infected in the mechanical inoculation tests were further tested by grafting infected scions onto cuttings or seedlings of the apparently resistant lines. These were then observed for development of symptoms and tested for the presence of the virus as described above. Selected lines were also tested for susceptibility to PSV in a field near infected white clover.

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Table 2. Reaction of susceptible *Arachis* collections to peanut stunt virus.

Collection no. or species name	Collector[a]	Section	PI number	Ratings[b] Test 1 Symptoms	Test 1 Virus recov.	Test 2 Symptoms	Test 2 Virus recov.
9566A	GKP	Rhizomatosae	262812	0	0	2	-
9578	GKP	"	262824	0	0	2	-
9667	GKP	"	262848	0	0	2	-
9830	GKP	"	262797	0	0	2	-
9882	GKP	"	262286	0	0	2	-
9990	GKP	Erectoides	261853/261877	0	0	2	-
10574	--	"	276226	0	0	2	-
10585	GK	"	276231	0	0	2	-
A. correntina	--	Arachis	--	0	0	2	-
A. glabrata	--	Rhizomatosae	--	0	0	2	-
A. marginata	--	"	--	0	0	2	-
9629	GKP	"	262834	0	0	3	-
9893	GKP	"	262287	0	0	3	-
A 23	H	"	--	0	0	3	-
9645	GKP	"	262841	0	0	4	-
9834	GKP	"	262798	0	0	4	-
10017	GKP	Arachis	262141	0	0	5	-
9835	GKP	Erectoides	262308	0	0	8	-
7897	K	Arachis	261868/262134	0	L	0	0
9548	GKP	"	262839/262873	0	L	-	-
11462	KFC	Erectoides	--	0	L	0	0
Manfredi #8	--	Arachis	--	0	L	0	0
Manfredi #36	--	"	--	0	L	0	0
7830	K	"	261871/262137	0	S	2	-
9530	GKP	"	262808	0	S	0	0
9642	GKP	Rhizomatosae	262839/262873	0	S	0	0
9646	GKP	Erectoides	262842/262874	0	S	0	0
9769	GKP	"	262862	0	S	0	0
9841	GKP	"	262278	2	-	-	-
10038	GKP	Arachis	262133	2	-	-	-
9645	GKP	Rhizomatosae	262841	3	-	-	-
10034	GKP	Erectoides	261875/262142	3	-	-	-
11488	KC	"	--	3	-	-	-
10127	GKP	Extranervosae	276203/276309	4	-	-	-
A. monticola	--	Arachis	--	4	-	-	-
A. villosa	--	"	--	4	-	-	-
9566B	GKP	Rhizomatosae	262813/262871	4	-	-	-
10602	GKP	Arachis	276235	5	-	-	-
9572	GKP	Rhizomatosae	262819	6	-	-	-
9825	GKP	Erectoides	263105	6	-	-	-
10576	GK	"	276228	8	-	-	-

[a]Abbreviation of collectors' names: B = Burkart, C = Cristobal, F = Fugarazzo, G = Gregory, H = Hammons, K = Krapovickas, P = Pietrarelli.

[b]Symptoms: 0 = none, 1-2 = mild, 3-5 = moderate, 6-9 = severe. Virus recovery: 0 = no virus, L = virus recovered from inoculated leaves only, S = virus recovered from systemically invaded leaves.

Results and Discussion

Greenhouse inoculation tests demonstrated that peanuts were more difficult to infect with PSV than either beans or cowpeas. Usually less than 100% of the inoculated *A. hypogaea* plants became infected. In some tests with a single inoculation, less than 50% of the peanut plants became infected. This large number of escapes in inoculated peanut lines increased the difficulty of evaluating resistance. It was necessary to repeatedly inoculate many lines.

Available lines of cultivated peanuts (*ca.* 4000) were tested, and all were susceptible to PSV in greenhouse and field tests; however, virus-induced symptoms varied among peanut lines. The following lines sustained the least damage in field tests: Dixie Giant, Talladega T1820, Ga. C37 (NewBerry Runner x *A. monticola*), Ga. Hy 197 (VB46-2 x Dixie Giant); plant introduction numbers 259747, 259832R4, 268644, 268644R3, 268807, 291253-1, and 295977-2; and 10 selections from Florida crosses F393 (Florispan x Jenkin's Jumbo), F460 (F393-7-1 x Croft Jumbo), and F420. Differences among lines in degree of stunting of infected plants and in percentage of infected plants were similar to those observed by Culp and Troutman (3). Although PSV symptoms in these lines were less severe than others, all lines were infected with PSV.

Collections of wild *Arachis* species exhibiting no symptoms after three inoculations varied as to presence or absence of PSV. Of the 76 collections without symptoms, PSV was not detected in 66 collections (Tables 1, 2, Test 1), while PSV was detected in inoculated leaves in only five collections, and from systemically invaded leaves in five other collections (Table 2, Test 1). New cuttings of the 76 collections without symptoms in the first test were inoculated at least three additional times and tested for the presence of PSV. PSV was not detected in 56 of these collections (Tables 1, 2, Test 2). Grafts of scions from infected peanuts were established on 16 of these lines, and none developed symptoms of PSV (Table 1, nos. 1-16). Seven of the grafted lines were also assayed for the presence of PSV, and virus was not detected (Table 1, nos. 1-7). Resistance to PSV was present in four of the five observed botanical sections of the genus *Arachis*, including sections *Arachis, Caulorhizae, Erectoides and Rhizomatosae.*

In addition to the original collections, 11 F_1 interspecific hybrids were evaluated for resistance to PSV (Table 3). The reactions indicated that resistance to PSV is not conditioned by a single dominant gene and is probably multigenic in nature. This will increase the difficulty of selecting homozygous-resistant genotypes.

The potential for utilizing PSV-resistant wild species is great. However, utilization of this germplasm is restricted by our inability to obtain hybrids among most *Arachis* species and *A. hypogaea* (4). For example, members of sections *Caulorhizae, Erectoides, and Rhizomatosae* (three of the four sections where PSV-resistant species was found) will not hybridize with the cultivated peanut. Although PSV-resistant members of section *Arachis* are at a different ploidy level than *A. hypogaea*, the cultivated and wild species are cross-compatible (4, 8). The most promising wild species for developing PSV-resistant populations are *A. duranensis* Krap. et Greg. *nom. nud.* (7988 K), *A. villosa* Benth (22585 B), *A.* sp. 10598, and Manfredi No. 5 (which is probably an *A. villosa-A. correntina* Krap. et Greg. *nom. nud.* hybrid derivative). Two other *A. correntina* collections (7897 K and 9548 GKP) plus two *A. villosa-A. correntina* hybrid derivatives (Manfredi No. 8 and No. 36) are also highly tolerant to PSV.

Table 3. Reaction of *Arachis* species and corresponding F_1 hybrids to peanut stunt virus.

Female Collection	Female Rating[a]	Male Collection	Male Rating	F1 Rating
7988	0	10598	0	3
9935	0 G	10017	5	6
9646	0 S	9990	2	6
9990	2	9646	0 S	5
10573	0	10034	3	7
7988	0	10017	5	6
9841	2	10034	3	4
10038	2	*A. monticola*	4	0
10038	2	*A. villosa*	4	3
A. villosa	4	*A. monticola*	4	2
10576	8	10034	3	6

[a]Peanut stunt virus rating: 0 = no symptoms, 1-2 = mild symptoms, 3-5 = moderate symptoms, 6-9 = severe symptoms, 0 G = successfully grafted showing no symptoms but not assayed, and 0 S = no symptoms but systemic virus multiplication.

The above wild species can either be hybridized directly with *A. hypogaea,* fertility restored at the 6x ploidy level, and then backcrossed to obtain 40-chromosome plants; or 4x amphidiploids can be developed and then hybridized with cultivated peanuts. Forty-chromosome breeding lines which include PSV-resistant species of section *Arachis* are being developed at North Carolina State University.

Losses attributable to PSV in North Carolina have been insignificant during the past 10 years. Block (1) found that flights of the principal aphid vector (*Aphis craccivora* Koch.) peaked during the first month after emergence of the peanut crop and then dropped to a low level. This has resulted in the very small amount of secondary spread of PSV. Previously reported losses occurred when peanuts were planted near sources of PSV inoculum such as pastures of infected white clover. In the commercial peanut production area of eastern North Carolina, the population of wild white clover plants is low, providing a minimal amount of PSV as inoculum. Usually only a few peanut plants infected with PSV are found in peanut fields. Thus, a concentrated effort to develop commercially acceptable peanut cultivars resistant to peanut stunt virus for use in North Carolina is not a high priority research objective.

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