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Screening Melon (*Cucumis melo*) for Resistance to Gummy Stem Blight in the Greenhouse and Field

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Abstract. **Greenhouse and field evaluations of melon (*Cucumis melo* L.) for resistance to gummy stem blight, caused by the fungus *Didymella bryoniae* (Auersw.) Rehm, were conducted on 798 U.S. Dept. of Agriculture Plant Introduction (PI) accessions and 24 related *Cucumis* species. Plants were inoculated at the three to four true-leaf stage with a virulent isolate of *D. bryoniae* collected from Onondaga County, N.Y., and disease indices were calculated based on foliar and stem symptoms. In greenhouse screens, 43 *C. melo* accessions showed a high level of resistance. Results were consistent between the optimized greenhouse screening procedure described and inoculated replicated field tests. Of these accessions, a Chinese group, PIs 157076, 157080, 157081, 157082, 157084; another group from Zimbabwe, PIs 482393, 482398, 482399, 482402, 482403, 482408; and some others from different origins, PI 255478 (Korea) and PI 511890 (Mexico), showed high levels of resistance, at least equal to that in PI 140471, the leading source of resistance to date.**

Gummy stem blight (GSB) is one of the most serious diseases of melon (*Cucumis melo* L.) in the United States. The disease is caused by the fungus, *Didymella bryoniae* [teleomorph, synonyms: *Mycosphaerella citrullina* (C.O. Sm.) Gross, and *M. melonis* (Pass.) Chiu and Walker] and *Phoma cucurbitacearum* (anamorph, synonyms: *Ascochyta cucumis* Fautr. and Roum., *A. citrullina* C.O. Sm. and *Phyllosticta cucurbitacearum* Sacc.) (Sherf and MacNab, 1986; Van Der Meer et al., 1978). The foliar lesions begin as circular spots with dark tan edges, but a large portion of the leaf area can be affected as small spots coalesce during severe infection. The infected stems develop brown or black stripes and become girdled and withered in advanced stages of the disease (Zitter et al., 1996). Resistance has been reported in several *C. melo* accessions in the U.S. Dept. of Agriculture (USDA) National Plant Germplasm System (NPGS), including PI 140471 (Sowell et al., 1966), which was used to develop 'Gulfcoast', 'Chilton', (Norton, 1971, 1972), 'AUrora' (Norton et al., 1985) and 'AC-70-154' (Norton and Cosper, 1989), and PIs 266935, 436533, and 266934 (McGrath et al., 1993; Sowell, 1981). There is still interest in breeding melons with higher GSB resistance than the cultivars released to date. One hindrance in achieving this objective has been lack of a reliable seedling screen. Thus far, in cucumbers (*Cucumis sativus* L.) where more information is available, greenhouse seedling disease screens have not been uniformly highly correlated with field performance, presumably because of variable environmental conditions and biotic interactions in the field (Abad and Wehner, 1992; Wehner and St. Amand, 1993; Wyszogrodzka et al., 1986), although recently a seedling screen procedure that was highly correlated with field ratings has been reported (St. Amand and Wehner, 1995).

The objectives of this study were first to develop a greenhouse screen for melons that would predict performance in the field under a natural disease epidemic, and, second, to use that screen to evaluate available melon accessions for resistance from the NPGS collection. In the latter study, we emphasized accessions originating in the humid tropics or subtropics and those in which resistance to other foliar diseases of melon had been located. We report here several accessions with high resistance to GSB in greenhouse screens and field tests, identified among 798 PI *C. melo* accessions and 24 related species. Optimized procedures for greenhouse screens and field tests are also presented.

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Materials and Methods

Germplasm. Accessions were chosen based on site of collection, those in which resistance to other foliar diseases was reported, and those with small fruits and seeds. Any accessions that showed resistance were rescreened in the greenhouse and also included in field tests to evaluate levels of resistance further. Seeds of accessions from the NPGS were obtained from the USDA Plant Introduction Station at Ames, Iowa. Cultivars and breeding lines included in this study were UC Topmark (Zink and Gubler, 1987), Honeydew Greenflesh (Asgrow Seed Co., San Juan Bautista, Calif.), Gulfcoast, Chilton (P.V.P.) (Norton, 1971, 1972), AUrora (Norton et al., 1985), AC-70-154 (Norton and Cosper, 1989), Mainstream (Nugent, 1979), Perlita, and TAM-Uvalde (Correa, 1977).

Plant culture. For greenhouse experiments, seeds were germinated on paper towels in a 25 °C incubator for 2 days and seedlings of similar size were selected for transplant to assure uniform stands. Seedlings were transplanted to 4 × 8 cell Todd planter flats (Hummert International, Earth City, Mo.) in peat lite mix with each entry represented by seven plants per replication and two replications per screen. Two resistant (PI 140471) and two susceptible (Honeydew Greenflesh) control plants were placed randomly in each flat. Some entries were rescreened with four replications (four plants per replication) in a randomized complete-block design with susceptible and resistant plants included as controls. Seedlings were grown in the greenhouse at about 24 °C. For field experiments, 2-week-old seedlings (with one fully expanded true leaf), germinated as above, were transplanted to the field on beds with black plastic mulch. There were eight plants per plot and two plants per hill. Hills were 0.6 m apart within the row, and rows were 1.8 m apart. A randomized complete-block design with four replications was used for field tests. The same susceptible and resistant genotypes were included as controls.

Inoculum preparation and inoculation. Inoculum for all tests was an isolate of *D. bryoniae* designated NY1 collected from Onondaga County, N.Y., that gave reproducible and severe symptoms when commercial melon cultivars were inoculated in mist chamber tests (Keinath et al., 1995). Cultures were maintained on V-8 agar plates containing V-8 vegetable juice (Campbell Soup Co., Camden, N.J.) at 200 mL·L^{-1}, $CaCO_3$ (Fisher Scientific, Fair Lawn, N.J.) at 3.0 g·L^{-1}, Bacto-Agar (Difco Laboratories, Detroit) at 15.0 g·L^{-1} (pH 6.0) at room temperature (22 °C) with 14 h of fluorescent light (40 to 60 μmol·m^{-2}·s^{-1} photon flux) and 10 h of darkness. For all inoculations, conidial suspensions were prepared by growing *D. bryoniae* at room temperature for 10 to 14 days, flooding the culture with distilled water, gently scraping the cultures with a rubber policeman, and straining the suspension through two layers of cheesecloth. The inoculum suspension was adjusted to 10^5

spores/mL with a nutrient solution containing 0.1% sucrose and 0.05% hydrolyzed casein (Sigma Chemical Company, St. Louis) (Bergstrom et al., 1982). Triton x100 (Fisher Scientific, Fair Lawn, N.J.) was added to the suspension to a final concentration of 0.01% to enhance spore adherence.

In greenhouse experiments, 3 to 4 week-old seedlings (with three to four fully expanded true leaves) were inoculated with an atomizing sprayer (D8CX; Doerr Electric Corporation, Cedarburg, Wis.) at 68 kPa. Stems and both surfaces of leaves were sprayed thoroughly until runoff. Immediately after inoculation, the plants were incubated in a mist chamber for 72 h at 25 °C before transfer to a greenhouse for observation. For field experiments, two to three inoculations were applied 7 to 10 days apart, with the first inoculation at six- to eight-leaf stage. A spore suspension was applied at 3 to 5×10^5 spores/mL with a backpack sprayer in an evening preceding a day with forecasted overcast skies and high humidity or light rain. We avoided days with either full sun or heavy rain.

Data collection and analyses. Visual ratings of disease development on leaves and stems were made 7 days after inoculation. In greenhouse and field screens, each plant was given a rating that was averaged within a replication, and across the two or four replications to determine a mean rating for each accession. Leaves were rated according to the following scale: 1 = 0% of the leaf area affected, 2 = ≥1% ≤25%, 3 = ≥25% ≤50%, 4 = ≥50% ≤75%, and 5 = ≥75% ≤100%. Stem damage ratings were made using a 1 to 5 scale with 1 = no damage; 2 = single lesion 1 to 10 mm in length or composite lesions 1 to 20 mm, stem not girdled; 3 = lesion 21 to 80 mm and/or girdling of the stem; 4 = stem withered; and 5 = seedling dead. PROC GLM from SAS (SAS Institute, Cary, N.C., for analysis of variance) and StatView™SE+Graphics (Abacus Concepts, for analysis of correlation) were used for data analyses. The coefficient of simple correlation (r) was determined. Accessions were ranked on grand mean scores for leaf disease indices over all experiments, and mean differences were determined by Fisher's Protected LSD.

Results

Greenhouse screens for resistance. During 1992 and 1993, 798 PI accessions of *Cucumis melo* and 24 related species (*C. anguria* L., *C. myriocarpus* Naud., *C. africanus* L., *C. metuliferus* Naud., *C. zeyheri* Sond., *C. dinteri* Cogn., and *C. hookeri* Naud.) were screened in the greenhouse of Dimock Environmental Control Laboratory at Cornell Univ. For all accessions, data were converted to a 1 to 9 scale and entered into the Germplasm Resources Information Network, USDA. Among those accessions, the 43 most resistant *C. melo* entries from 35 screens were selected for re-evaluation in a second greenhouse screen (G93) and field tests (F92 and F93). In general, results for this set of accessions were consistent with the initial screen (Table 1). The correlation coefficients between results obtained in greenhouse screens and field screens in 1992 and 1993 were calculated, and in every case a significant positive correlation ($r = 0.50$ to 0.92) existed (Table 2).

Several of the most resistant PIs that appeared especially promising for breeding commercial melons in view of productivity and fruit characters were compared further with the leading sources of resistance reported in previous studies, including PI 140471 (Sowell et al., 1966), PI 266934 (McGrath et al., 1993), PI 266935 (Sowell, 1981), and breeding lines reported to carry some level of resistance to gummy stem blight (Norton, 1971, 1972; Norton et al., 1985; Norton and Cosper, 1989). The PIs identified in the current study showed the highest levels of resistance and large differences were observed between the most resistant PIs and the cultivars reported to have resistance (Table 3). 'AUrora' consistently was more resistant than susceptible controls and more so than other GSB-resistant cultivars and breeding lines (e.g., Table 3). This result suggests that at least some resistance from PI 140471 was transferred into 'AUrora', although the level of resistance that existed in the resistant (unadapted) parent has not been recovered.

Eight of the 24 related species (PIs 299568, 299569, 299570, 299571, 299572, 364472, 374152, and 374153) showed very high resistance, with disease indices of 1.0 on stems and 1.1 to 1.6 on leaves (data not shown). Those species are not sexually compatible with *C. melo*, however, and were not included in later experiments.

Field tests. In 1992, the 16 most resistant accessions identified from greenhouse screens prior to field planting were included. In 1993, the 43 most resistant accessions from all greenhouse screens were used. Results from greenhouse screens were significantly and highly correlated with each other and with results from inoculated field trials (Table 2), despite very different humidity, temperature, and rainfall conditions during the two growing seasons. The 1992 season was wet and cold, while the 1993 season was more typically hot and dry. Of these accessions, a Chinese group, PIs 157076, 157080, 157081, 157082, 157084; another group from Zimbabwe, PIs 482393, 482398, 482399, 482402, 482403, 482408; and some others from different origins, PI 255478 (Korea) and PI 511890 (Mexico), showed high levels of resistance that at least equaled and often exceeded the level of resistance in the leading resistant source of PI 140471 identified previously (Tables 1 and 3). PI 482399 was intermediate among the top 16 highly resistant accessions (Table 1), but in 1993 was considerably more productive than most others in terms of number and size of fruit set and in some screens was highly resistant (e.g., Table 3). The remaining accessions showed lower levels of resistance, but still were significantly superior to the susceptible control, 'Honeydew'. Interestingly, the PIs from Zimbabwe showed levels of resistance similar to or less than those from China in the greenhouse screens, but they performed much better than the Chinese group in the 1993 field test (Table 1), probably because the Chinese group was more susceptible to powdery mildew. The Chinese group did perform well in the 1992 field test, but the PIs from Zimbabwe were not included in that test. The coefficient of variability for GSB ratings ranged from 9.8 to 22.2 (Table 1), reflecting low variance in each experiment. Results from the greenhouse and field experiments were all significantly correlated (Table 2).

Leaf symptoms vs. stem symptoms. In greenhouse and field screens, the disease indices from leaves and stems were recorded and the relationship between leaf score and stem score in greenhouse and field tests was examined. When screened in the field, leaf and stem scores were significantly correlated, with the leaf score slightly higher. This correlation was not evident in greenhouse screens when the full set of 45 entries was considered. However, when the distribution of the ratio of leaf score to stem score for a given accession was examined, it was clear that there were two distinct groups of accessions, one where the two ratings were very similar, i.e., with the ratio of leaf to stem rating <2.0, and a second in which leaf scores were significantly higher (Fig. 1). When these two groups were considered separately for correlation analysis, the first group of accessions showed a very high correlation between leaf and stem scores ($r = 0.967$, $P = 0.0001$ and $r = 0.963$, $P = 0.0001$ between leaf and stem ratings among accessions with leaf to stem ratios <2.0 in the G92 and G93 screens, respectively), while those accessions with a leaf to stem ratio of ≥2.0 showed no significant correlation between leaf and stem ratings.

Discussion

A reliable seedling screen that reveals clear differences among individuals or progenies and that correlates well with field performance can dramatically increase the rate of progress in any breeding program (Abad and Wehner, 1992; St. Amand and Wehner, 1995; Wehner and St. Amand, 1993). We present here a rapid and reliable large-scale greenhouse screen procedure to evaluate GSB resistance in melons. Several factors were optimized. First, because plant age and size affect reaction to disease, seedlings at a uniform stage of development and vigor were selected for transplanting into the Todd planter flats from populations that had been pregerminated on paper towels in a incubator. It was also critical to use fresh inoculum prepared from a virulent fungal isolate of at least 10^5 spores/mL or higher with added nutrient (1% sucrose and 0.05% hydrolyzed casein) (Bergstrom et al., 1982). Both appropriate inoculum concentration and thorough coverage of plants during inoculation were important to obtain consistent results. Finally, environmental conditions, especially temperature and humidity for the first few days post-inoculation, had an important effect on the extent of disease development.

While it is not possible to control conditions in inoculated field trials, important considerations for establishing strong disease pres-

sure appeared to be the concentration of inoculum and the humidity in the vicinity immediately after inoculation (within 24 h). We typically used 3 to 5 times higher spore concentrations for field inoculations than in the greenhouse (Van Steekelenburg, 1985) and applied the inoculum just before dark. The night dews on leaves may be particularly beneficial for disease development. We typically applied a second inoculation 7 to 10 days after the first inoculation to ensure good infection in the field, but leaf symptoms were still routinely more severe in greenhouse screens.

Until recently (St. Amand and Wehner, 1995), it had been reported that greenhouse seedling screens for GSB resistance in cucumber were not highly consistent among tests, nor was there evidence of strong correlation between greenhouse seedling screens and field tests (Abad and Wehner, 1992; Wehner and St. Amand, 1993). In our experiments with melon, greenhouse screens showed a good correlation with field tests (Table 2), similar to the results of St. Amand and Wehner (1995) for cucumber. Our data for correlation analysis were skewed, however, since only the most resistant accessions and susceptible control plants were used in our field tests. Thus, the intermediate genotypes, which often react inconsistently and may reduce the correlations, were not included. The optimized screening method reported here greatly increased consistency and reliability of our screens in the

Table 1. Disease indices from greenhouse and field screens for the 43 melon USDA Plant Introduction accessions most resistant to gummy stem blight among 798 accessions evaluated.

		Mean disease indices[z]									
		1992				1993					
		Greenhouse		Field		Greenhouse		Field		Grand mean	
Rank[y]	Accession	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
1	157082	1.9	1.3	1.3	1.4	2.1	1.2	2.1	1.4	1.8	1.3
2	157081	1.9	1.2	1.3	1.1	2.2	1.1	2.1	1.2	1.9	1.1
3	255478	2.1	1.2	1.3	1.2	2.1	1.3	2.3	1.3	1.9	1.2
4	157076	2.4	1.7	1.2	1.2	2.2	1.1	2.1	1.4	1.9	1.3
5	140471	2.6	1.0	1.5	1.0	2.0	1.1	1.8	1.0	2.0	1.0
5	482398	2.3	1.0	---[x]	---	2.4	1.0	1.3	1.0	2.0	1.0
5	482408	2.4	1.0	---	---	2.5	1.0	1.3	1.1	2.0	1.0
5	511890	2.0	1.1	1.6	1.0	2.5	1.0	2.2	1.1	2.0	1.0
6	482393	2.5	1.2	---	---	2.0	1.0	1.5	1.0	2.0	1.1
7	157084	2.3	1.3	1.3	1.3	2.3	1.0	2.3	1.4	2.0	1.2
8	157080	2.7	1.5	1.3	1.2	2.1	1.2	2.1	1.4	2.0	1.3
9	482399	2.4	1.0	---	---	2.6	1.0	1.4	1.0	2.1	1.0
9	482402	2.2	1.0	---	---	2.5	1.0	1.7	1.0	2.1	1.0
9	482403	2.5	1.0	---	---	2.2	1.0	1.7	1.1	2.1	1.0
10	157071	1.9	1.2	1.6	1.0	2.2	1.2	2.6	1.1	2.1	1.1
11	323498	2.6	1.2	---	---	2.3	1.3	2.5	1.1	2.1	1.2
12	482413	2.5	1.0	---	---	2.3	1.0	1.7	1.0	2.2	1.0
12	482421	2.3	1.0	---	---	2.2	1.0	2.1	1.1	2.2	1.0
13	482396	2.1	1.0	---	---	2.5	1.0	2.1	1.4	2.2	1.1
13	482407	2.2	1.0	---	---	2.7	1.1	1.7	1.1	2.2	1.1
14	436534	1.6	1.0	2.2	1.5	2.7	1.1	2.5	1.2	2.2	1.2
14	536481	2.0	1.1	2.2	1.5	2.6	1.0	2.1	1.2	2.2	1.2
15	321004	2.3	1.4	1.2	1.2	2.5	1.3	2.7	1.3	2.2	1.3
16	420147	2.2	1.0	---	---	2.7	1.0	2.1	1.1	2.3	1.0
16	420148	2.4	1.0	---	---	2.7	1.0	1.8	1.1	2.3	1.0
16	482397	2.6	1.1	---	---	2.6	1.0	1.8	1.1	2.3	1.0
17	378059	2.5	1.0	---	---	2.0	1.2	2.6	1.5	2.3	1.2
18	157085	2.5	1.5	1.9	1.3	2.3	1.0	2.4	1.6	2.3	1.3
19	157083	2.5	1.4	1.6	1.4	2.4	1.5	2.9	1.3	2.3	1.4
20	420144	2.3	1.0	---	---	2.6	1.1	2.3	1.3	2.4	1.1
21	157070	2.6	1.6	2.3	1.3	2.5	1.1	2.1	1.4	2.4	1.3
22	211922	2.1	1.2	---	---	2.7	1.5	2.5	1.9	2.4	1.5
23	420145	2.2	1.0	---	---	2.8	1.0	2.5	1.1	2.5	1.0
24	266929	2.8	1.1	---	---	2.3	1.1	2.4	1.1	2.5	1.1
25	482430	2.5	1.0	---	---	2.9	1.1	2.1	1.6	2.5	1.2
26	182937	2.5	1.6	---	---	2.4	1.0	2.6	1.5	2.5	1.3
26	266930	2.7	1.2	---	---	2.4	1.3	2.5	1.3	2.5	1.3
27	482429	2.7	1.0	---	---	2.9	1.1	2.2	1.2	2.6	1.1
28	482431	2.7	1.0	---	---	2.9	1.0	2.3	1.5	2.6	1.2
29	378064	2.5	1.2	---	---	2.7	1.1	2.8	1.5	2.7	1.2
30	296345	2.8	1.4	---	---	---	---	1.9	1.4	2.7	1.7
31	420149	2.5	1.0	---	---	3.1	1.4	2.9	1.2	2.8	1.2
32	180281	2.5	1.0	---	---	3.2	1.6	2.7	2.1	2.8	1.6
33	192939	2.6	1.6	2.4	1.8	3.4	1.5	2.8	2.0	2.8	1.7
34	HD	4.5	3.0	4.7	3.5	4.4	2.8	4.4	3.8	4.5	3.3
$LSD_{0.05}$		0.7	0.5	0.6	0.4	0.4	0.2	0.5	0.4	0.3	0.2
Mean		2.4	1.2	1.8	1.4	2.5	1.2	2.2	1.3	2.3	1.2
Minimum		1.6	1.0	1.2	1.0	2.0	1.0	1.3	1.0	1.8	1.0
Maximum		4.5	3.0	4.7	3.5	4.4	2.8	4.4	3.8	4.5	3.3
CV (%)		15.2	22.2	21.4	19.8	12.6	14.2	17.6	20.4	9.8	12.3

[z]Disease indices were recorded separately for foliar and stem lesions according to a 1 to 5 scale: Leaf score: 1 = 0% of the leaf area affected, 2 = ≥1% ≤25%, 3 = ≥25% ≤50%, 4 = ≥50% ≤75%, and 5 = ≥75% ≤100%; Stem score: 1= no damage, 2 = single lesion < 10 mm in length or composite < 20 mm, 3 = lesion > 20 mm with girdling of the stem, 4 = stem withered, and 5 = plant dead. There were two replications in 1992 greenhouse screens and four replications for all other experiments.

[y]Accessions were ranked according to grand mean leaf ratings over all experiments, and grand mean stem ratings were then used to rank accessions with the same leaf scores.

[x]Accession not included in the test.

greenhouse and field. Seedling tests may be especially useful for preliminary selection of segregating breeding materials, while field tests will allow confirmation of resistance as well as selection for yield, plant and fruit type, resistance to fruit infection (black rot), and other horticultural traits.

In general, stem scores obtained in different tests of a given accession were more highly correlated than were leaf scores. For a given accession within one test, stem and leaf disease indices were also highly correlated, although a clear difference between ranking based on leaf score vs. ranking based on stem score was occasionally noted for a particular accession. This difference existed consistently for some accessions, suggesting that accessions may vary with regard to the degree to which stem and leaf disease symptom development were correlated. When the ratio of leaf to stem ratings were examined for the 43 most resistant accessions, two clear classes emerged (Fig. 1), supporting this observation and suggesting that there may be distinct mechanisms of resistance.

In the present study, we report some PIs with a high level of resistance to GSB. To determine how this work compares with previous work, we evaluated selected PIs from this study in two greenhouse screens together with PIs reported as resistant in previous work (Table 3). As expected from previous greenhouse and field screens, the PIs included in this experiment had lower mean disease ratings than PI 140471, indicating equal or higher resistance. Sources of resistance reported by McGrath et al. (1993) included PI 266934, which they suggested had higher resistance than PI 266935 identified by Sowell (1981). However, our results did not distinguish a large difference between these two accessions. In this test (Table 3) and more generally in our screens (data not shown), both of these PIs have shown lower levels of resistance than PI 140471 and clearly lower resistance than the leading PIs identified in this study. Several cultivars and breeding lines reported to have some resistance to GSB were also included. 'AUrora' and 'Gulfcoast' had intermediate ratings in this test, while AC-70-154 (Auburn Univ.), 'TAM-Uvalde', 'Mainstream', and 'Chilton' P.V.P. were indistinguishable from the susceptible control under greenhouse screen conditions. Prasad and Norton (1967) reported resistance was due to a single dominant gene, *Mc*, but the failure to recover the parental level of resistance in the cultivars, even in seedling screens, suggests that if there is a single major dominant gene, its expression must be dependent on genetic background. The level of GSB resistance observed under field conditions may also be affected by the increased physiological stress that occurs in cultivated melons with a large fruit load and interactions with other foliar diseases, including viruses. We have not yet determined the degree to which plant morphology affects level of resistance. Many of the wild species are considerably less productive and, consequently, may be under less physiological stress than commercial types at maturity.

In our breeding trials, 'TAM-Uvalde' occasionally remained relatively free of foliar symptoms under natural GSB epidemics. Similarly, 'Mainstream', bred under unprotected conditions in the southeastern United States (Nugent 1979), may also have some field tolerance that was not evident in this seedling screen.

As reported previously (Lhotsky et al., 1991; Wehner and St. Amand, 1993), some related *Cucumis* species have extremely high resistance to GSB. Although they are not sexually compatible with *C. melo*, successful interspecific hybridizations have been reported (den Nijs and Custers, 1990), and hybridization barriers may be further reduced or overcome with various techniques, including embryo rescue and somatic fusion of protoplasts.

We have used these procedures to identify some accessions that will serve as sources of resistance in a breeding program to transfer GSB resistance to netted melons for North American production, with a particular focus on recurrent parents that contribute resistance to other diseases. These procedures also work well for screening *Cucurbita* genotypes (Zhang et al., 1995). It is not known whether these accessions possess distinct genes for resistance or whether accessions with resistance to GSB will show a consistently improved reaction to black rot.

Table 2. Correlation analyses of gummy stem blight disease indices on melon leaves and stems from greenhouse screens and from field screens.

		Plant part			
	Data pairs	Leaf		Stem	
Experiments	(no)	*r*	*P*	*r*	*P*
Field 1992 vs. greenhouse 1992	17	0.721	0.0005	0.830	0.0001
Field 1992 vs. greenhouse 1993	17	0.916	0.0001	0.915	0.0001
Field 1992 vs. field 1993	17	0.624	0.0043	0.900	0.0001
Field 1993 vs. greenhouse 1992	45	0.495	0.0006	0.810	0.0001
Field 1993 vs. greenhouse 1993	44	0.582	0.0001	0.894	0.0001
Greenhouse 1992 vs. greenhouse 1993	44	0.557	0.0001	0.780	0.0001

Table 3. Results from greenhouse screens of selected PIs, breeding lines, and cultivars, 1995.

	Mean disease indices[z]			
	January		March	
Entry	Leaf	Stem	Leaf	Stem
PI 482398	2.6	2.3	2.2	2.0
PI 482399	---[y]	---	2.3	1.8
PI 511890	---	---	2.5	2.0
PI 140471	2.8	2.5	2.7	1.9
PI 266935	---	---	3.3[x]	2.0[x]
AUrora	3.7	3.7	3.3	2.7
PI 266934	---	---	3.4[w]	1.5[w]
Gulfcoast	3.2	3.1	3.9	2.8
AC-70-154	4.1	4.1	4.1	3.4
TAM-Uvalde	3.7	3.3	4.2	3.2
Honeydew[v]	4.3	4.1	4.3	3.7
Topmark[v]	4.5	4.5	4.3	3.4
Mainstream	3.8	3.4	4.4	3.2
Chilton P.V.P	---	---	4.4	3.5
Perlita	4.2	4.1	4.8	3.9
$LSD_{0.05}$	0.8	1.0	0.7	0.7
Mean	3.7	3.5	3.6	2.7
Minimum	2.6	2.3	2.2	1.5
Maximum	4.5	4.5	4.8	3.9
CV (%)	14.2	19.2	14.6	18.8

[z]Disease indices were recorded separately for foliar and stem lesions according to a 1 to 5 scale: Leaf rating: 1 = 0% of the leaf area affected, 2 = ≥1% ≤25%, 3 = ≥25% ≤50%, 4 = ≥50% ≤75%, and 5 = ≥75% ≤100%; Stem rating: 1= no damage, 2 = single lesion < 10 mm in length or composite < 20 mm, 3 = lesion > 20 mm with girdling of the stem, 4 = stem withered, and 5 = plant dead. There were two replications in 1992 greenhouse screen and four replications for all other experiments.
[y]Accession not included in the test.
[x]Rating from a 1992 greenhouse screen.
[w]Rating from a 1993 greenhouse screen.
[v]Susceptible controls.

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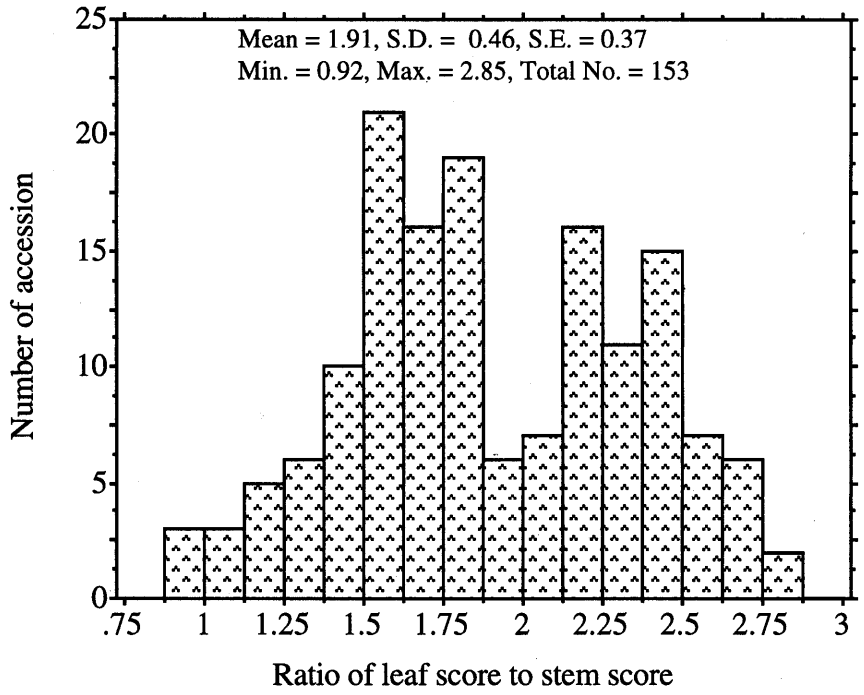

Fig. 1. The relationship of mean leaf rating to mean stem rating over all experiments for the 43 accessions included in Table 1.

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