Cucumber Germplasm Resistant to *Cladosporium cucumerinum*

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Abstract. Scab (caused by *Cladosporium cucumerinum* Ell. & Arth.) is an important disease of cucumber (*Cucumis sativus* L.), and the only source of resistance traces back to the cultivar Maine No. 2. We inoculated hypocotyls of 188 cucumber accessions with one strain of the scab fungus to identify other sources of scab resistance. Accessions NSL5731, 255933, 264666, 264667, 306785, 342951, 354952, 458845, and 535881 showed no symptoms. Plants in accession 525075 showed a continuous phenotypic distribution for reaction to scab; all other accessions were susceptible.

Scab is an important disease of cucumber, and was a serious threat to cucumber production in the northern United States, Canada, and northern Europe before 1950. Bailey (1939) developed the scab-resistant cultivar Maine No. 2, which Bailey and Burgess (1935) and Walker (1950) used to demonstrate that resistance was controlled by a dominant allele at the *Ccu* locus (Xie and Wehner, 2001). To the knowledge of the authors, all current scab-resistant cucumbers trace back to 'Maine No. 2' (Walker et al., 1953). There is no evidence of race specialization in the scab fungus, and this single source of resistance has remained effective over many years. Nevertheless, it is important to identify other sources of scab resistance in the event of failure of the presently used source of resistance. In addition, the dominance of scab resistance and the ease of seedling evaluations (Abul-Hayja, 1975; Vakalounakis and Williams, 1989) make scab resistance an excellent phenotypic marker for hybridity.

Materials and Methods

Phenotypic evaluations for scab resistance were conducted using hypocotyl inoculations as described by Abul-Hayja (1975). A total of 188 cucumber plant introductions (PIs) were selected, taking into account maximum geographical diversity [all PIs were listed by Park (2002)]. Seeds were obtained either from

the North Central Regional Plant Introduction Station (Ames, Iowa) or National Seed Storage Laboratory (Fort Collins, Colo.). Cucumber seeds were sown in steam-sterilized coarse-grade vermiculite in wooden flats (52 × 36 × 7 cm). Each flat contained 10 rows. Twenty-five seeds per each PI were sown in each row with resistant (Gy14) and susceptible (Straight 8) controls in a center row. The flats were placed on a heated bench at 32 °C and covered with wet newspapers to ensure rapid and uniform germination. The seedlings were inoculated on the fifth day after seeding, when the cotyledons were just expanded.

Scab strain MJH #662 was stored at 4 °C on potato dextrose agar (PDA) under mineral oil. A piece of mycelium was aseptically removed and placed on a petri plate with PDA and incubated at 20 °C in the dark. For spore collection, 3–4 mLs of distilled water were added to 7- to 10-day-old scab culture; the culture was scraped with a bacteriological loop to dislodge spores; and the liquid was filtered through a single layer of cheesecloth. Spores were counted with a hemacytometer and concentrations adjusted to 4×10^5 spores/mL with sterile distilled water. The inoculum was sprayed onto hypocotyls until runoff, using an airbrush (Badger model 100, Franklin Park, Ill.). Inoculated plants were incubated for 48 h at 20 °C in the dark at 100% relative humidity. Flats were then placed on the greenhouse bench for 3 d and scored 5–7 d after inoculation using a 0 to 9 scale, where 0 = no symptoms; 1 = blisters on hypocotyls; 3 = restricted tan lesion on hypocotyls; 5 = larger tan lesion on hypocotyls; 7 = large sunken lesion on hypocotyls; and 9 = collapsed plant (Abul-Haya, 1975). Mean disease severity indices (DSI) of 3 or less were considered resistant; those >5 were considered susceptible. Disease evaluations were replicated for PI accessions that had a mean DSI <3 in the first inoculation.

Results and Discussion

Susceptible plants developed large sunken lesions on hypocotyls, and most seedlings collapsed 4–5 d after inoculation. Resistant plants showed either no symptoms or shallow tan lesions on hypocotyls. The resistant control (Gy14) had a mean DSI = 0.0 for all inoculations. The susceptible control (Straight 8) was

Table 1. Phenotypic distributions in cucumber plant introductions showing relatively high frequencies of scab resistance (mean disease severity index ≤ 3.0).

Accession	Origin	Nos. of plants with disease severity index ²				
		0	1	3	5	7
197086	India	21				1
229808	Canada	29	2	1		1
255933	Netherlands	25				
264664	Germany	37			1	1
264665	Germany	31	1			
264666	Germany	42				
264667	Germany	43				
264668	Germany	30	1	3		1
283899	Czech Republic	35	1		1	4
285606	Poland	35			2	
285609	Poland	14				
306785	Canada	9				
314425	Former USSR	41				
324239	Sweden	19				1
342951	Denmark	46				
354952	Denmark	50				
379285	Macedonia	33				1
458845	Russia	38				
481614	Bhutan	8	18	8	3	
481617	Bhutan	17	5			
500359	Zambia	31				
525075	Mauritius	17	4	13	2	2
535881	Poland	48				
Ames 19221	Ukraine	10	5	5	2	1
Ames 20206	India	11	3		2	2
Ames 21224	USA	8	14	4		5
NSL 5731	Unknown	22				

²Disease severity indices are described in Materials and Methods. Numbers of plants are the sum of two replications, except 285609 and 306785, which were evaluated once.

Received for publication 16 Sept. 2002. Accepted for publication 4 Feb. 2003. Names are necessary to report factually on available data; however, the U.S. Dept. of Agriculture (USDA) neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.

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rated higher than mean DSI = 8.2, except for two flats with mean DSI = 6.0 and 7.7. Among 188 PI accessions, 27 had high frequencies of resistant plants (mean DSI <3) (Table 1) and 161 had primarily susceptible plants (mean DSI >5). All phenotypic distributions were submitted to the USDA germplasm resource information network (GRIN) and reported in Park (2002). Numerous PI accessions had both resistant and susceptible plants and were likely segregating for these phenotypes. Some PIs showed continuous phenotypic distributions, but these tended to occur in inoculations in which the susceptible controls had relatively low ratings (mean DSIs between 6.0 and 7.7). PI 525075 showed a continuous phenotypic distribution, even though all susceptible controls were killed and the other PIs simultaneously inoculated showed discontinuous phenotypes. For eight PI accessions (NSL 5731, 255933,

264666, 264667, 306785, 342951, 354952, 458845, and 535881), all plants showed no symptoms (DSI = 0.0). PI accessions possessing only resistant plants or segregating for scab resistance tended to be from northern countries and represent important additional sources of scab resistance. However, these accessions may carry the scab-resistance gene originating from 'Maine No. 2'. Among the PI accessions showing high levels of scab resistance (Table 1), the earliest entry into the USDA plant germplasm system was 197086, obtained from India in 1951, well after Bailey (1939) had developed the scab-resistant cultivar Maine No. 2.

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