Evaluation of Melon Germplasm for Resistance to Downy Mildew

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Abstract. Field evaluations for resistance against downy mildew, incited by *Pseudoperonospora cubensis* [(Berk. and Cart.) Rostow], were conducted on 942 U.S. Plant Introductions (PI) of *Cucumis melo* L. (melon). A disease index (DI) was calculated for each entry. Based on DI, PI 124112 was highly resistant (DI = 3.7), and PIs 124111, 122847, 124210, 145594, and 165525 were resistant (DI = 3.0, 2.8, 2.6, 2.7, and 2.5, respectively). PIs 124111 and 124112 had one or more plants that exhibited a highly resistant reaction type (RT 4). Resistant (RT 3) plants were identified in 31 accessions, and 49 accessions had moderately resistant (RT 2) plants.

Downy mildew of melon and other cucurbits is incited by *Pseudoperonospora cubensis*. The disease has a wide geographic distribution (Palti, 1975) and causes severe losses in melon production near the Atlantic Seaboard and Gulf of Mexico in the United States (Whitaker and Davis, 1962). The principal methods of disease control are the use of protective fungicides and host resistance (Chupp and Sherf, 1960). Environ-

mental, economic, and energy conservation concerns are placing increasing emphasis on the need for development of commercially acceptable, resistant cultivars (Thomas, 1982). The U.S. Plant Introduction collection is a possible source of resistant germplasm against this disease.

The purpose of this study was to evaluate available melon Plant Introductions (PIs) from the U.S. Plant Introduction collection for resistance to a local isolate of *P. cubensis* pathotype 4, the incitant of downy mildew. Because pathotypes 1, 2, 3, 4, and 5 of *P. cubensis* are highly compatible with at least one *Cucumis melo* differential genotype and pathotype 4 is highly compatible with all differential genotypes (Thomas et al., 1987), evaluations against pathotype 4 should provide a valid indication of potential resistance against it and the other four pathotypes. This report gives the results of the evaluation of 942 *C. melo* (melon) PIs and four control cultivars.

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Table 1. Disease indices of melon U.S. Plant Introductions (PI) that had one or more plants with a reaction type^a (RT) ≥ 2 and cultivars to artificial inoculation with *Pseudoperonospora cubensis* in glasshouse/dew chamber replicated trials.

PI/Cv.	Disease index ^b	PI/Cv.	Disease index	PI/Cv.	Disease index
PI 116666	1.8	PI 126145	1.1	PI 171594	1.2
PI 116667	1.2	PI 136224	1.4	PI 174133	1.2
PI 122847	2.8	PI 145594	2.7	PI 176930	1.2
PI 123188	1.5	PI 157071	1.8	PI 177334	1.0
PI 123493	1.8	PI 157081	1.6	PI 179666	1.3
PI 123494	1.4	PI 161375	1.8	PI 179669	1.0
PI 123498	1.4	PI 163206	1.7	PI 179677	1.1
PI 123500	1.5	PI 163219	1.1	PI 179895	1.1
PI 123502	1.6	PI 164320	1.0	PI 180280	1.0
PI 123683	1.6	PI 164323	1.6	PI 180283	1.2
PI 123684	1.8	PI 164329	1.1	PI 180428	1.6
PI 123689	1.5	PI 164330	1.5	PI 182952	1.0
PI 123823	1.7	PI 164331	2.1	PI 183037	1.2
PI 123824	1.5	PI 164343	1.9	PI 183055	1.2
PI 124092	1.4	PI 164418	1.3	PI 183311	1.8
PI 124102	1.3	PI 164492	1.4	PI 192939	1.2
PI 124103	1.6	PI 164493	2.0	PI 193495	1.1
PI 124109	1.6	PI 164551	2.2	PI 200816	1.1
PI 124111	3.0 ^a	PI 164610	1.2	PI 208741	1.4
PI 124112	3.7	PI 164635	1.2	PI 211956	1.2
PI 124206	1.7	PI 164653	1.2	PI 212803	1.6
PI 124208	1.6	PI 164723	1.3	PI 212895	1.4
PI 124210	2.6	PI 164756	1.2	Controls	
PI 124214	1.6	PI 164794	1.6	MR-1	4.0
PI 124436	1.4	PI 164797	1.5	Seminole	3.0
PI 124552	1.8	PI 164815	1.4	Cinco	2.0
PI 125875	1.8	PI 165450	1.0	Ananas	
PI 125901	1.3	PI 165513	1.6	Yokneam	1.0
PI 126030	1.0	PI 165525	2.5		
PI 126090	2.2	PI 169348	1.0		

^aLeaves one and two on glasshouse-produced plants at the two-expanded leaf stage were inoculated with 5.0×10^3 sporangia/ml from a local isolate of *P. cubensis*. Inoculated plants were incubated in a dew chamber for 18 h at 20°C and were then placed in the glasshouse for 5 days. On the 6th day after inoculation, plants were returned to the 20°C dew chamber for 18 h and ratings for downy mildew reaction type (RT) were made at 7 days postinoculation. Reaction type descriptors are as follows: RT 1 = 10- to 15-mm irregular, chlorotic lesions with abundant sporulation that may extend beyond the apparent margins of the lesions. RT 2 = Type "1" lesions, above, mixed with type "3" lesions, below. RT 3 = 3- to 4-mm irregular to circular chlorotic lesions with water-soaked margins beneath and sparse sporulation. RT 4 = 1 mm, circular, chlorotic lesions with necrotic centers and water-soaked margins beneath and extremely limited or no readily apparent sporulation.

^bWeighted disease indices were calculated from the RTs to give the following rating scale: RT 1 = susceptible. RT 2 = moderately resistant. RT 3 = resistant. RT 4 = highly resistant. LSD ($P = 0.05$) = ± 0.5 .

^cNot available from U.S. Plant Introduction Station.

Preliminary field studies were made in nonreplicated plots to evaluate PI accessions for downy mildew-resistant plants. Plots were composed of two to five plants, depending on availability and viability of seeds. Inoculum was prepared from a local isolate of *P. cubensis* maintained on cotyledons of melon 'Ananas Yokneam'. Cotyledons that supported abundant sporulation by the pathogen were collected and shaken vigorously in distilled water to dislodge the sporangia. The resulting sporangial suspension was filtered through a layer of cheesecloth, and the concentration was determined with the aid of a hemacytometer and adjusted to 2.0×10^4 sporangia/ml. The adaxial leaf surfaces were sprayed with this inoculum using a Micro Ulva (Micron Sprayers Ltd., Bromyard, U.K.) when the plants were at the 10-leaf stage. Two, and sometimes three, inoculations were necessary to ensure adequate disease development if dewfall did not occur following inoculation. In all cases, inocula were prepared and administered as described

above. Classifications of downy mildew reaction type (RT) were made ≈ 19 days after the initial inoculation using a 1 to 4 scale of increasing plant resistance: RT 1 = 10- to 15-mm diameter, irregular, chlorotic lesions with abundant sporulation that may extend beyond the apparent margins of the lesions; RT 2 = type "1" lesions, above, mixed with type "3" lesions, below; RT 3 = 3- to 4-mm diameter, irregular to circular, chlorotic lesions with water-soaked margins beneath and sparse sporulation; RT 4 = 1-mm-diameter, circular, chlorotic lesions with necrotic centers and water-soaked margins beneath and extremely limited or no readily apparent sporulation.

Remnant seed of those PIs in which one or more plants had a RT ≥ 2 in the field trials were used to produce plants for retesting under glasshouse/dew chamber conditions in replicated trials. Twenty-four seeds of each PI were sown in Jiffy Mix (Jiffy Products, Batavia, Ill.) in two no. 812 Corn-Packs trays (T.P. Plastics, Minneapolis). The 12 cells of

each of the Corn-Packs trays were cut in half to produce two sets of six cells each, for a total of four replicates per entry. These packs of six cells were completely randomized to form the four replicates. Seedlings were grown in a glasshouse to the two-expanded leaf stage.

Inoculum was produced as described above for the field tests, with the exception that the concentration was adjusted to 5.0×10^3 sporangia/ml. The adaxial surfaces of all leaves of all test and control plants were sprayed with this inoculum to incipient run-off using a Paasche Type H airbrush (Paasche Airbrush, Chicago) at 27.5 kPa. After inoculation, plants were placed in a dark 20°C dew chamber for 18 h, then kept on a glasshouse bench for 5 days. Six days postinoculation, plants were returned to the dew chamber for 18 h to enhance sporulation. Classifications for RT were made on the 7th day postinoculation.

Leaves one and two of each plant were observed with the aid of a stereo microscope at magnifications up to $\times 60$ to determine RT. These RT ratings were used to calculate a weighted disease index (DI) for each entry using Williams' (1985) formula. Based on these DIs, entries were assigned to the following resistance classes: 1 = susceptible, 2 = moderately resistant, 3 = resistant, and 4 = highly resistant.

In the replicated glasshouse trials, 82 PIs contained resistant plants (Table 1). Based on DI for these 82 PIs, PI 124112 was highly resistant [(DI = 3.7), LSD ($P = 0.05$) = ± 0.5] with 75% of the plants exhibiting RT 4. PI 124111 was rated resistant (DI = 3.0), with 33% of the plants having RT 4 and 44% having RT 3. The most resistant control, breeding line MR-1 (DI = 4.0), was derived from 90319, an inbred line of PI 124111 (Thomas, 1986). PIs 122847, 124210, 145594, and 165525 were resistant (DI = 2.8, 2.6, 2.7, and 2.5, respectively), with 100%, 100%, 100%, and 90% of the plants having a RT ≥ 2 . Of the remaining 76 PIs, 27 had plants that were rated resistant (RT = 3), and 49 PIs had one or more plants that were rated moderately resistant (RT = 2). Even though some PIs contained primarily susceptible plants, the few RT 3 plants in some of these PIs may represent useful sources of resistance. Only PI 124112 had a DI significantly higher (3.7) than that of the most resistant cultivar, Seminole (DI = 3.0). The origin of downy mildew resistance in 'Seminole' is uncertain. It was released in 1960 as a selection from open-pollinated fruit, with 'Smith's Perfect' and a Hale type included in the pedigree (Whitner, 1960). Eight additional PIs, 126030, 164320, 165450, 169348, 177334, 179669, 180280, and 182952, had one plant each with RT = 2, but their DIs were rated susceptible (1.0).

Although no PIs were identified that had an overall DI higher than that of the most resistant melon line, MR-1, the identification of highly resistant plants within the PIs tested (Table 1) offers additional sources for the development of downy mildew-resistant melon cultivars.

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