Resistance to Downy Mildew in *Cucumis melo* Plant Introductions and American Cultivars

CLAUDE E. THOMAS, Research Plant Pathologist, USDA, ARS, Oklahoma-Texas Area, Weslaco, TX 78596

ABSTRACT

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Twenty-two *Cucumis melo* plant introductions, 14 cantaloup cultivars, and other selected Cucurbitaceae were evaluated for resistance to downy mildew under epiphytotic conditions at Weslaco, TX, in 1978 and 1979. Only nine plant introductions, all from India, and three cultivars had ≤50% leaf loss due to the disease. The most resistant entry was an inbred derivative of PI 124111. *Cucumis sativus* and *Citrullus lanatus* were infected in both years. *Luffa cylindrica* was not infected in either year. Three species of *Cucurbita* were infected in 1979 but not in 1978. Artificial inoculations in growth chambers produced the same differential host response that was expressed under field conditions.

Downy mildew of cantaloup (*Cucumis melo* L.), caused by *Pseudoperonospora cubensis* (Berk. & Curt.) Rost., has a wide geographic distribution (7). In the United States it is particularly severe in production areas near the Atlantic Seaboard and Gulf of Mexico (11). Currently the principal means of control of this disease on cantaloups are the use of protective fungicide applications and host resistance (2).

Environmental, economic, and energy conservation considerations have strengthened emphasis on the development of commercially acceptable resistant cultivars. The basic sources of resistance have come from plant introductions of *C. melo* maintained by the U.S. Southern Regional Plant Introduction Station at Experiment, GA. Sowell et al (9) listed those that have been reported to be resistant to downy mildew at various locations and in different years. They also indicated into what cultivars these reported resistant sources have been incorporated.

The purpose of this study was to simultaneously evaluate the level of resistance in the abovementioned plant introductions and cultivars and other currently popular cultivars in the U.S.A. to provide a source of reference and comparison for use by plant pathologists and breeders.

MATERIALS AND METHODS

Meteorological conditions, especially presence and duration of dew, in south Texas usually favor the singular occurrence of downy mildew on the foliage of *C. melo* in the fall. In the spring, downy mildew occurs as one component of the foliage disease complex on *C. melo* along with powdery mildew, *Sphaerotheca fuliginea* (Schlecht ex Fr.) Poll., and Alternaria leaf blight, *Alternaria cucumerina* (Ell. & Ev.) J. A. Elliot (4,10). Therefore, the principal evaluation plots in this study were planted in late summer to take advantage of these meterological conditions so that downy mildew resistance under field conditions could be observed with as little interference from other foliage diseases as possible.

On 8 August 1978, 22 plant introductions and 14 cultivars were planted at Weslaco, TX, in 6-m plots, 10 hills per plot, in a completely randomized design containing four replicates. Also included in this test were replicated plots of *Cucumis sativus* 'Ashley' and 'National Pickling'; *Luffa cylindrica; Citrullus lanatus* 'Charleston Gray,' 'Smokeylee,' and 'Crimson Sweet'; *Cucurbita pepo* 'Early Prolific Straightneck'; *Cucurbita moschata* 'Cushaw Golden'; and *Cucurbita maxima* 'Banana Pink.'

Plots were examined twice weekly for downy mildew. When the disease was established, four random counts of the number of living and dead leaves (which do not absciss) per 0.25 m^2 were made in each plot of *C. melo* at 4-day intervals to calculate the percent leaf loss. The other Cucurbitaceae were observed only for the presence of disease. On 1 March 1979, the nine plant introductions that had had ≤50% leaf loss due to downy mildew were planted in replicated field plots for further evaluation; however, early powdery mildew infections completely killed four entries and were severe enough on surviving entries to preclude any meaningful evaluation of subsequent downy mildew infection. On 21 August 1979, those five *C. melo* plant introductions that also had some level of resistance to powdery mildew and the same 14 cultivars, along with the other species and cultivars of Cucurbitaceae mentioned, were planted in the same replicated plots as in 1978 and evaluated for resistance to downy mildew.

The fall 1978 isolate of *P. cubensis* had been maintained in continuous culture on *C. melo* in plant growth chambers at 22 C (± 1) for use in other studies. When the fall 1979 isolate became available, it was also established on *C. melo* in a separate chamber. Simultaneous comparative inoculations to the differential cucurbit hosts *C. melo* 'Perlita,' *Citrullus lanatus* 'Charleston Gray,' *Cucurbita moschata* 'Dickinson,' and *L. cylindrica* were made in separate polyethylene, high humidity tents in a third chamber at 22 C with an 8/24, light/dark cycle. Tents were opened during the light portion of each 24-hr cycle. The primary leaves of ten 21-day-old plants of each species of differential host were inoculated with each isolate. Inoculated leaves were sprayed to runoff with a water suspension of 5.0×10^3 sporangia per milliliter using a DeVilbiss No. 15 atomizer. Plants were observed for symptom expression 5, 7, 10, and 14 days after inoculation. These comparative inoculations were repeated twice.

RESULTS AND DISCUSSION

A few lesions were found in some plots on 3 October 1978, but the disease was not sufficiently established for leaf loss counts to be made until 29 October. By the final counting date, only nine plant introductions and three cultivars had ≤50% leaf loss (Table 1). *C. sativus* was severely infected, with resultant heavy leaf loss. *Citrullus lanatus* was moderately infected, with many lesions on the crown leaves but very little leaf loss. No downy mildew infection was detected on *L. cylindrica, Cucurbita pepo, C. moschata,* or *C. maxima.* Except for a trace amount of powdery mildew lesions on *C. moschata* and *C. maxima* in both years, no other foliar diseases were detected in the fall plantings in either 1978 or 1979.

In the August 1979 planting (Table 1), reactions of plant introductions were similar to those in 1978. In all instances, however, final leaf loss was greater in 1979. Rio Gold and Georgia 47 were the most resistant cultivars in both years. Smith's Perfect, which had the highest level of resistance in 1978, had severe leaf

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loss in 1979. Relative resistance among the other cultivars was similar in 1978 and 1979. Perlita, the most susceptible cultivar, is planted on more than 90% of the acreage in this area. It was released in 1964 as "highly resistant" to downy mildew (1), but its resistance has declined sharply since then probably because of physiologic race shifts in the pathogen population similar to that observed by Epps and Barnes (3) on cucumber.

Table 1. Severity of downy mildew on *Cucumis melo* entries

Entry[a]	Percent[b] leaf loss
1978	
PI 124111 India (inbred)	5 a
PI 180283 India	13 ab
PI 164323 India	14 ab
PI 164723 India	22 bc
PI 164756 India	24 bc
PI 182959 India	26 bc
Smith's Perfect	29 bc
PI 124111 India (mass lot)	34 cde
Rio Gold	35 cde
PI 212895 India	41 def
Georgia 47	49 efg
PI 180280 India	50 efgh
PMR-6	55 fgh
PI 124112 India	62 ghi
PI 179671 India	63 ghi
PI 165449 Mexico	65 ghij
Hale's Best	66 hijk
PI 223637 India	74 ijkl
Top Mark	75 ijklm
Edisto	79 ijklmn
PMR-45	79 ijklmn
PI 182954 India	81 jklmno
PI 182953 India	81 jklmno
PI 123517 India	82 klmno
Edisto 47	84 lmno
PI 182952 India	85 lmno
PI 174143 Turkey	86 lmno
PI 193495 Ethiopia	88 lmno
PI 179669 India	91 lmno
PI 136224 Canada	92 mno
Seminole	92 mno
Dulce	94 no
Gulfstream	94 no
PI 234607 S. Africa	96 no
PI 177334 Turkey	97 o
Delicious 51	97 o
Perlita	98 o
1979	
PI 124111 India (inbred)	15 a
PI 124111 India (mass lot)	37 b
Rio Gold	38 b
Georgia 47	41 b
PI 164323 India	43 b
PI 164723 India	48 bc
Edisto	53 bcd
Edisto 47	53 bcd
PI 180280 India	55 bcde
Gulfstream	63 cdef
PMR 6	66 cdef
Smith's Perfect	67 cdef
Top Mark	67 cdef
Dulce	70 def
Hale's Best	71 def
Seminole	72 def
PMR 45	76 efg
Delicious 51	80 fg
Perlita	93 g

[a] With country of origin for plant introductions.
[b] Data are averages of four random counts in each of four replicates on 7 November 1978 and 6 November 1979. Means not followed by the same letter are significantly different ($P = 0.05$) according to Duncan's multiple range test for each year.

Of special interest in the 1979 study is the fact that *C. sativus* and *Citrullus lanatus* as well as *Cucurbita pepo, C. moschata,* and *C. maxima* were all moderately to heavily infected by downy mildew in the test plots. As in 1978, there was no trace of infection on *L. cylindrica* in 1979. This seemed a clear indication that a different physiologic race of the pathogen with a wider host range was present in 1979. The comparative inoculations in the growth chamber with the 1978 and 1979 isolates confirmed this.

Responses to each isolate were similar on *C. melo, Citrullus lanatus,* and *L. cylindrica* but differed on *Cucurbita moschata.* Five days after inoculation, pale yellow lesions with necrotic centers and moderate sporulation were present on *C. melo.* By 7 days, lesions were mostly necrotic with yellow halos, but sporulation was abundant near the lesion margins. Most inoculated *C. melo* leaves were dead at 14 days. On *Citrullus lanatus* only faint yellow lesions were present by 5 days. At 7 days all tissue in the lesions appeared necrotic with very sparse sporulation at the lesion margin. The leaves were still alive at 14 days with only traces of sporulation. No lesions were produced on *L. cylindrica* by either isolate by 14 days. On *Cucurbita moschata,* the 1978 isolate did not induce either lesion formation or sporulation in 14 days. With the 1979 isolate distinct yellow lesions with moderate sporulation were present on *C. moschata* by 5 days. Lesions remained yellow at 7 and 10 days and sporulation was abundant. By 14 days the centers of lesions were necrotic and sporulation was reduced to a moderate amount.

As Palti (6) points out, controlled inoculations to these four genera give good indications of physiologic races of *P. cubensis.* Thus it is evident that the 1978 and 1979 isolates in these studies represent distinctly different physiologic races as indicated by differential host response and range. Except for its lack of infectivity to *Cucurbita,* the 1978 isolate was similar to isolate H of Hughes and Van Haltern (5), which was very weakly pathogenic to *Cucurbita.* However, their isolate V and the 1979 isolate were distinctly different in host reaction on *Citrullus* and *Cucurbita.* The presence of different physiologic races would likewise account for the drastic decrease in resistance of Smith's Perfect in 1979. Furthermore, the seemingly total lack of any appreciable degree of resistance in some reportedly resistant plant introductions and cultivars in this study can be attributed to the fact that they were resistant to the race of the pathogen against which they were originally tested but are not resistant to all races that occur in the U.S.A. This is further substantiated by Sitterly's (8) ranking of cantaloup cultivars for resistance to downy mildew in which Seminole is listed as immune and Georgia 47 and Smith's Perfect are listed as moderately resistant and tolerant, respectively. Sitterly summarized the results of resistance evaluations and reports that had been conducted predominately in the southeastern U.S.A. and probably represent, due to geographic diversity, results of tests against quite different races of *P. cubensis* than those that occur in south Texas. Although the results of the resistance evaluations reported herein may not be all inclusive for diverse geographic areas, they do, for the first time, give insight into the relative degree of resistance in the tested plant introductions and cultivars to two different physiologic races of the pathogen in concurrent, replicated studies. Further resistance evaluations should include provision for delimiting the race of *P. cubensis* through the only means presently available—differential host reaction and range.

Of the 22 plant introductions with reported resistance, 17 in the collection are from India. All of the nine that were defoliated $\leqslant 50\%$ in the 1978 study are from India. Of these nine, the five chosen for testing in 1979 because of their higher level of resistance to powdery mildew are, likewise, manifestly from India. Until this time, two of these plant introductions (124111 and 124112) have been the two principal sources of downy mildew resistance used by cantaloup breeders in this country.

The objective leaf loss rating used in this study draws easy distinctions without undue technicality when dealing with a moderate number of entries. Also, it evaluates each entry against itself, which allows direct relative comparisons to be made with other entries; ie, it measures what percentage of the available leaves are lost as a result of disease, not just how many leaves are lost. It thus gives both a direct and a relative measure of an entry's capacity to retain its foliage against the onslaught of the pathogen. This is especially useful and significant when dealing with entries that vary greatly in the number of leaves produced per unit area.

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