Resistance to Sclerotinia Blight and Early Leafspot in Chinese Peanut Germplasm[1]

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ABSTRACT

Sclerotinia minor, causal agent of Sclerotinia blight, and *Cercospora arachidicola*, causal agent of early leafspot, are two of the most important pathogens of peanut (*Arachis hypogaea* L.) in Virginia and North Carolina. Twenty-two Chinese peanut germplasm lines were screened to identify resistance to these two pathogens, and evaluated for agronomic characteristics including seed size, testa color, and pod yield. Germplasm lines with PI numbers 476824 and 476843 exhibited more resistance to *S. minor* than other Chinese plant introductions, or the U.S. cultivars Florigiant and VA 81B. PI 476823 and PI 476837 were most resistant to *C. arachidicola*. Resistance to one pathogen was often associated with high levels of susceptibility to the other pathogen. Resistance to *S. minor* was also associated with undesirable characteristics for large-seeded virginia-type peanuts such as tan testa color and small seed size.

Key Words: Peanut germplasm, *Arachis hypogaea*, disease resistance, testa color, spanish-type, groundnut.

Millions of dollars are spent annually in Virginia to control Sclerotinia blight, caused by *Sclerotinia minor* Jagger (13), and early leafspot, caused by *Cercospora arachidicola* Hori (16). Although current strategies are based principally on chemical controls, other approaches such as the development of resistant cultivars (5, 6, 8, 10, 17), rotations (16), cultural practices (14, 16) and biological control (1, 11) are being used. At best, these approaches provide only partial control and must be used in conjunction with fungicides. The development of cultivars with resistance to the major peanut diseases such as Sclerotinia blight and early leafspot is a common goal of peanut breeders and would significantly impact production.

Hammons (9) noted that the number of reports of disease resistance will increase as more diverse samples of germplasm, representing wider geographical areas, are screened. Resistance to several diseases has been identified in plant introductions (PI) obtained abroad. In fact, resistance to the bacterial wilt pathogen (*Pseudomanas solanacearum*) has been found in Schwarz 21, a peanut endemic to Indonesia (2). One of the limiting factors in peanut breeding programs is the availability of germplasm with a broad base and useful genetic diversity. Since peanuts are grown on six continents, some diversity must exist. China, one of the world's largest peanut producers, grows in excess of seven million acres annually and has a repository of thousand of germplasm lines and/or cultivars developed over the past four centuries. A portion of this germplasm has recently become available in the U. S. for breeding purposes. One of three Chinese germplasm lines tested in 1985 exhibited some resistance to *S. minor* (7).

The objectives of this study were to evaluate 22 peanut germplasm lines obtained from China for resistance to Sclerotinia blight and early leafspot. Other characteristics evaluated included seed weight, testa color, and pod yield.

Materials and Methods

Seed of peanut germplasm used in this study were collected by R. O. Hammons and D. M. Porter from the People's Republic of China (PRC) in 1982. The Institute of Oil Crops at Wuhan, Hubei Province; the Guangdong Academy of Agricultural Sciences at Guangzhou, Guangdong Province; and the Economic Crops Research Institute at Zhengzhou, Henan Province provided seed (Table 1). Plant introduction numbers were assigned to each Chinese germplasm line.

Table 1. Peanut germplasm lines obtained from three provinces of the People's Republic of China with assigned plant introduction numbers (PI).

Germplasm Line	PI Number	Germplasm line	PI Number
Hubei Province			
Bai sha 1016	476821	Xu xi 4	476823
320-14	476824	Hai hua	476825
Yi shui zao shu	476826	Hong hua 1	476827
You ma 1	476828	Che ke hua sheng	476829
Fu jia ping 17	476831	Yue you 589	476834
He you 2	476835	Zi jin zhong	476836
Nan fu luo	476837	Pu yang ruan yang	476838
Henan Province			
Kainong	476840	Zheng zhou 7432	476841
Guangdong Province			
Yue you 22	476842	Shi xuan 64	476843
De dou	476844	Hui za 24	476845
Zhan you 1	476846	Chen you 505	476847

During 1986 and 1988 the Chinese germplasm lines and two U.S. cultivars, Florigiant (3) and VA 81B (6), were planted in grower-owned fields with histories of Sclerotinia blight. Plots, 6.1 m long and two rows wide, were arranged in a randomized complete block design with four replications. Rows were spaced 0.9 m apart and intrarow seed spacing was 6.4 cm. Peanuts were planted about May 1 of each year and production practices recommended by the Virginia Cooperative Extension Service were followed. Chlorathalonil (Bravo 720), applied with a tractor-mounted sprayer, was used for leafspot control (4 to 6 applications at 1.75 L ha^{-1} per application) and to enhance severity of Sclerotinia blight (12). A 1 m row segment located in the center of each two-row plot was left unsprayed to assess the severity of leafspot.

Evaluation for Sclerotinia blight resistance. Plants were evaluated September 22, 1986 and September 28, 1988 for severity of Sclerotinia blight. Each two-row plot was divided into 0.3 m subunits totaling 40 per plot. Any evidence or sign of Sclerotinia blight (diseased or dead tissues) or the presence of *S. minor* (presence of mycelium on plants) within each subunit of row was considered as infected. The total number of subunits (0.3 m) observed to be infected was divided by 40 to determine infection percentage per plot.

Evaluation for leafspot resistance. Plants not sprayed with chlorathalonil were evaluated for leafspot susceptibility. Leafspot severity was determined using a disease index scale of 1 to 10: 1 = < 5% damage and 10 = 100% leaflet infection or complete defoliation. Four observations were averaged for each plot. Measurements were made September 23, 1986, and September 29, 1988.

Evaluation of germplasm characteristics. Seed weight was determined by weighing 100 seed that were retained on a 5.95 mm X 2.54

[1]Mention of firm names or trade products in this paper does not constitute a recommendation by the USDA or VPI & SU nor does it imply registration under FIFRA.

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cm slotted screen. Testa color was determined visually with the predominant colors being pink and tan. Pod yield was determined by weighing dried pods (7% moisture, wet weight basis) from each plot.

Results

Sclerotinia evaluation. Sclerotinia blight was severe during both years of the study (Table 2). In general, Sclerotinia was more severe in the U.S. cultivars (Florigiant and VA 81B) than in the Chinese germplasm. In 1986, onlt three Chinese germplasm lin es (PI 476837, PI 476840, and PI 476838) exhibited significantly more severe symptoms of Sclerotinia blight than the resistant U.S. cultivar VA 81B. In 1988, with severe disease presence, five of the 22 Chinese germplasm lines exhibited numerically more severe symptoms of Sclerotinia blight than VA 81B but only one was significantly higher. In 1986 and 1988, PI 476824, from Hubei, and PI 476843, from Guangdong, appeared the most resistant to *Sclerotinia minor*. The percentage of infection for the Chinese germplasm lines ranged from 7.5% to 67.5% in 1986, and 24.5% to 97.8% in 1988. Florigiant and VA 81B averaged 61.1% and 42.5% in 1986 and 88.8% and 78.8% in 1988, respectively. The two germplasm lines from Henan Province (PI 476840 and PI 476841) appeared susceptible to *Sclerotinia minor* even though PI 476841 was numerically better than VA 81B in 1988. In general, germplasm from Guangdong Province were less susceptible than germplasm from Hubei or Henan Provinces.

Leafspot evaluation. All Chinese germplasm lines were susceptible to early leafspot (Table 2). The disease index in the Chinese germplasm ranged from 2.3 to 7.0 in 1986. In 1988, disease incidence ranged from 3.3 to 7.0. Leafspot severity in the Florigiant and VA 81B was 5.5 in 1986 and 6.0 and 6.3, respectively, in 1988. Mean susceptibility of the germplasm from the three provinces to esrly leafspot was similar. PI 476823 and PI 476837 showed some resistance both years.

Evaluation of germplasm characteristics. About on-half of the Chinese germplasm evaluated met virginia market grade standards with pods grading higher than 40% fancy (pods retained on 5.95 mm x 2.54 slotted screen). However, seed of the majority of the germplasm lines were smaller (g/100 seed) than the U.S. cultivars (Table 3). Seed weight of the 22 Chinese germplasm lines ranged from 45 to 87 g/100 seed compared to 71 and 83 g/100 for Florigiant and VA 81B, respectively.

Seed testa color ranged from pink to tan (Table 3). One-half of the germplasm lines obtained from Hubei Province, two-thirds of the germplasm lines from Guangdong Province, and both of the germplasm lines from Henan Province exhibited pink testa.

Pod yields of the Chinese germplasm averaged 2129 kg/ha in 1986 and 2714 kg/ha in 1988 compared to 2219 and 2793 kg/ha for U.S. cultivars in 1986 and 1988, respectively. In 1986 pod yields in the Chinese germplasm ranged from 1415 to 2910 kg/ha. Yields in 1988 ranged from 1403 to 3388 kg/ha.

Discussion

In this study, a range of susceptibility to Sclerotinia blight and early leafspot was exhibited in the Chinese germplasm when compared with the U.S. cultivars, Florigiant and VA 81B (Table 2). Genotype./year interactions were noted for

Table 2. Reaction of 22 Chinese peanut germplasm lines and two U.S. cultivars to *Sclerotinia minor* and *Cercospora arachidicola* in 1986 and 1988.[Y]

Cultivar/Plant introduction	Sclerotinia blight plants infected (%) 9/22/86	9/28/88	Early leafspot DI: 1-10[Z] 9/23/86	9/29/88
Florigiant	61.1 ab	88.8 a-c	5.5 b-f	6.0 ab
VA 81B	42.5 cd	78.8 b-d	5.5 b-f	6.3 ab
PI 476821	18.8 ef	97.8 a	7.0 a	7.0 a
PI 476823	18.3 e-g	82.3 a-d	4.0 g	3.5 e
PI 476824	7.5 g	26.3 ij	6.0 b-e	4.5 c-e
PI 476825	23.2 e	43.8 f-h	4.8 d-g	6.3 ab
PI 476826	12.5 e-g	77.5 b-d	5.5 b-f	4.0 de
PI 476827	12.0 fg	55.0 e-g	7.0 a	6.0 ab
PI 476828	37.0 d	48.8 fg	7.0 a	6.0 ab
PI 476829	10.7 fg	55.0 e-g	5.0 d-f	5.3 b-d
PI 476831	17.5 e-g	56.3 e-g	4.8 d-g	5.8 a-c
PI 476834	12.0 fg	27.5 ij	6.8 ab	5.8 a-c
PI 476835	14.5 e-g	77.0 b-d	6.8 ab	6.0 ab
PI 476836	17.0 e-g	30.0 h-j	6.3 b-d	5.5 bc
PI 476837	67.5 a	75.0 cd	2.3 h	3.8 e
PI 476838	46.2 cd	80.1 b-d	4.5 e-g	5.5 bc
PI 476840	51.1 bc	92.5 ab	4.3 fg	5.3 b-d
PI 476841	35.8 d	70.0 de	6.8 ab	5.8 a-c
PI 476842	17.5 e-g	58.8 ef	6.5 b-d	5.8 a-c
PI 476843	8.8 fg	24.5 j	7.0 a	6.0 ab
PI 476844	18.3 e-g	83.8 a-d	6.3 b-d	3.3 e
PI 476845	12.5 e-g	53.4 fg	6.3 b-d	6.0 ab
PI 476846	10.7 fg	51.1 fg	5.3 c-f	5.5 bc
PI 476847	10.7 fg	41.1 g-i	6.3 b-d	6.3 ab

[Y] Treatment means within a column, followed by a common letter are not significantly different at the P = 0.05 level as determined by the Waller-Duncan K-ratio T Test.

[Z] Disease index scale: 1 = < 5% infection and 10 = 100% leaflet infection or complete defoliation.

Table 3. Plant characteristics and pod yield of Chinese peanut germplasm.[Z]

Cultivar/Plant introduction	Seed wt. (g/100 seed)	Testa color	Yield (kg/ha) 1986	1988
Florigiant	71	Pink	2625 ab	2828 b-f
VA 81B	83	Pink	1812 f-j	2757 d-g
PI 476821	65	Tan	1415 j	2818 b-f
PI 476823	78	Pink	2259 b-e	3286 ab
PI 476824	57	Tan	1557 ij	2187 hi
PI 476825	59	Tan	2287 b-e	3317 a
PI 476826	74	Pink	1842 f-i	1780 ij
PI 476827	66	Tan	2544 a-c	3265 a-c
PI 476828	63	Pink	2014 d-g	1403 j
PI 476829	46	Tan	2106 d-h	2564 e-h
PI 476831	45	Tan	2361 b-d	3388 a
PI 476834	53	Pink	2106 d-h	2442 f-h
PI 476835	55	Pink	2391 b-d	2523 e-h
PI 476836	58	Tan	2045 d-h	2798 c-f
PI 476837	75	Pink	2910 a	2361 f-h
PI 476838	84	Pink	2197 c-g	2686 d-g
PI 476840	67	Pink	2208 c-f	3143 a-d
PI 476841	87	Pink	1760 h-j	2961 a-e
PI 476842	52	Tan	1933 e-i	2736 d-g
PI 476843	59	Tan	2137 c-h	3317 a
PI 476844	59	Pink	2217 b-f	2574 e-h
PI 476845	52	Pink	2065 d-h	2279 gh
PI 476846	55	Tan	2523 a-c	3276 a-c
PI 476847	62	Tan	1790 g-j	2564 e-h
Mean seed/yield wt.	64		2128	2719

[Z] Treatment means within a column, followed by a common letter are not significantly different at the P = 0.05 level as determined by the Waller-Duncan K-ratio T Test.

some germplasm lines. The interactions reflect a greater increase in the percentage of diseased plants for some germplasm lines in 1988 as compared to 1986. This might have resulted from escapes in 1986 which were infected in 1988 as a result of the heavier inoculum load, the overwhelming of low levels of resistance that were apparent in 1986, or some unknown situation such as temperature induced sensitivity at stages of plant development which affected the infection process. Chinese germplasm such as PI 476824, PI 476834, PI 476836, and PI 476843 were moderately resistant to Sclerotinia blight but highly susceptible to early leafspot. In 1988, germplasm lines PI 476823 and PI 476837 appeared very susceptible to Sclerotinia blight but somewhat resistant to early leafspot. In 1988, germplasm lines PI 476821 and PI 476835 were susceptible to both diseases. Resistance to both *S. minor* and *C. arachidicola* is apparent in the Chinese germplasm when compared to the U.S. cultivars Florigiant and VA 81B (Table 2). Germplasm from the PRC could be used in developing superior peanut cultivars with resistance to Sclerotinia blight and early leafspot.

The Chinese germplasm lines (PI 476824 and PI 476843) most resistant to Sclerotinia blight were small-seeded with tan testa, a trait not desired by the industry. Such traits are not preferred for use usually in the development of large-seeded cultivars for production in Virginia and North Carolina. However, both of these germplasm lines are early maturing and PI 476843 as well as PI 476846 exhibited high yield potentials; traits which are desirable in the Virginia and other breeding programs.

Peanut cultivars with spanish ancestry appear to be more resistant to Sclerotinia blight than cultivars or breeding lines from non-Spanish ancestry (10, 15). Porter *et al.* (15) noted that three of the most Sclerotinia blight resistant cultivars studied exhibited Spanish characteristics. For example, PI 343392, obtained from a cross between V4 and Schwartz 21 (a spanish line), was most resistant to Sclerotinia blight. Chico, a spanish line, was more resistant to Sclerotinia blight than cultivars or breeding lines without Spanish ancestry (5). Six peanut germplasm lines with Spanish ancestry were recently released as having multiple disease resistance (8). Recently released Sclerotinia blight resistant germplasm lines (TXAG-4 and TXAG-5) are spanish-types (17). Based on branching characteristics the two most Sclerotinia blight resistant Chinese germplasm lines in this study, PI 476824 and PI 476843, were thought to have spanish pedigrees. Spanish cultivars have been for many years the peanut of choice for Chinese growers in Hubei and Guangdong Provinces. The planting of such cultivars might be the reason why Sclerotinia blight is not a serious problem in the PRC, even though this disease was discovered in China in 1933 (4). Even in Lianoning Province, one of the northernmost provinces that produces peanuts and a province where the environment is similar to that found in Virginia, predominately Spanish peanuts are planted and Sclerotinia blight is not a serious problem.

The 22 Chinese peanut germplasm lines utilized in this study exhibited some undesirable characteristics such as small seed size and tan testa color. However, *S. minor* resistance noted in plant introductions PI 476824 and PI 476843 might be useful in the development of agronomically acceptable cultivars resistant to this destructive soilborne pathogen.

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