Pod Breakdown Resistance in Peanuts[1]

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ABSTRACT

During 1969-73, 13 commonly grown Virginia-type peanut (**Arachis hypogaea** L.) cultivars, 15 plant introductions. and two breeding lines were evaluated under field conditions for resistance to the pod breakdown fungi **Pythium myriotylum** and **Rhizoctonia solani.** Four cultivars—Early Runner. Florunner, Florigiant, and NC 17—having related pedigrees were consistently more resistant to infection by these two fungi. P.I. 341880 and P.I. 341885 and Florida breeding line F439-16-6 showed similar resistance to infection. Cultivars most susceptible to pod breakdown were NC 5, Va. 56R, Ga. 119-20 and Va. 72R. P.I. 343410 and a selection from P.I. 319178 were extremely susceptible to pod breakdown. Resistance to pod breakdown seems to have been derived from a cross between a small, white-seeded Spanish-type peanut and Dixie Giant, a large-seeded Virginia-type peanut. All resistant cultivars are related to this cross, whereas the susceptible cultivars lack these parental types in the pedigrees.

Additional index words: **Pythium myriotylum, myriotylum, Rhizoctonia solani, Arachis hypogaea.** groundnut, soil-borne fungi.

Peanut pod breakdown, caused mainly by *Pythium myriotylum* Drechs. and *Rhizoctonia solani* Kuehn, became a serious problem throughout the Virginia-North Carolina peanut belt in the early 1960's. In some fields, pod breakdown is so severe that yields are greatly reduced. Long-term crop losses have been estimated at 15-20% (19).

In some years, most of the pod breakdown is caused by *P. myriotylum,* whereas in other years, it is caused by *R. solani.* Also, certain fields seem to have high inoculum densities of *P. myriotylum,* whereas other fields seem to have high inoculum densities of *R. solani.* Pod breakdown caused by *P. myriotylum* is described by Garren (7, 8). pathogenicity of this fungus to peanut pods has also been shown in Israel (4, 5) and in Libya (18). *P. myriotylum* can also cause wilt (15, 16), a root rot (13), a seedling damping-off (2), and a seed decay (1) of peanut. Pods damaged by insects such as the southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber) are more often colonized by *P. myriotylum* than similar non-damaged pods (17). According to Middleton (14), *P. myriotylum* thrives best in hot soils (34-37 C). Pythium pod breakdown is also favored in soils having a continuous supply of moisture (3).

The omnipresent *R. solani* can attack peanuts at all stages of growth. Although Krantz and Pucci (12) associated *R. solani* with an in-soil peanut pod rot, Garren (9) was the first to demonstrate pathogenicity. Disease development is favored by temperatures ranging from 19 to 36 C and moderate soil-moisture levels (11).

Pod breakdown caused by *R. solani* and *P. myriotylum* is indistinguishable visually. Both rots are characterized by brownish black lesions on the shell. The entire pod may become discolored. Pods infected with *P. myriotylum* and *R. solani* may be found on the same plant. In fact, both organisms have been isolated from the same rotted pod. In advanced stages of rot, mycelia of either *P. myriotylum* or *R. solani* can be observed inside pod cavities. Oospores of *P. myriotylum* are readily observed inside pods rotted by this fungus.

Many fungi, including *Sclerotium rolfsii* Sacc., *Sclerotinia sclerotiorum* (Lib.) d By., and *Botrytis cinerea* Pers. ex Fr, can also cause a rotting of developing peanut pods. However, the pod rots caused by these pathogens are phases of diseases with above-ground symptoms such as stem cankers and foliage blights. Severe pod breakdown can be caused by either *P. myriotylum* or *R. solani* without above-grousd symptoms. Nevertheless, the occurrence of a wilt (16) during the growing season, even though the plants appear to recover, may indicate that *P. myriotylum* is present in the field and thus forecast a pod breakdown problem.

The objectives of this study were (a) to determine the relative susceptibility of currently grown peanut cultivars to pod breakdown caused by *P. myriotylum* and *R. solani* and (b) to evaluate and compare the pod breakdown susceptibility of peanut plant introductions and breeding lines to the susceptibility of cultivars currently available. A preliminary report has been published (19).

Materials and Methods

During 1969-73, peanut cultivars, including the majority of those currently available to growers of Virginia and North Carolina, were grown near Holland, Va, in fields having histories of pod breakdown. Land preparation, planting of seed, cultivation, and pesticide usage were the same as those recommended for growers. Nematicides were not used. Plots were two rows wide (1.8 m) and 4.6 m long, arranged in a randomized complete block with four replications.

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One to two weeks before normal harvest time (2nd week in October), plots were sampled for pod breakdown as follows: (a) Four plants were selected at random from within each plot, two plants from each row. (b) Plants were carefully removed from the soil with a handfork. (c) Soil was searched for the presence of sound and rotted detached pods. (d) Plants and detached pods, were hand-washed, and remaining pods were removed by hand. (e) Pods less than 1.5 cm in length were discarded. (f) A total pod count per plant was determined, and pods were observed for evidence of rot, as indicated by shell discoloration. (g) Pod breakdown percentages were calculated. Pieces of shell from randomly selected rotted pods were plated on corn-meal agar (a medium adapted to isolation of pythiaceous fungi such as **P. myriotylum**) and potato-dextrose agar (a general-purpose medium), to determine the pathogen(s) responsible for pod breakdown during any particular sampling.

During 1970-73, several peanut plant introductions and two Florida breeding lines were included in the pod breakdown screening trials. The plant introductions included in the test had been screened for resistance to pod and root diseases in Israel (6).

Results and Discussion

Table 1 lists the percentages of pod breakdown for the 13 Virginia-type peanuts which are most often planted in Virginia and North Carolina. On the basis of this 5 year screening program, cultivars were ranked and divided into three groups, depending on susceptibility to the pod breakdown fungi. Cultivars appearing most resistant to pod breakdown were Early Runner, Florunner, Florigiant, and NC 17. Moderately resistant cultivars were Va. Bunch 46-2, NC 2, Shulamit, Va. 61R, and NC-Fla. 14. Cultivars appearing most susceptible to pod breakdown were NC 5, Va. 56R, Ga. 119-20, and Va. 72R. In 4 of the 5 years, Early Runner had fewer rotted pods than all the other cultivars tested. In most years, pod breakdown was significantly lower in Early Runner than in other cultivars. Similar results were noted in comparisons between Florunner, Florigiant, and NC 17 and the more susceptible cultivars.

The reaction of peanut breeding lines and plant introductions to pod breakdown is given in Table 2. Florida breeding line F439-16-6 appeared to be as resistant to the pod breakdown fungi as Early Runner, Florunner and Florigiant. Interestingly, F439-16-6 is a bunch-type selection from the cross from which Florunner was derived. Also, P.I. 341880 and P.I. 341885 showed similar resistance to the pod breakdown fungi. Both of these plant introductions have been previously reported (6) to be highly resistant to the pythium root-and pod-rot complex in Israel. Breeding line NC Acc 344, P.I. 295214, P.I. 341879, and P.I. 341881 were moderately resistant to pod breakdown. The most susceptible introductions included a selection from P.I. 319178 and P.I. 343410.

Table 1. The reaction of peanut cultivars grown under field conditions for 5 years at Holland, Va., to pod breakdown, caused by Pythium myriotylum **and** Rhizoctonia solani.

		Yearly pod breakdown percentages				
Cultivar	5-Year mean	1969 [1]	1970	1971	1972	1973
Early Runner	1.5	1.6^{a}	0.7^{a}	1.8^{a}	3.0^{a}	0.3^{a}
Florunner	3.3	4.1^{ab}	0.4^{a}	1.8^{a}	7.3^{ab}	3.0^{abc}
Florigiant	3.3	2.2^{a}	0.9^{a}	1.8^{a}	8.3^{ab}	3.3^{abc}
NC 17	4.1	-	1.0^{a}	0.4^{a}	13.0^{abc}	1.9^{ab}
Va. Bunch 46-2	5.1	7.3^{bc}	5.5^{bc}	5.1^{a}	-	2.4^{abc}
NC 2	5.3	3.3^{ab}	0.6^{a}	3.6^{a}	-	13.8^{cd}
Shulamit	7.5	-	5.9^{bc}	4.9^{a}	8.0^{ab}	11.1^{abcd}
Va. 61R	8.1	10.1^{cd}	4.8^{bc}	5.6^{a}	-	11.8^{abcd}
NC-Fla. 14	8.3	-	-	1.8^{a}	15.8^{bc}	7.2^{abc}
NC 5	11.1	11.1^{d}	3.2^{ab}	16.6^{b}	-	13.4^{cd}
Va. 56R	12.2	6.8^{bc}	3.7^{ab}	19.7^{b}	18.0^{c}	12.7^{bcd}
Ga. 119-20	12.2	11.5^{d}	8.8^{c}	5.0^{a}	18.3^{c}	17.4^{d}
Va. 72R	13.6	-	-	8.3^{a}	19.3^{c}	13.1^{bcd}
Yearly mean		5.9	3.1	5.8	12.2	8.6

[1] Means followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range test.

Table 2. Reaction of most resistant peanut cultivars, selected breeding lines, and plant introductions to pod breakdown caused by Pythium myriotylum and Rhizoctonia solani.

Line or Plant Introduction	Identification or pedigree	Source	% Pod Breakdown
Early Runner	Florida Spanish X Dixie Giant	Florida	1.2
Florunner	F334A-B-14 X F230-118-B-8-1	Florida	3.1
Florigiant	F334A-3-5-5-1 X F359-1-3-14	Florida	3.6
F439-16-6	F334A-B-14 X F230-118-B-8-1	Florida	4.0
P.I. 341880	Venezuela C-15607	Israel	4.1
P.I. 341885	Schwartz 21, Rehovot 121	Israel	4.1
P.I. 341881	A-K-10	Israel	5.1
NC Acc 344	NC Bunch X P.I. 121067	NC	5.4
P.I. 295214	Mwitunde-7	Israel	5.5
P.I. 341879	Tarapoto 63-1556	Israel	5.9
P.I. 343394	VBD 4[1] X Schwartz 21	Israel	7.1
P.I. 343419	Nambyquarae X Unknown	Israel	7.2
P.I. 343379	Virginia Sihit[2] X Schwartz 21	Israel	7.4
P.I. 341884	Matjan, Rehovot 119	Israel	7.9
P.I. 343378	Virginia Sihit X Schwartz 21	Israel	7.9
P.I. 343409	VBD X Schwartz 21	Israel	8.1
P.I. 343380	Virginia Sihit X Schwartz 21	Israel	8.5
P.I. 343381	Virginia Sihit X Schwartz 21	Israel	8.8
P.I. 319178S1	Selection from Shulamit	Israel	10.3
P.I. 343410	VBD 4 X Schwartz 21	Israel	12.4

[1] Same as Va. Beit Dagon #4 or V4.

[2] Same as Va. Sihit Meshubahat or VSM.

Severity of pod breakdown varied from year to year, ranging from 3.1% in 1970 to 12.2% in 1972. In 1972, pod breakdown severity ranged from 3.0% in Early Runner to 19.3% in Va. 72R. This was the highest pod breakdown reading recorded for Early Runner for the 5 years. Pod breakdown in 1972 was caused mainly by *P myriotylum*. This fungus was isolated from about 80% of the rotted pod pieces plated on corn-meal agar. *R. solani* was isolated infrequently from rotted pods. *P. myriotylum* also dominated rotted pods in 1969 and 1973. *R. solani* was isolated from rotted pods at a greater frequency than *P. myriotylum* during 1970 and 1971. Sometimes, both *P. myriotylum* and *R. solani* could be isolated from individual rotted pods coming from the same plant. Occasionally, both fungi could be isolated from the same rotted pod. Perhaps an interaction such as described by Frank (5), which involved *P. myriotylum* and *Fusarium solani* (Mart.) Appel & Wr. peanut pod rot, could occur between *P. myriotylum* and *R. solani*.

The pedigrees of the most resistant and susceptible cultivars are noteworthy, because genotypic differences between each group appear readily (Table 3). The resistant cultivars Early Runner, Florunner, Florigiant, and NC 17 have a Spanish-type pedigree. These cultivars are descendents of a cross made in Florida in 1933 between a Florida small white Spanish (*A. hypogaea* ssp. *vulgaris*) and Dixie Giant (*A. hypogaea* ssp. *hypogaea*). The Florida breeding line F439-16-6 is also a descendant of this cross and is likewise resistant to pod breakdown. The susceptible cultivars NC 5, Va. 56R, Ga. 119-20, and Va. 72R are selections from or crosses among Virginia-type genotypes (*A. hypogaea* ssp. *hypogaea*). Except for NC 5, the pedigrees of the cultivars susceptible to pod breakdown lack a Spanish-type ancestry. Although one of the parents of NC 5 is a Spanish-type (P.I. 121067) it is not related to the Florida small white Spanish parent of the resistant cultivars. This fact suggests that resistance to pod breakdown was present in the Florida small white Spanish cultivar.

Table 3. Cultivars ranked according to pod breakdown severity and pedigree of each cultivar screened for resistance to pod breakdown caused by Pythium myriotylum and Rhizoctonia solani.

Cultivar	Rank	Pedigree
Early Runner	1	Florida Spanish X Dixie Giant
Florunner	2	F334-A-B-14 X F230-118-B-8-1
Florigiant	3	F334A-3-5-5-1 X F359-1-3-14
NC 17	4	F334A-3-5-5-1 X Jenkins Jumbo
Va. Bunch 46-2	5	Atkins Runner Selection
NC 2	6	Ga. 207-2 X Whites Runner
Shulamit	7	Florigiant X F334A-B-17-1
Va. 61R	8	Atkins Runner Selection
NC-Fla. 14	9	F334A-3-5-5-1 X Jenkins Jumbo
NC 5	10	P.I. 121067 X NC Bunch
Va. 56R	11	Atkins Runner Selection (Va. A12-2)
Ga. 119-20	12	Southeastern Runner X Virginia Runner
Va. 72R	13	Va. B22-15 X Va. A89-15

According to Frank (3), soil moisture conditions may influence the severity of pod breakdown. In 1972, severe pod breakdown (12.2%) occurred in the test plots. Rainfall was excessive during September (17.3 cm) although near drought-like conditions prevailed during August (1.9 cm). The drought-resistant Pythium (10) could have survived the dry soil of August and, when soil moisture increased in September, could germinate and colonize available substrates freely. These may be some of the reasons for the high incidence in 1972 of pod breakdown caused by *P. myriotylum*. Similar conditions are known to enhance the severity of pythium wilt, also caused by *P. myriotylum* (16).

Although the cultivars Early Runner, Florunner, Florigiant, and NC 17 rank as most resistant to pod breakdown caused by *P. myriotylum* and *R. solani*, the level of resistance is not high enough to prevent serious yield reduction under some field conditions. Therefore, the search for a greater degree of resistance should continue.

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