Reprinted from *Crop Science*
Vol. 35, No. 1

Anthracnose Resistance of the Cucumber Germplasm Collection in North Carolina Field Tests

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ABSTRACT

The resistance of the entire cucumber (*Cucumis sativus* L.) germplasm collection within the U.S. National Plant Germplasm System and of many available cultigens (improved cultivars, breeding lines, land races, feral cucumbers, and plant introductions) to anthracnose [*Colletotrichum orbiculare* (Berk. and Mont.) Arx] was tested under field conditions in North Carolina and compared with known resistant cultigens. Mean anthracnose leaf ratings for environments ranged from 5.5 to 7.7. Data within an environment were standardized to a mean of 4.5 and a standard deviation of 1 to improve comparisons among cultigens by removing the main effect of environments. The most resistant 27 cultigens are all of U.S. origin and are improved cultivars or breeding lines. The most resistant cultigens, for which multiple environment data are available, were 'Dual', 'Regal', 'Slice', and Gy 3. The most susceptible cultigens, for which multiple environment data are available, were PI 390248, PI 251028, and PI 277741. Thirty-one cultigens were classified resistant, 100 moderately resistant, and 773 susceptible. No plant introductions were found to be more resistant than the most resistant named cultivars or breeding lines tested. Cultigens found to be resistant in other studies were generally moderately resistant or resistant in this study, except for PI 179676 and PI 183445, which were susceptible in this test.

ANTHRACNOSE is a major foliar disease of cucumber and under certain environmental conditions, epidemics of anthracnose can cause 60% yield loss (Thompson and Jenkins, 1985a). In North Carolina, the estimated annual incidence of anthracnose is 70% and the average annual dollar loss is 2.8% based on yield and quality reduction of slicing and processing cucumbers (St. Amand and Wehner, 1991). Anthracnose of cucumber is caused by *Colletotrichum orbiculare* (Berk. and Mont.) Arx (Farr et al., 1989). Synonymous names for the pathogen appearing in the literature are, *Colletotrichum lagenarium* (Pass.) Ellis and Halst., *Gloeosporium orbiculare* Berk. and Mont., and *Gloeosporium lagenarium* (Pass.) Sacc. The teleomorph is *Glomerella lagenarium* F. Stevens (Farr et al., 1989).

Fungicides decrease the impact of the disease but are ineffective under environmental conditions favorable to the pathogen, such as frequent rain. Also, efforts to decrease the number of required fungicide applications have not been successful (Thompson and Jenkins, 1985a). Resistant cultivars have been developed (Sitterly, 1973), and yield loss is proportional to cultivar susceptibility (Thompson and Jenkins, 1985a). Resistant cultivars also offer the grower the safest and most cost effective method to reduce pesticide inputs.

The objectives of this experiment were to determine the resistance of the cucumber germplasm collection within the U.S. National Plant Germplasm System and of many available cultigens (improved cultivars, breeding lines, land races, feral cucumbers, and plant introductions) to anthracnose under field conditions in North Carolina and to compare new sources of resistance with that of known resistant cultigens.

MATERIALS AND METHODS

All experiments were run at the Horticultural Crops Research Station at Castle Hayne, NC, using recommended horticultural practices (Hughes et al., 1983). In 1987 and 1988, each cultigen was planted in a single plot 1.5 m long and each plot was thinned to five plants. In 1989, each cultigen was planted in two plots 1.5 m long, in two separate blocks, and each plot was thinned to five plants. Four plots were examined for most cultigens during the 3-yr period; however, 53 cultigens were examined in one plot only.

Fertilizer was incorporated before planting at a rate of 90-39-74 kg ha^{-1} (N-P-K), with an additional 34 kg N ha^{-1} applied at the vine-tip-over stage (four to six true leaves). Seeds were planted on raised, shaped beds with centers 1.5 m apart. The soil was an Onslow loamy fine sand (fine-loamy, siliceous, thermic Spodic Paleudult) with a 6.4 pH. Irrigation was applied when needed for a total of 25 to 40 mm wk^{-1}, and a tank mix of 2.2 kg ha^{-1} of naptalam (2-[(1-naphthalenylamino) carbonyl] benzoic acid) and 4.4 kg ha^{-1} of bensulide (O,O-bis(1-methylethyl) S-[2-[(phenylsulfonyl) amino] ethyl] phosphorodithioate) was applied preplant for weed control.

All available PIs from the U.S. National Plant Germplasm System were tested, along with available breeding lines and cultivars for a total of 904 cultigens from 44 countries (Table 1). The majority of cultigens tested were from Turkey, the USA, the Peoples Republic of China, Yugoslavia, Iran, India, Japan, Sweden, Czechoslovakia, and the Netherlands. Seeds of most cultigens were obtained from the North Central Regional Plant Introduction Station in Ames, IA. Some seeds were obtained from the National Seed Storage Laboratory in Fort Collins, CO, or from commercial sources. Based on PI passport data and other sources, the collection included 218 improved cultivars, 72 breeding lines, 9 landraces, and 17 feral (wild) cucumbers. Most of the cultigens tested (588) could not be placed into one of the above categories due to insufficient passport data.

Cucumber leaves infected with anthracnose were collected from adjacent fields and soaked in water with surfactant (Tween-80 [sorbitan mono-9-octadecenoate poly(oxy-1,2-ethanediyl) derivs]) for 15 min to collect spores. The suspension was filtered through four layers of cheesecloth to remove leaf debris. The presence of anthracnose conidia in the suspension was verified by microscopic examination. The spore concentration used in each test was estimated and ranged from 1×10^2 to 1×10^5 spores mL^{-1} depending on the year of the test. Few spores of other fungi were noted. No artificial inoculum was used. Based on race differentiating cultigens tested along with the cultigens in this test, anthracnose Race 7 is endemic to North Carolina and is likely the race used in our test

Dep. of Horticultural Science, North Carolina State Univ., Raleigh, NC 27695-7609. The use of trade names in this publication does not imply endorsement by the NCARS of the products named, nor criticism of similar ones not mentioned. Received 28 Feb. 1994. *Corresponding author (todd_wehner@ncsu.edu).

Published in Crop Sci. 35:228-236 (1995).

Abbreviations: LSD, least significant difference; G, genotype; E, environment.

Table 1. Mean anthracnose leaf rating for 904 cultigens of *Cucumis sativus* field tested in North Carolina in 1987, 1988, and 1989.†

Cultigen	Origin	Rating‡
Cracker Lee	U.S.A.	0.9§
Discover	U.S.A.	1.6§
Dual	U.S.A.	1.7
Regal	U.S.A.	1.7
Slice	U.S.A.	1.7
Gy 3	U.S.A.	1.7
HMX4490	U.S.A.	2.0
Gy57u	U.S.A.	2.0
Bush Champion	U.S.A.	2.1
M 41	U.S.A.	2.2§
Transamerica	U.S.A.	2.2§
Cross Country	U.S.A.	2.2
M 21	U.S.A.	2.3
Marketsett	U.S.A.	2.3
Pickalot (de)	U.S.A.	2.3
Palmetto	U.S.A.	2.4§
M 22	U.S.A.	2.5
Galaxy	U.S.A.	2.6
Gy 4	U.S.A.	2.6
Olympian	U.S.A.	2.6
Polaris	U.S.A.	2.8
SC 57M	U.S.A.	2.8
Little John (AR79-75)	U.S.A.	2.8§
Centurion	U.S.A.	2.9
Picarow	U.S.A.	2.9
Royal	U.S.A.	2.9
Gy 6	U.S.A.	2.9
PI 163221	India	2.9§
PI 175111	India	3.0
PI 426170	Philippines	3.0
PI 481617	Bhutan	3.0
PI 234517	U.S.A.	3.1
Poinmarket	U.S.A.	3.2
Pick	U.S.A.	3.2
Addis	U.S.A.	3.2
Gy 2	U.S.A.	3.3
PI 306179	Poland	3.3
M 27	U.S.A.	3.3
Gy 14	U.S.A.	3.3
PI 164433	India	3.3
Poinsett 76	U.S.A.	3.4
PI 163216	India	3.4
PI 163213	India	3.4
Gy 5	U.S.A.	3.4
PI 205995	Sweden	3.4§
Clinton	U.S.A.	3.4
Southern Pickler	U.S.A.	3.4§
Poinsett	U.S.A.	3.4§
Sumter	U.S.A.	3.5
PI 319216	Egypt	3.5
PI 163217	India	3.5
PI 200818	Burma	3.5
PI 174177	Turkey	3.5
PI 163218	India	3.5
PI 183127	India	3.5
PI 163222	India	3.5
PI 197087	India	3.6
PI 163223	India	3.6
PI 212896	India	3.6
PI 183677	Turkey	3.6
PI 173674	Turkey	3.6§
Calypso	U.S.A.	3.6
PI 330628	Pakistan	3.6
PI 220789	Afghanistan	3.6§
PI 470254	Indonesia	3.7
PI 173892	India	3.7
PI 302443	Taiwan	3.7
Gy 1	U.S.A.	3.7
Boston Pickling	U.S.A.	3.7
PI 435946	U.S.S.R.	3.7
PI 419182	PR China	3.7
PI 172838	Turkey	3.7
Chipper	U.S.A.	3.7
Pixie	U.S.A.	3.7
PI 209064	U.S.A.	3.7
PI 271327	India	3.8
PI 262974	India	3.8
PI 279463	Japan	3.8
PI 249562	Thailand	3.8

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 164465	India	3.8
Chinese Long Green	U.S.A.	3.8
General Lee	U.S.A.	3.8
PI 169396	Turkey	3.8
PI 169395	Turkey	3.8
PI 422191	Czechoslovakia	3.8
PI 344439	Iran	3.8
MSU 9429M	U.S.A.	3.8
PI 171605	Turkey	3.8§
PI 179260	Turkey	3.8
PI 176519	Turkey	3.9
PI 264231	France	3.9
PI 164734	India	3.9
PI 165046	Turkey	3.9
PI 308916	U.S.S.R.	3.9
PI 172841	Turkey	3.9
PI 426629	Pakistan	3.9
PI 167358	Turkey	3.9
Carolina	U.S.A.	3.9
PI 137857	Iran	3.9
PI 174172	Turkey	3.9
PI 169397	Turkey	3.9
PI 358813	Malaysia	3.9
PR 27	U.S.A.	3.9§
Lemon	U.S.A.	3.9§
PI 164670	India	3.9
PI 179921	India	4.0
PI 175120	India	4.0
PI 222987	Iran	4.0
Balam Khira	India	4.0
Homegreen #2	U.S.A.	4.0
PI 432859	PR China	4.0
PI 390266	Japan	4.0
PI 183056	India	4.0
PI 205181	Turkey	4.0
PI 422182	Czechoslovakia	4.0
PI 264666	Germany	4.0
PI 175121	India	4.0
PI 105340	PR China	4.0
PI 217644	India	4.0
PI 183231	Egypt	4.0
PI 169334	Turkey	4.0
PI 207476	Afghanistan	4.0
PI 181942	Syria	4.0
PI 164816	India	4.0
PI 137846	Iran	4.0
PI 176951	Turkey	4.0
PI 249550	Iran	4.0
PI 422180	Czechoslovakia	4.0
Prolific	U.S.A.	4.0
PI 500365	Zambia	4.0
PI 167223	Turkey	4.0
Dasher II	U.S.A.	4.1
Coolgreen	U.S.A.	4.1§
Khira Patna	India	4.1§
PI 432849	PR China	4.1§
PI 483343	Korea	4.1§
PI 227209	Japan	4.1
PI 174174	Turkey	4.1§
PI 179263	Turkey	4.1
PI 109484	Turkey	4.1
PI 279467	Japan	4.1
PI 177360	Turkey	4.1
PI 357858	Yugoslavia	4.1
PI 171606	Turkey	4.1
PI 193496	Ethiopia	4.1
PI 432861	PR China	4.1
PI 164819	India	4.1
PI 223841	Philippines	4.1
PI 264230	France	4.1
PI 109483	Turkey	4.1
PI 135123	N. Zealand	4.1
PI 426169	Philippines	4.1
PI 164743	India	4.1
PI 169351	Turkey	4.1
PI 458850	U.S.S.R.	4.1
PI 306180	Poland	4.1
PI 163214	India	4.1

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Table 1. cont'd

Cultigen	Origin	Rating‡
PI 204569	Turkey	4.1
PI 306785	Canada	4.1
PI 432860	PR China	4.1
PI 267746	India	4.1
PI 169328	Turkey	4.1
PI 164679	India	4.2
PI 458849	U.S.S.R.	4.2
PI 173893	India	4.2
PI 267744	Hong Kong	4.2
PI 197088	India	4.2
PI 432867	PR China	4.2
PI 178886	Turkey	4.2
PI 436648	PR China	4.2
PI 176516	Turkey	4.2
Cubit	U.S.A.	4.2
PI 390239	Japan	4.2
PI 172852	Turkey	4.2
PI 196289	India	4.2
PI 176957	Turkey	4.2
PI 181940	Syria	4.2
PI 109482	Turkey	4.2
PI 200815	Burma	4.2
PI 176526	Turkey	4.2
PI 172840	Turkey	4.2
PI 109063	Turkey	4.2
PI 137848	Iran	4.2
PI 326597	Hungary	4.2
Crystal Salad	U.S.A.	4.2
PI 432851	PR China	4.2
PI 390245	Japan	4.2
PI 181756	Lebanon	4.2
PI 164284	India	4.2
PI 171602	Turkey	4.2
PI 175693	Turkey	4.2
PI 211943	Iran	4.2
PI 169352	Turkey	4.2
PI 419214	Hong Kong	4.2
PI 390262	Japan	4.2
PI 212985	India	4.2
PI 103049	PR China	4.2
PI 176525	Turkey	4.2
PI 390256	Japan	4.2
Muronium	U.S.A.	4.2§
PI 355052	Israel	4.2
PI 135122	N. Zealand	4.2
PI 174173	Turkey	4.2
PI 167043	Turkey	4.2
PI 165509	India	4.2
PI 422218	Israel	4.2
PI 188749	Egypt	4.2
PI 169380	Turkey	4.3
PI 265887	Netherlands	4.3
Early Russian	U.S.A.	4.3
PI 370449	Yugoslavia	4.3
PI 390268	Japan	4.3
PI 206952	Turkey	4.3
PI 478367	PR China	4.3
PI 432897	PR China	4.3
Packer	U.S.A.	4.3
PI 344437	Iran	4.3
PI 169385	Turkey	4.3
PI 368558	Yugoslavia	4.3
PI 224668	Korea	4.3
PI 137847	Iran	4.3
PI 288238	Egypt	4.3
PI 171612	Turkey	4.3
PI 279465	Japan	4.3
PI 109275	Turkey	4.3
PI 391569	PR China	4.3
PI 227210	Japan	4.3
PI 233932	Canada	4.3
PI 179259	Turkey	4.3
PI 181755	Lebanon	4.3
PI 419078	PR China	4.3§
PI 211979	Iran	4.3
PI 171609	Turkey	4.3
PI 279466	Japan	4.3
PI 178888	Turkey	4.3
PI 370022	India	4.3
PI 360939	Netherlands	4.3

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 167134	Turkey	4.3
PI 255937	Netherlands	4.3
PI 179676	India	4.3
PI 271326	India	4.3
PI 176954	Turkey	4.3
Balam Model	India	4.3
Beit Alpha MR	U.S.A.	4.3
Dublin	U.S.A.	4.3
Fancipak	U.S.A.	4.3
Maximore 102	U.S.A.	4.3
PI 370448	Yugoslavia	4.3
PI 326595	Hungary	4.3
PI 390240	Japan	4.3
PI 390244	Japan	4.3
PI 391570	PR China	4.3
PI 432866	PR China	4.3
PI 432885	PR China	4.3
PI 458847	U.S.S.R.	4.3
PI 464873	PR China	4.3
Slice Max	U.S.A.	4.3
Spartan Salad	U.S.A.	4.3
WI 2757	U.S.A.	4.3
Wautoma	U.S.A.	4.3
PI 478366	PR China	4.3
PI 167050	Turkey	4.3
PI 171608	Turkey	4.3
PI 174167	Turkey	4.3
PI 175694	Turkey	4.3
PI 204567	Turkey	4.3
PI 171603	Turkey	4.3
PI 339244	Turkey	4.3
PI 175680	Turkey	4.3
Davis Perfect	U.S.A.	4.3
PI 169391	Turkey	4.3
PI 206043	U.S.A.	4.3
PI 271754	Netherlands	4.3
PI 169383	Turkey	4.3
PI 171604	Turkey	4.4
PI 178887	Turkey	4.4
PI 113334	PR China	4.4
PI 169381	Turkey	4.4
PI 181910	Syria	4.4
PI 174160	Turkey	4.4
PI 257486	PR China	4.4
PI 192940	PR China	4.4
PI 285606	Poland	4.4
PI 183224	Egypt	4.4
PI 206953	Turkey	4.4
PI 264229	France	4.4
Snows Pickling	U.S.A.	4.4
PI 171601	Turkey	4.4
PI 169384	Turkey	4.4
PI 211967	Iran	4.4
PI 175690	Turkey	4.4
PI 179678	India	4.4
PI 466922	U.S.S.R.	4.4
PI 169390	Turkey	4.4
PI 114339	Japan	4.4
PI 344353	Turkey	4.4
PI 169400	Turkey	4.4
PI 109481	Turkey	4.4
PI 193497	Ethiopia	4.4
PI 483339	Korea	4.4
PI 211984	Iran	4.4
PI 432871	PR China	4.4
PI 357860	Yugoslavia	4.4
PI 175683	Turkey	4.4
PI 390264	Japan	4.4
PI 271334	India	4.4
PI 175697	Turkey	4.4
PI 181874	Syria	4.4
PI 211982	Iran	4.4
PI 165499	India	4.4
PI 419040	PR China	4.4
PI 165506	India	4.4
PI 177361	Turkey	4.4
PI 175691	Turkey	4.4
PI 288994	Hungary	4.4

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Table 1. cont'd

Cultigen	Origin	Rating‡
PI 169393	Turkey	4.4
PI 427089	PR China	4.4
PI 385967	Kenya	4.4
PI 211975	Iran	4.4
PI 422177	Czechoslovakia	4.4
PI 211978	Iran	4.4
PI 267942	Japan	4.4
White Wonder	U.S.A.	4.4
PI 137844	Iran	4.4
PI 292011	Israel	4.4
PI 169392	Turkey	4.4
PI 169402	Turkey	4.4
PI 357842	Yugoslavia	4.4
Double Yield	U.S.A.	4.4
PI 209069	U.S.A.	4.5
PI 390261	Japan	4.5
PI 204692	Turkey	4.5
PI 182189	Turkey	4.5
PI 220860	Korea	4.5
PI 167389	Turkey	4.5
PI 177359	Turkey	4.5
PI 182190	Turkey	4.5
PI 174164	Turkey	4.5
PI 264227	France	4.5
PI 267745	Brazil	4.5
PI 288993	Hungary	4.5
PI 135345	Afghanistan	4.5
Crystal Apple	U.S.A.	4.5§
Picklers Special	U.S.A.	4.5§
Poona Khira	India	4.5§
PI 368551	Yugoslavia	4.5§
PI 391571	PR China	4.5§
PI 422200	Czechoslovakia	4.5§
PI 167052	Turkey	4.5
PI 169401	Turkey	4.5
PI 214049	India	4.5
PI 478365	PR China	4.5
PI 172851	Turkey	4.5
PI 263049	U.S.S.R.	4.5
PI 211728	Afghanistan	4.5
PI 137853	Iran	4.5
PI 483341	Korea	4.5
PI 178885	Turkey	4.5
PI 489752	PR China	4.5
PI 173889	India	4.5
PI 222986	Iran	4.5
PI 211117	Israel	4.5
PI 222243	Iran	4.5
PI 385968	Kenya	4.5
PI 392292	U.S.S.R.	4.5
PI 296121	Egypt	4.5
PI 342950	Denmark	4.5
PI 171610	Turkey	4.5
PI 169394	Turkey	4.5
PI 422169	Czechoslovakia	4.5
PI 169388	Turkey	4.5
PI 263085	PR China	4.5
PI 175695	Turkey	4.5
PI 432864	PR China	4.5
PI 211962	Iran	4.5
PI 326596	Hungary	4.5
PI 202801	Syria	4.5
PI 169398	Turkey	4.5
PI 172843	Turkey	4.5
PI 172839	Turkey	4.5
PI 304803	U.S.A.	4.5
PI 271331	India	4.5
PI 271328	India	4.5
PI 263046	U.S.S.R.	4.5
Burpee Pickler	U.S.A.	4.5
PI 137851	Iran	4.5
PI 169387	Turkey	4.5
PI 390258	Japan	4.5
PI 391572	PR China	4.5
PI 422199	Czechoslovakia	4.5
PI 169304	Turkey	4.5
PI 400270	Japan	4.5
PI 432855	PR China	4.5
York State Pickle	U.S.A.	4.5
PI 269481	Pakistan	4.5

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 418964	PR China	4.5
PI 390246	Japan	4.5
PI 176956	Turkey	4.5
PI 263080	U.S.S.R.	4.5
PI 390954	U.S.S.R.	4.5
PI 264228	France	4.5
PI 257494	Iran	4.5
PI 419017	PR China	4.5
PI 432894	PR China	4.5
PI 177363	Syria	4.5
PI 264668	Germany	4.5
PI 357849	Yugoslavia	4.5
PI 137839	Iran	4.5
PI 390260	Japan	4.5
PI 164173	India	4.5§
PI 204568	Turkey	4.5
PI 211986	Iran	4.5
PI 164950	Turkey	4.5
PI 357859	Yugoslavia	4.5
PI 176524	Turkey	4.5
PI 218036	Iran	4.5
PI 355055	Iran	4.5
PI 169350	Turkey	4.5
PI 172849	Turkey	4.5
PI 422168	Czechoslovakia	4.5
PI 267742	Hong Kong	4.5
PI 167198	Turkey	4.5
PI 466921	U.S.S.R.	4.6
PI 339250	Turkey	4.6
PI 211977	Iran	4.6
PI 175686	Turkey	4.6
PI 293432	Lebanon	4.6
PI 118279	Brazil	4.6
PI 344438	Iran	4.6
PI 357869	Yugoslavia	4.6
PI 176950	Turkey	4.6
PI 212599	Afghanistan	4.6
Ashley	U.S.A.	4.6
Delcrow	U.S.A.	4.6
Early Michigan	U.S.A.	4.6
Early White Spine	U.S.A.	4.6
EC 128264	Great Britain	4.6
Marketmore 80F	U.S.A.	4.6
PI 176518	Turkey	4.6
PI 183445	India	4.6
PI 369717	Poland	4.6
PI 379278	Yugoslavia	4.6
PI 379280	Yugoslavia	4.6
PI 379286	Yugoslavia	4.6
PI 422185	Czechoslovakia	4.6
PI 432865	PR China	4.6
PI 432878	PR China	4.6
PI 432880	PR China	4.6
PI 432891	PR China	4.6
PI 432895	PR China	4.6
PI 458845	U.S.S.R.	4.6
PI 458853	U.S.S.R.	4.6
PI 478364	PR China	4.6
PI 105263	Turkey	4.6
PI 137835	Iran	4.6
PI 176924	Turkey	4.6
PI 357845	Yugoslavia	4.6
PI 217946	Pakistan	4.6
PI 422190	Czechoslovakia	4.6
PI 275412	Netherlands	4.6
PI 418989	PR China	4.6
PI 176517	Turkey	4.6
Brice	U.S.A.	4.6
PI 176952	Turkey	4.6
PI 246930	Afghanistan	4.6
PI 181752	Syria	4.6
PI 344445	Iran	4.6
PI 176522	Turkey	4.6
PI 169382	Turkey	4.6
PI 264665	Germany	4.6
PI 357850	Yugoslavia	4.6
PI 174166	Turkey	4.6
PI 137845	Iran	4.6

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Table 1. cont'd

Cultigen	Origin	Rating‡
PI 137836	Iran	4.6
PI 169378	Turkey	4.6
PI 436649	PR China	4.6
PI 326594	Hungary	4.6
PI 174170	Turkey	4.6
PI 167197	Turkey	4.6
PI 344440	Iran	4.6
PI 321009	Taiwan	4.6
PI 209068	U.S.A.	4.6
PI 255938	Netherlands	4.6
PI 176523	Turkey	4.6
PI 451975	Canada	4.6
PI 167079	Turkey	4.6
Straight 8	U.S.A.	4.6
PI 368550	Yugoslavia	4.6
PI 321008	Taiwan	4.6
PI 321010	Taiwan	4.6
PI 175688	Turkey	4.6
PI 339248	Turkey	4.6
PI 432854	PR China	4.6
PI 422174	Czechoslovakia	4.6
PI 263078	U.S.S.R.	4.6
PI 357853	Yugoslavia	4.6
PI 175689	Turkey	4.6
PI 339241	Turkey	4.6
Staygreen	U.S.A.	4.6
PI 222985	Iran	4.6
PI 221440	Afghanistan	4.6
PI 206955	Turkey	4.6
PI 175696	Turkey	4.6
PI 250147	Pakistan	4.6
PI 226461	Iran	4.7
PI 344444	Iran	4.7
PI 248778	Iran	4.7
PI 172846	Turkey	4.7
PI 204690	Turkey	4.7
PI 182192	Turkey	4.7
PI 285605	Poland	4.7
PI 422179	Czechoslovakia	4.7
PI 171611	Turkey	4.7
PI 304805	U.S.A.	4.7
PI 357868	Yugoslavia	4.7
PI 264226	France	4.7
PI 432870	PR China	4.7
PI 175679	Turkey	4.7
Giant Wt. Arnstadt	U.S.A.	4.7
PI 285610	Poland	4.7
PI 229808	Canada	4.7
PI 432879	PR China	4.7
PI 435947	U.S.S.R.	4.7
PI 188807	Philippines	4.7
PI 356809	U.S.S.R.	4.7
PI 171613	Turkey	4.7
Long Green	U.S.A.	4.7§
Mandarin	U.S.A.	4.7§
Medalist	U.S.A.	4.7§
PI 227013	Iran	4.7§
PI 390249	Japan	4.7§
PI 432872	PR China	4.7§
PI 432873	PR China	4.7§
Spacemaster	U.S.A.	4.7§
PI 263081	PR China	4.7
PI 279468	Japan	4.7
PI 092806	PR China	4.7
PI 205996	Sweden	4.7
PI 165029	Turkey	4.7
PI 222244	Iran	4.7
PI 357837	Yugoslavia	4.7
Sprint 440	U.S.A.	4.7
PI 206425	Turkey	4.7
PI 263083	PR China	4.7
PI 458856	U.S.S.R.	4.7
Magnolia	U.S.A.	4.7
PI 267197	PR China	4.7
PI 172845	Turkey	4.7
PI 197086	India	4.7
PI 357834	Yugoslavia	4.7
Marketmore 76	U.S.A.	4.7
PI 175692	Turkey	4.7
PI 171607	Turkey	4.7

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 222783	Iran	4.7
PI 390952	U.S.S.R.	4.7
PI 422183	Czechoslovakia	4.7
PI 279469	Japan	4.7
PI 257487	PR China	4.7
PI 222720	Iran	4.7
PI 220169	Afghanistan	4.7
PI 267087	U.S.S.R.	4.7
PI 314425	U.S.S.R.	4.7
PI 357848	Yugoslavia	4.7
PI 422198	Czechoslovakia	4.7
PI 223437	Afghanistan	4.7
PI 283901	Czechoslovakia	4.7
PI 264664	Germany	4.7
PI 422173	Czechoslovakia	4.7
PI 487424	PR China	4.7
PI 390238	Japan	4.7
PI 432868	PR China	4.7
PI 206954	Turkey	4.7
PI 164951	Turkey	4.7
PI 267935	Japan	4.7
PI 292010	Israel	4.7
PI 344352	Turkey	4.7
PI 432857	PR China	4.7
PI 172844	Turkey	4.7
PI 164952	Turkey	4.7
PI 344442	Iran	4.7
PI 390253	Japan	4.7
PI 212233	Japan	4.7
PI 419010	PR China	4.7
PI 483344	Korea	4.7
Delicatesse	U.S.A.	4.7
SR 551	U.S.A.	4.7§
PI 324239	Sweden	4.7
PI 281448	Korea	4.7
PI 263079	U.S.S.R.	4.8
PI 344349	Turkey	4.8
Alpha Green	U.S.A.	4.8
PI 339245	Turkey	4.8
Stono	U.S.A.	4.8
PI 326598	Hungary	4.8
PI 227207	Japan	4.8
Chicago Pickling	U.S.A.	4.8
PI 391568	PR China	4.8
Pacer	U.S.A.	4.8
PI 279464	Japan	4.8
PI 262990	Netherlands	4.8
PI 357854	Yugoslavia	4.8
Tablegreen 72	U.S.A.	4.8
PI 280096	U.S.S.R.	4.8
PI 177364	Iran	4.8
PI 182188	Turkey	4.8
PI 169386	Turkey	4.8
PI 422170	Czechoslovakia	4.8
PI 357861	Yugoslavia	4.8
PI 285609	Poland	4.8
Arlington Wt. Spine	U.S.A.	4.8
PI 227664	Iran	4.8
Nappa 63	U.S.A.	4.8
PI 251519	Iran	4.8
PI 343452	U.S.S.R.	4.8
PI 344434	Iran	4.8
PI 288995	Hungary	4.8
PI 269480	Pakistan	4.8
PI 227208	Japan	4.8
PI 390243	Japan	4.8
PI 229309	Iran	4.8
PI 338236	Turkey	4.8
Early Cluster	U.S.A.	4.8
PI 283902	Czechoslovakia	4.8
PI 178884	Turkey	4.8
PI 176521	Turkey	4.8
PI 372905	Netherlands	4.8
PI 226509	Iran	4.8
PI 176520	Turkey	4.8
PI 418962	PR China	4.8
PI 379285	Yugoslavia	4.8
PI 263082	PR China	4.8

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Table 1. cont'd

Cultigen	Origin	Rating‡
PI 357865	Yugoslavia	4.8
PI 211980	Iran	4.8
PI 401733	U.S.A.	4.8
PI 422186	Czechoslovakia	4.8
PI 427090	PR China	4.8
PI 222099	Afghanistan	4.8
PI 351140	U.S.S.R.	4.8
PI 137856	Iran	4.8
PI 274902	Great Britain	4.8
PI 432896	PR China	4.8
PI 275410	Netherlands	4.8
PI 432858	PR China	4.8
PI 285607	Poland	4.8
PI 422171	Czechoslovakia	4.8
PI 432887	PR China	4.8
PI 209066	U.S.A.	4.8
PI 288992	Hungary	4.8
PI 432850	PR China	4.8
Armstrong Er. Cluster	U.S.A.	4.8
Challenger	U.S.A.	4.8
Klondike	U.S.A.	4.8
PI 368554	Yugoslavia	4.8
PI 368556	Yugoslavia	4.8
PI 368560	Yugoslavia	4.8
PI 370019	India	4.8
PI 370643	U.S.S.R.	4.8
PI 390951	U.S.S.R.	4.8
PI 391573	PR China	4.8
PI 419009	PR China	4.8
PI 419108	PR China	4.8
PI 419183	PR China	4.8
PI 422181	Czechoslovakia	4.8
PI 432853	PR China	4.8
PI 432876	PR China	4.8
PI 432881	PR China	4.8
PI 432883	PR China	4.8
PI 458854	U.S.S.R.	4.8
Shamrock Resistant	U.S.A.	4.8
Wis. SMR 18	U.S.A.	4.8
PI 209065	U.S.A.	4.8
PI 357841	Yugoslavia	4.8
PI 372903	Netherlands	4.8§
Wt. Spine Davis Perfect	U.S.A.	4.8§
PI 390250	Japan	4.8§
PI 169377	Turkey	4.8
PI 436672	PR China	4.8
PI 338235	Turkey	4.8
PI 489754	PR China	4.8
PI 357846	Yugoslavia	4.8
PI 451976	Japan	4.8
PI 169403	Turkey	4.9
PI 226510	Iran	4.9
PI 293923	Israel	4.9
PI 211983	Iran	4.9
PI 357832	Yugoslavia	4.9
Heinz Pickling	U.S.A.	4.9
PI 172842	Turkey	4.9
PI 432892	PR China	4.9
PI 358814	Malaysia	4.9
PI 390259	Japan	4.9
PI 432893	PR China	4.9
PI 288237	Egypt	4.9
PI 288990	Hungary	4.9
PI 344432	Iran	4.9
PI 357855	Yugoslavia	4.9
PI 339243	Turkey	4.9
PI 169353	Turkey	4.9
PI 422176	Czechoslovakia	4.9
PI 169389	Turkey	4.9
PI 344067	Turkey	4.9
Monopol	Netherlands	4.9
PI 368548	Yugoslavia	4.9
PI 368552	Yugoslavia	4.9
PI 368555	Yugoslavia	4.9
PI 370450	Yugoslavia	4.9
PI 379281	Yugoslavia	4.9
PI 379282	Yugoslavia	4.9
PI 379284	Yugoslavia	4.9
PI 432888	PR China	4.9
PI 436673	PR China	4.9

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 489753	PR China	4.9
PI 357847	Yugoslavia	4.9
PI 432848	PR China	4.9
PI 292012	Israel	4.9
PI 390241	Japan	4.9
PI 172847	Turkey	4.9
PI 357852	Yugoslavia	4.9
PI 356833	Great Britain	4.9
PI 338234	Turkey	4.9
PI 351139	U.S.S.R.	4.9
PI 269482	Pakistan	4.9
PI 285603	Poland	4.9
PI 288332	India	4.9
PI 296387	Iran	4.9
PI 419136	PR China	4.9
PI 390257	Japan	4.9
PI 271753	Netherlands	4.9
PI 285608	Poland	4.9
PI 401732	U.S.A.	4.9
PI 211988	Iran	4.9
PI 169315	Turkey	4.9
PI 257286	Spain	4.9
PI 176953	Turkey	4.9
PI 267741	Japan	4.9
PI 354952	Denmark	4.9
PI 422167	Czechoslovakia	4.9
PI 419041	PR China	4.9
PI 222782	Iran	4.9
PI 197085	India	4.9
PI 422172	Czechoslovakia	4.9
PI 357833	Yugoslavia	4.9
PI 275411	Netherlands	4.9
PI 267086	U.S.S.R.	4.9
PI 342951	Denmark	4.9
PI 432863	PR China	4.9
PI 432889	PR China	4.9
PI 458848	U.S.S.R.	4.9
PI 181753	Syria	4.9
Shogoin	U.S.A.	4.9
PI 432856	PR China	4.9
PI 357830	Yugoslavia	4.9
PI 314426	U.S.S.R.	4.9
PI 249561	Thailand	4.9
PI 255935	Netherlands	4.9
PI 283900	Czechoslovakia	4.9
PI 432862	PR China	4.9
PI 482464	Zimbabwe	4.9
PI 344435	Iran	4.9
Everbearing	U.S.A.	5.0
PI 357835	Yugoslavia	5.0
PI 283899	Czechoslovakia	5.0
PI 220338	Afghanistan	5.0
PI 339246	Turkey	5.0
PI 175681	Turkey	5.0
Model	U.S.A.	5.0
PI 321007	Taiwan	5.0
PI 255936	Netherlands	5.0
PI 344351	Turkey	5.0
PI 220171	Afghanistan	5.0
Earliest of All	U.S.A.	5.0
PI 261609	Spain	5.0
Green Thumb	U.S.A.	5.0
PI 390953	U.S.S.R.	5.0
PI 211589	Afghanistan	5.0
PI 357856	Yugoslavia	5.0
PI 220791	Afghanistan	5.0
PI 218199	Lebanon	5.0
Mincu	U.S.A.	5.0§
Minn. Dw. Cuke XII	U.S.A.	5.0§
PI 379279	Yugoslavia	5.0§
PI 432882	PR China	5.0§
PI 432886	PR China	5.0§
PI 458855	U.S.S.R.	5.0§
PI 339247	Turkey	5.0
PI 357851	Yugoslavia	5.0
PI 263047	U.S.S.R.	5.0
PI 357836	Yugoslavia	5.0
PI 289698	Australia	5.0

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Table 1. cont'd

Cultigen	Origin	Rating‡
PI 344347	Turkey	5.0
PI 418963	PR China	5.0
PI 414158	U.S.A.	5.0
PI 308915	U.S.S.R.	5.0
PI 483340	Korea	5.0
PI 356832	Netherlands	5.0
PI 357838	Yugoslavia	5.0
Shamrock R	U.S.A.	5.0
PI 357863	Yugoslavia	5.0
Redlands Long Wt.	U.S.A.	5.0
PI 211985	Iran	5.0
PI 357864	Yugoslavia	5.0
PI 255933	Netherlands	5.0
PI 357857	Yugoslavia	5.0
PI 296120	Egypt	5.0
PI 458846	U.S.S.R.	5.0
PI 458851	U.S.S.R.	5.0
PI 169319	Turkey	5.0
PI 344350	Turkey	5.0
PI 436609	PR China	5.0
PI 321011	Taiwan	5.0
PI 267747	U.S.A.	5.0
PI 458852	U.S.S.R.	5.0
PI 344443	Iran	5.1
Early Fortune	U.S.A.	5.1
PI 483342	PR China	5.1
PI 261608	Spain	5.1
PI 285604	Poland	5.1
PI 321006	Taiwan	5.1
PI 169399	Turkey	5.1
PI 263084	PR China	5.1
PI 357867	Yugoslavia	5.1
PI 414157	U.S.A.	5.1
PI 401734	U.S.A.	5.1
PI 263048	U.S.S.R.	5.1
PI 267943	Japan	5.1
PI 376063	Israel	5.1
Sunny South	U.S.A.	5.1
Producer	U.S.A.	5.1
Marketer	U.S.A.	5.1
PI 368553	Yugoslavia	5.1
PI 370447	Yugoslavia	5.1
PI 379283	Yugoslavia	5.1
PI 390255	Japan	5.1
PI 390263	Japan	5.1
PI 422184	Czechoslovakia	5.1
PI 432869	PR China	5.1
PI 227235	Iran	5.1
PI 267088	U.S.S.R.	5.1
PI 344348	Turkey	5.1
PI 430585	PR China	5.1
PI 209067	U.S.A.	5.1
PI 372587	Netherlands	5.1
PI 288996	Hungary	5.1
PI 414159	U.S.A.	5.1
PI 255934	Netherlands	5.1
PI 264667	Germany	5.1
PI 357866	Yugoslavia	5.1
PI 355053	Iran	5.1
PI 436610	PR China	5.1
PI 171600	Turkey	5.1
AC 1811	U.S.A.	5.1
PI 368557	Yugoslavia	5.1
PI 390265	Japan	5.1
PI 422189	Czechoslovakia	5.1
PI 432874	PR China	5.1
PI 344433	Iran	5.1
PI 357831	Yugoslavia	5.1
PI 357844	Yugoslavia	5.2
PI 357862	Yugoslavia	5.2
PI 357839	Yugoslavia	5.2
National Pickling	U.S.A.	5.2
Armenian Yd. Long	U.S.A.	5.2
PI 390247	Japan	5.2
PI 390267	Japan	5.2
PI 172848	Turkey	5.2
Danish Mustard	U.S.A.	5.2
MR 25	U.S.A.	5.2
Early Green Cluster	U.S.A.	5.2
PI 288991	Hungary	5.2

Table 1. cont'd

Cultigen	Origin	Rating‡
PI 344441	Iran	5.2
PI 228344	Iran	5.2
Extra Early Majestic	U.S.A.	5.2
PI 251520	Iran	5.2
PI 436608	PR China	5.2
PI 343451	U.S.S.R.	5.2
PI 284699	Sweden	5.3
PI 390251	Japan	5.3
PI 212059	Greece	5.3
PI 432852	PR China	5.3
PI 372893	Netherlands	5.3§
PI 422197	Czechoslovakia	5.3§
PI 432890	PR China	5.3§
PI 357843	Yugoslavia	5.3
SMR 58	U.S.A.	5.3
PI 406473	Netherlands	5.3
PI 357840	Yugoslavia	5.4
PMR 551	U.S.A.	5.4
Favor II	U.S.A.	5.4
Burpless 33	U.S.A.	5.4
PI 368559	Yugoslavia	5.4
PI 422188	Czechoslovakia	5.4
PI 422192	Czechoslovakia	5.4
PI 432875	PR China	5.4
PI 432877	PR China	5.4
SR 551F	U.S.A.	5.4
TMG-1	PR China	5.4
PI 220790	Afghanistan	5.4
PI 267743	Hong Kong	5.4
PI 277741	Netherlands	5.5
PI 251028	Afghanistan	5.5
Longfellow	U.S.A.	5.5§
Midget	U.S.A.	5.5§
Sieger	U.S.A.	5.5§
PI 390248	Japan	5.6

† LSD (0.05 = 1.1; 0.001 = 1.9) based on harmonic mean of sample size due to unequal numbers of cultigens per environment.

‡ Rating assessed visually 1 wk and 2 wk after inoculation and is percentage leaf area affected using a 0 to 9 scale (0 = no symptoms, 9 = all leaves completely necrotic).

§ Cultigens tested in only one environment.

(unpublished data). Yearly field testing has indicated that Race 7 and Race 1 are present in North Carolina.

Plants were inoculated at the vine-tip-over stage, 3 wk after planting. Inoculum was sprayed on leaves and stems to run-off using a Solo back-pack sprayer at 100 to 140 kPa (15–20 psi) pressure. Overhead irrigation was used Monday, Wednesday, and Friday (25–40 mm wk^{-1}) to spread the inoculum and encourage uniform disease development. Every fourth row was planted with susceptible 'Wisconsin SMR 18' to enhance the uniformity of disease spread.

Field plots were rated 2 and 4 wk after inoculation for foliar lesions using a 0 to 9 visual rating scale (0 = no foliar symptoms, 1 to 2 = trace, 3 to 4 = slight, 5 to 6 = moderate, 7 to 8 = advanced, 9 = plant dead). The rating system was adapted from the categories described by Thompson and Jenkins (1985b).

Due to the unbalanced arrangement of blocks (one block per year in 1987 and 1988 and two blocks in 1989), each block was treated as a separate replication in the analysis of variance; therefore, the experimental design was simply a randomized complete-block design with four blocks. Prior to analysis, data were checked for normality, error variance homogeneity, and additivity by residual plot analysis. Residual plots had a random distribution, indicating that the statistical model was valid and its assumptions were met (Fernandez, 1992). Rating scale data were not transformed because assumptions for the analysis of variance were met (Little, 1985). Data for some cultigens were not available for all environments; so all data within an environment were standardized to a mean

of 4.5 and a standard deviation of 1. The use of multiple comparison procedures for mean separation of unstructured qualitative treatments, such as cultigens in a germplasm screening, is statistically valid (Petersen,1977; Steel and Torrie, 1980) and has the added benefit of simplicity of presentation when many means are listed in one table. Single degree of freedom contrasts are not appropriate if no logical a priori structure exists among the treatments of a test (Steel and Torrie, 1980). The least significant difference (LSD) method was used for mean separations because it controls the comparison-wise error rate better than other methods (Steel and Torrie, 1980). To calculate a single LSD value for means with unequal sample sizes the harmonic mean of the sample sizes must be used (SAS Institute, 1988; Winer, 1971). Use of the harmonic mean of sample sizes is valid if, as in this study, the difference between sample sizes is not great (Dunnett, 1980).

RESULTS AND DISCUSSION

As expected, the two blocks from 1989 were more closely correlated with each other than with blocks from 1987 or 1988. However, the correlation was low (R^2 = 0.24), indicating that the treatment of blocks as replications was not likely to violate the assumptions of the analysis of variance.

Anthracnose leaf ratings averaged across environments and rating dates followed a normal distribution with a mean of 6.6 and a standard deviation of 1.2 (Fig. 1A). The mean of each of the four environments was significantly different from all other environments in the test at an alpha level of 0.001 (data not shown). The means for environments ranged from 5.5 to 7.7. Because the range of environment means was large, the mean of any cultigen not tested in all four environments could be greatly affected by the lack of data for an environment. The primary reason for this large-scale germplasm screening was to compare cultigen means for anthracnose resistance and to determine which cultigens were most resistant. Standardizing within environments improved the comparisons among cultigens by removing the main effect of environments. Standardized anthracnose leaf ratings averaged across environments and rating dates followed a normal distribution with a mean of 4.5 and a standard deviation of 1.0 (Fig. 1B). Standardizing data within an environment cannot remove specific genotype × environment (G × E) effects. Specific G × E effects can be detected only by growing each cultigen in each environment.

No implications could be made concerning the resistance of feral cucumbers for a given country because the assortment of cultigens for a given country includes any combination of improved cultivars, breeding lines, landraces, and feral cucumbers. A comparison between countries for only feral cucumbers was not possible because information available from the Germplasm Resources Information Network or from the North Central Regional Plant Introduction Station did not indicate if most accessions were feral or not.

Cultigens were ranked based on the standardized mean anthracnose leaf rating averaged across environments and rating dates (Table 1). The most resistant 27 cultigens were all of U.S. origin and were improved cultivars or breeding lines. The top two cultigens, 'Cracker Lee' and

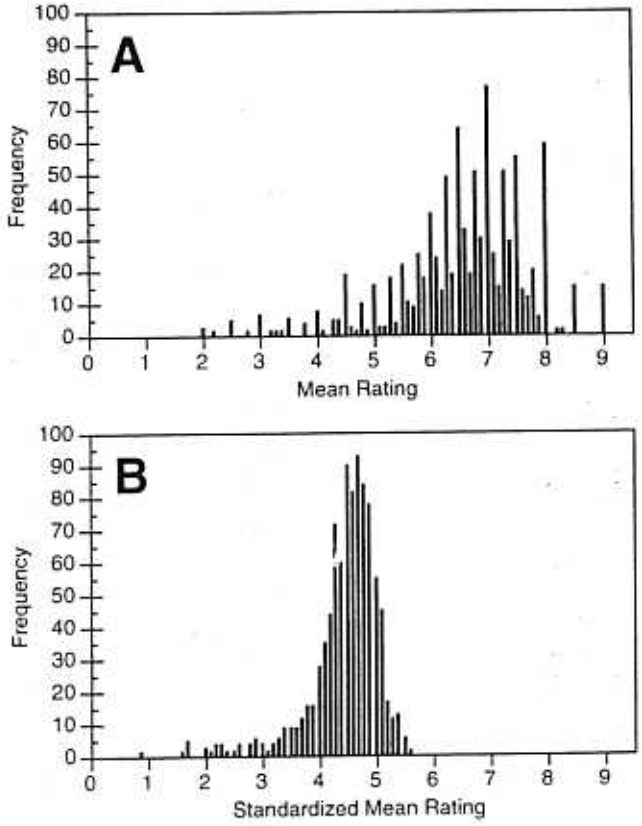

Fig. 1. Frequency distributions of anthracnose leaf ratings for 904 cultigens of *Cucumis sativus* L. field tested in North Carolina in 1987, 1988, and 1989. (A) Mean rating is the actual rating averaged across environments. (B) Standardized mean rating is the actual rating standardized to a mean of 4.5 and a standard deviation of 1 within each environment, then averaged across environments for each cultivar.

'Discover,' and 51 other cultigens were tested in only one environment, however, and ratings for those cultigens should be interpreted with that fact in mind. The most resistant cultigens, for which multiple-environment data were available, included 'Dual,' 'Regal,' 'Slice,' and Gy 3. The most susceptible cultigens, for which multiple environment data were available, included PI 390248, PI 251028, and PI 277741.

The degree of heterozygosity for most of the cultigens tested was unknown; however, heterozygosity for most of the PI accessions can be assumed to be high. Those PI accessions found to be resistant in this study probably have useful genes for resistance; whereas those PIs found to be susceptible may also have genes for resistance that simply were not discovered due to the necessarily small sample sizes used and the high degree of heterozygosity presumably present.

Single gene resistance to anthracnose has been reported (Abul-Hayja et al., 1978; Bush and Walker, 1958) as well as oligogenic resistance (Barnes and Epps, 1952; Bush and Walker, 1958; Linde et al., 1990). Linde et al. (1990) reported that at least five effective factors controlled resistance of cucumber to anthracnose Race 2 in the cross of resistant AR 79-95 with susceptible 'Model.' The wide and continuous range of anthracnose leaf ratings (0.9–5.6) that we measured (Table 1) indi-

cated that resistance was most likely controlled by more than a few genes, in addition to environmental effects. When resistance is rated on a continuous scale, it is difficult to assign cultigens to discrete categories such as resistant or susceptible. In practice, however, breeders often use those terms for quantitative traits. In keeping with that practice, cultigens rated 0 to 3.0 were classified resistant, from 3.1 to 4.0 moderately resistant, and >4.0 susceptible. The range of values for those three categories were not chosen arbitrarily but were based on the past performance of field resistance of cultivars that fall within each category. Based on those classifications, 31 cultigens were resistant, 100 moderately resistant, and 773 susceptible.

The cultivar Palmetto, reported by Barnes and Epps (1952) to carry the *ar* gene for anthracnose susceptibility was among the 2% most resistant cultigens in our test at one environment. Barnes and Epps (1952) identified four plant introductions (PI 175111, PI 175120, PI 179676, and PI 183445) as carriers of the *Ar* gene for anthracnose resistance. In our test, PI 175111 was resistant, PI 175120 was moderately resistant, and PI 179676 and PI 183445 were susceptible. Different results between our study and that of Barnes and Epps (1952) for resistance in Palmetto, PI 179676, and PI 183445 could be due to race, environment, sample sizes, or inoculation differences. Barnes and Epps (1952) did not report the race(s) of anthracnose used in their tests because races were unknown until 1956 when Goode (1956) first reported their occurrence. The race of anthracnose used in our tests was probably 7; however, evidence from field studies indicated Race 1 also occurs in North Carolina. In addition to race, inoculum concentration may be important in determining resistance to anthracnose (Abul-Hayja et al., 1978). In our study, inoculum concentration varied each year; however, year to year correlations for anthracnose ratings indicated that consistent results were obtained using variable natural inoculum. Correlations for anthracnose ratings ranged from 0.74 to 0.87 on a race differentiating set of 35 cultigens tested from 1990 to 1993 using natural inoculum (data not shown).

Abul-Hayja et al. (1978) reported that Wisconsin SMR 18 carried the *Cla* gene for susceptibility to anthracnose Race 1. Wisconsin SMR 18 was susceptible in this test. No genes, other than *Ar* and *Cla*, for resistance to anthracnose in cucumber have been reported (Pierce and Wehner, 1990).

Sitterly (1973) reported that PI 197087 was resistant to anthracnose Race 2 and that Model is very susceptible. PI 197087 has polygenic resistance and has been used in the development of resistant cultivars (Sitterly, 1973). In this test, PI 197087 was moderately resistant and Model was susceptible. Barnes (1961) reported that 'Pixie' had multigenic resistance, and in our test, Pixie was moderately resistant. Two PIs were identified by Bush and Walker (1958) as resistant. They suggested that PI 163213 had single gene resistance that is modified by several other genes and that PI 163217 had multigenic resistance. In this study, both were moderately resistant. The breeding lines Gy 3 and Gy 14 are used as anthracnose resistant checks in greenhouse screening tests (Wyszogrodzka et al., 1987). In this test, Gy 3 was one of the most resistant cultigens and Gy 14 was moderately resistant.

In this study, no plant introductions were found to be more resistant than the most resistant cultivars or breeding lines tested. Cultigens found to be resistant in other studies were generally moderately resistant or resistant in this study, except for PI 179676 and PI 183445, which were susceptible in this test.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the technical assistance of R.R. Horton, Jr. This research was funded in part by the North Carolina Pickle Producers Association.

REFERENCES

Abul-Hayja, Z., P.H. Williams, and C.E. Peterson. 1978. Inheritance of resistance to anthracnose and target leaf spot in cucumbers. Plant Dis. Rep. 62:43–45.

Barnes, W.C. 1961. Multiple disease resistant cucumbers. Proc. Am. Soc. Hortic. Sci. 77:417–423.

Barnes, W.C., and W.M. Epps. 1952. Two types of anthracnose resistance in cucumbers. Plant Dis. Rep. 36:479–480.

Bush, L.V., and J.C. Walker. 1958. Studies of cucumber anthracnose. Phytopathology 48:302–304.

Dunnett, C.W. 1980. Pairwise multiple comparisons in the homogeneous variance, unequal sample size case. J. Am. Stat. Assoc. 75: 789–795.

Farr, D.F., G.F. Bills, G.P. Chamuris, and A.Y. Rossman. 1989. Fungi on plants and plant products in the U.S.A. Am. Phytopathol. Soc., St. Paul, MN.

Fernandez, G.C.J. 1992. Residual analysis and data transformations: Important tools in statistical analysis. HortScience 27:297–300.

Goode, M.J. 1956. Physiologic specialization in *Colletotrichum lagenarium*. Plant Dis. Rep. 40:741.

Hughes, G.R., C.W. Averre, and K.A. Sorensen. 1983. Growing pickling cucumbers in North Carolina. N.C. Agric. Ext. Serv. Bull. AG-315.

Linde, D.C., W.C. Bridges, and B.B. Rhodes. 1990. Inheritance of resistance in cucumber to race 2 of *Colletotrichum lagenarium*. Theor. Appl. Genet. 79:13–16.

Little, T.M. 1985. Analysis of percentage and rating scale data. HortScience 20:642–644.

Petersen, R.G. 1977. Use and misuse of multiple comparison procedures. Agron. J. 69:205–208.

Pierce, L.K., and T.C. Wehner. 1990. Review of genes and linkage groups in cucumber. HortScience 25:605–615.

SAS Institute. 1988. SAS/STAT user's guide. Release 6.03 ed. SAS Inst., Cary, NC.

Sitterly, W.R. 1973. Cucurbits. *In* R.R. Nelson (ed.) Breeding plants for disease resistance, concepts and applications. Penn. State Univ. Press, University Park, PA.

St. Amand, P.C., and T.C. Wehner. 1991. Crop loss to 14 diseases in cucumber in North Carolina for 1983 to 1988. Cucurbit Genetics Cooperative 14:15–17.

Steel, G.D., and J.H. Torrie. 1980. Principles and procedures of statistics. 2nd ed. McGraw-Hill, New York.

Thompson, D.C., and S.F. Jenkins. 1985a. Influence of cultivar resistance, initial disease, environment, and fungicide concentration and timing on anthracnose development and yield loss in pickling cucumber. Phytopathology 75:1422–1427.

Thompson, D.C., and S.F. Jenkins. 1985b. Pictorial assessment key to determine fungicide concentrations that control anthracnose development on cucumber cultivars with varying resistance levels. Plant Dis. 69:833–836.

Winer, B.J. 1971. Statistical principles in experimental design. 2nd ed. McGraw-Hill, New York.

Wyszogrodzka, A.J., P.H. Williams, and C.E. Peterson. 1987. Multiple-pathogen inoculation of cucumber (*Cucumis sativus*) seedlings. Plant Dis. 71:275–280.