Races of *Puccinia menthae* in the Pacific Northwest and Interaction of Latent Period of Mints Infected with Rust Races

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ABSTRACT

Johnson, D. A. 1995. Races of *Puccinia menthae* in the Pacific Northwest and interaction of latent period of mints infected with rust races. Plant Dis. 79:20-24.

Physiologic specialization of *Puccinia menthae* on various *Mentha* spp. and the length of latent period on several *Mentha* spp. infected with isolates of *P. menthae* were investigated. Eleven races of *P. menthae* from 17 collections made over a 5-yr period were identified, showing a high degree of physiologic specialization within the *P. menthae* population. Rust isolates from *M. spicata* (Native spearmint) infected *M.* × *gracilis* (Scotch spearmint) but not *M.* × *piperita* (peppermint), and isolates from *M.* × *piperita* infected *M.* × *gracilis* but not commercial Native spearmint. A significant interaction for length of latent period was observed between rust isolates and mint genotypes. A significantly longer latent period occurred in *M.* × *gracilis* when infected with rust isolates from *M.* × *piperita* than when infected with isolates from *M. spicata*. Lengths of latent period on *M. spicata* and *M.* × *gracilis* were similar when infected with isolates from *M. spicata*.

Puccinia menthae Pers.:Pers. is an autoecious, macrocyclic rust that occurs on wild and cultivated species of the Lamiaceae (2,7). Rust frequently infects Native spearmint, *Mentha spicata* L., and Scotch spearmint, *M.* × *gracilis*, Sole (*M. cardiaca* Baker) in south central Washington. Peppermint, *M.* × *piperita* L., is usually not infected with rust in south central Washington because of high summer temperatures (8). Peppermint is grown commercially in the Willamette Valley of western Oregon where rust usually causes severe damage unless control measures (spring flaming and plowing) are taken (16). Defoliation and a reduction in essential oil content of mint plants results from severe rust infection (7,19).

A high degree of physiologic specialization has been found within collections of *P. menthae* on mint hosts. Eight races from 10 collections were identified in France during the early 1900s (5), 6 races from 6 hosts were found in the northeastern United States in the early 1940s (13), 15 races from 15 isolates were reported from the midwestern United States in 1953 (2), 9 races from 15 isolates were reported in England in 1963 (7), and 3 races from 12 isolates were reported in New Zealand in 1982 (3).

Two principal groups of races of *P. menthae* have been recognized (2,12). One infects *M. spicata* but not *M.* × *piperita* and is called Native spearmint rust; the other, peppermint rust, infects *M.* × *piperita* but not *M. spicata*. Both groups of races infect *M.* × *gracilis*. Urediniospores of the two groups of rust races are morphologically distinct according to scanning electron microscopy and prism image analysis (1).

This study was done to determine the degree of physiologic specialization of *P. menthae* in Washington and Oregon, and to quantify latent period in *M.* × *gracilis* after infection by Native spearmint rust and peppermint rust races.

MATERIALS AND METHODS

Thirty host clones, obtained as rhizomes from the National Clonal Germplasm Repository in Corvallis, OR, were tested. Rhizomes were immersed in water at 45 C for 10 min and then planted in 16-cm-diameter pots containing a 3:1 mixture of Warden silt loam soil and composted bark.

Rust was collected in mint fields from central Washington and western Oregon (Table 1). Isolates were derived from a single uredinium and increased in the greenhouse on the same host species from which they were collected. Urediniospores were stored between experiments in sealed glass vials at 4–5 C.

Urediniospores increased for inoculation were collected the day of inoculation with a minicyclone spore collector (4). The abaxial surfaces of fully expanded plant leaves near the plant's apex were inoculated with an oil suspension (Soltrol 170) of approximately 2×10^6 urediniospores per milliliter. Volume of spore-oil suspension applied per plant was 0.1 ml. Urediniospores were suspended in a size 00 gelatin capsule and were applied with an atomizer (4) at an air pressure of 60 kPa. Plants were placed in a mist chamber with continuous light (approximately 5 $\mu E \cdot m^{-2} \cdot s^{-1}$) for 24 hr, then returned to the greenhouse. Natural light supplemented with fluorescent lamps (approximately 40 $\mu E \cdot m^{-2} \cdot s^{-1}$) provided a photoperiod of 15 hr per day. Temperature ranged from 21 to 24 C during the day and from 17 to 21 C at night.

At least six leaves of five stems per mint genotype were inoculated with each rust isolate during three experiments. Isolates were separated in space and time in the greenhouse to prevent cross contamination. Host reactions were observed 14 and 18 days after each inoculation. Pustule development, and the degree of chlorosis and necrosis, were observed. A modified form of Baxter and Cummins's scale (2) of host reaction-infection type was developed and used to categorize reaction types.

N. No visible reaction.

0. Flecking or necrotic spots, no uredinia formed.

1. Uredinia small (300 μ or less), always in necrotic spots, uredinia usually failing to rupture epidermis.

2. Uredinia of moderate size (301–499 μ) and in necrotic spots. Necrosis may

Table 1. Source of *Puccinia menthae* isolates used for inoculation of various *Mentha* spp.

Isolate	*Mentha* spp.	Year	Location
88-1	*M. arvensis* L.	1988	Paterson, WA
89-2	*M. spicata*	1989	Albany, OR
89-4	*M.* × *gracilis*	1989	White Swan, WA
89-5	*M. spicata*	1989	Harrah, WA
89-6	*M. spicata*	1989	Prosser, WA
90-1	*M.* × *gracilis*	1990	Prosser, WA
90-2	*M. spicata*	1990	Outlook, WA
90-3	*M. spicata*	1990	Jefferson, OR
90-4	*M.* × *gracilis*	1990	Outlook, WA
90-5	*M. spicata*	1990	Jefferson, OR
90-6	*M. spicata*	1990	Harrah, WA
90-8	*M.* × *piperita*	1990	Jefferson, OR
90-9	*M.* × *piperita*	1990	Jefferson, OR
91-1	*M.* × *piperita*	1991	Jefferson, OR
91-4	*M. spicata*	1991	Sunnyside, WA
91-5	*M. spicata*	1991	Toppenish, WA
92-1	*M.* × *gracilis*	1992	Prosser, WA

Accepted for publication 28 September 1994.

develop after eruption of fully sized uredinia.

3. Chlorosis surrounding uredinia but no necrosis. Uredinia of any size.

4. No necrosis or chlorosis surrounding uredinia. Uredinia of any size.

No visible reaction and infection types 0 to 2 were considered resistant reactions (avirulent isolate), and those of 3 and 4 were considered susceptible reactions (virulent isolate).

Size of uredinia of susceptible reactions were estimated using a visual scale developed for bean rust (6). Uredinia were placed in size categories in two of the three sets of inoculations of each isolate: ≤ 300 μ; 301–499 μ; 500 μ or larger (6).

Rust isolates 90-6 and 90-9 were randomly selected from isolates collected in 1990 from *M. spicata* and *M.* × *piperita*, respectively; rust isolates 91-5 and 91-1 were randomly selected from isolates collected in 1991 from *M. spicata* and *M.* × *piperita*, respectively. *M. spicata* 'Native' spearmint, *M.* × *piperita* 'Black Mitcham,' and *M.* × *gracilis* 'Scotch' spearmint from commercial fields in central Washington, and *M.* × *gracilis* MEN 189, and *M. canadensis* MEN 178, from the National Clonal Germplasm Repository, were inoculated with *P. menthae* isolates 90-6 (collected from *M.*

Table 2. Infection type when *Mentha* spp. inoculated with isolates of *Puccinia menthae*

		Isolate (Race)																
***Mentha* spp.**		**88-1[a] (1)**	**89-2[b] (*)**	**89-4[c] (2)**	**89-5[b] (2)**	**89-6[b] (3)**	**90-1[c] (4)**	**90-2[b] (5)**	**90-3[b] (5)**	**90-4[c] (5)**	**90-5[b] (6)**	**90-6[b] (7)**	**90-8[d] (8)**	**90-9[d] (8)**	**91-1[d] (8)**	**91-4[b] (9)**	**91-5[b] (10)**	**92-1[c] (11)**
M. spicata L. cv. Native spearmint	MEN 29	4[e]	–[f]	4	4	4	4	4	4	4	4	4	0[g]	0	N[h]	4	4	4
M. spicata	MEN 66	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
M. spicata	MEN 75	0	1[i]	N	N	0	N	0	0	1	N	0	1	1	0	N	N	1
M. spicata	MEN 95	4	0	N	N	4	N	N	N	N	N	0	N	N	N	N	N	N
M. × *gracilis* cv. Scotch spearmint	MEN 189	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
M. × *piperita* L. cv. Mitcham	MEN 133	N	0	N	N	0	0	0	0	0	0	0	4	4	4	0	0	0
M. × *piperita* cv. Todd's Mitcham	MEN 199	0	–	0	0	N	0	0	0	0	0	0	4	4	4	0	0	0
M. × *piperita* cv. Murray Mitcham	MEN 200	N	–	N	0	N	0	0	0	0	0	0	4	4	4	0	0	0
M. × *piperita* subs *citrata* (Ehrh.) Briq.	MEN 123	N	0	N	N	N	N	0	0	0	0	0	0	0	N	0	0	0
M. × *piperita* subs *citrata*	MEN 127	N	N	N	N	N	N	N	N	N	N	N	2[j]	2	2	N	N	N
M. canadensis L.	MEN 158	0	N	0	N	0	N	0	0	0	0	0	0	0	0	0	0	0
M. canadensis	MEN 171	4	3[k]	4	4	3	2	2	2	2	2	1	0	0	0	N	1	4
M. canadensis	MEN 174	0	–	4	4	4	2	2	2	2	2	1	0	0	1	1	2	4
M. canadensis	MEN 178	4	3	4	4	3	4	3	4	4	4	4	4	4	4	3	4	4
M. arvensis L.	MEN 162	N	N	N	N	N	N	N	N	N	N	N	4	4	4	N	N	N
M. arvensis	MEN 165	N	–	N	N	N	N	N	N	N	N	N	2	2	2	N	N	N
M. aquatica L.	MEN 115	N	0	N	N	N	0	0	0	0	0	0	0	0	N	0	0	0
M. aquatica × *M. spicata*	MEN 149	N	N	N	N	N	N	N	N	N	N	N	0	0	0	N	N	N
M. aquatica × *spicata*	MEN 151	N	N	N	N	N	O	N	N	N	N	O	2	2	2	N	N	N
M. citrata × *aquatica*	MEN 247	N	N	N	N	N	N	N	N	N	N	N	0	0	N	N	N	N
M. spicata × *M. spicata* (*crispa*)	MEN 218	4	4	4	4	4	4	4	4	4	4	N	1	1	1	N	0	2
M. citrata × *M. aquatic*	MEN 126	N	N	N	N	N	N	N	N	N	N	N	0	0	N	N	0	N
M. longifolia L.	MEN 17	4	4	4	4	4	N	0	0	0	4	0	4	4	4	1	4	N
M. longifolia var. *typhoides* (Briq.) Harley	MEN 20	4	0	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
M. × *villosa* *Hudson* var. *alopecuroide* (Hull) Briq.	MEN 37	4	4	4	4	4	4	4	4	4	4	4	2	2	N	4	4	4
M. pulegium L.	MEN 3	N	N	N	N	N	0	0	0	N	0	0	1	1	N	N	N	N
M. gattefossei Maire	MEN 4	4	–	4	4	4	1	4	4	4	4	4	4	4	4	N	4	4
M. cervina L.	MEN 5	2	1	1	1	1	1	1	1	1	1	1	2	2	2	1	2	2
M. suaveoleus Ehrh.	MEN 9	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
M. × *smithiana* R. A. Graham	MEN 195	N	–	N	N	N	N	N	N	N	N	N	0	0	0	N	N	N

[a] Isolate originally collected from *M. arvensis*.
[b] Isolate originally collected from *M. spicata*.
[c] Isolate originally collected from *M.* × *gracilis*.
[d] Isolate originally collected from *M.* × *piperita*.
[e] Uredinia without chlorosis or necrosis and uredinia of any size (susceptible reaction).
[f] No inoculation was made.
[g] Fleck or necrotic spot.
[h] No visible reaction (resistant reaction).
[i] Small uredinia (300 μ or less) in necrotic spots (resistant reaction).
[j] Moderately sized uredinia (301–499 μ) in necrotic spots (resistant reaction).
[k] Chlorosis surrounding uredinia but no necrosis and uredinia of any size (susceptible reaction).

spicata) and 90-9 (from *M.* × *piperita*). Plants were arranged in a randomized complete block design with three replicates. The above five mint genotypes plus *M. longifolia* MEN 17 were inoculated with isolates 91-5 (from *M. spicata*) and 91-1 (from *M.* × *piperita*) in a randomized complete block design with five replicates. The five replicates were inoculated on three different dates. Methods of heat treating rhizomes, potting, inoculation, and postinoculation wet period were the same as previously described in this paper.

After inoculation, uredinia were counted when the red-orange of a pustule was visible to the unaided eye on two leaves per plant every day for 12 days and then on alternate days for 8 more days. The probit model provided a good fit of the occurrence of uredinia on *Mentha* spp. as seen from scatter plots and high coefficients of determination (usually >0.90) from regression analysis. Latent period then was taken as the number of days from inoculation until 50% of uredinia appeared and was calculated from linear regression of probit percent uredinia appeared on days after inoculation as described by Shaner (18).

Data were analyzed by two-way analysis of variance for a randomized complete block design with 2 missing cells to account for resistant infection types (17). Examination of residuals showed the assumptions of normality and homogeneity of variances were satisfied from the inoculations using isolates 90-6 and 90-9. Because of a significant interaction between rust race and mint genotype ($P = 0.0001$), the simple effects of each factor were examined within each level of the other factor, using linear contrasts.

Residuals were non-normal and variances appeared to be unequal from the inoculation using isolates 91-1 and 91-5. A satisfactory transformation of data was not found; therefore, a separate analysis was done for MEN 17 and MEN 178, and for MEN 189, Native spearmint, Black Mitcham, and Scotch spearmint. Estimates of variation from these analyses were used to construct confidence intervals for mean latent period for each rust isolate by mint genotype combination. Bonferroni adjustments were used to provide overall levels at confidence of 0.95 and 0.90 for the 10 intervals constructed. Comparisons between rust isolates and mint genotypes were made by determining whether the confidence intervals overlapped.

RESULTS

The reactions of the 30 hosts differed among all but two isolates, 90-8 and 90-9 (Table 2). Some isolates produced only slight differences in infection types but others produced distinctly different infection types on several mint clones. Eleven races were differentiated when either resistant or susceptible reactions were considered. Isolate 89-2 was not given a race designation because it was not tested against seven of the differentials.

Isolates collected from *M. spicata* and *M.* × *gracilis* were avirulent on *M.* × *piperita*, and the isolates from *M.* × *piperita* were avirulent on *M. spicata* cv. Native spearmint MEN 29. All isolates were virulent on *M.* × *gracilis* cv. Scotch spearmint MEN 189 and *M. spicata* MEN 66 (Table 2).

Size of uredinia varied among hosts and isolates (Table 3). Size categories for a particular mint host and rust isolate were usually consistent. Uredinia were consistently 300 μ or less on *M. crispa* × *M. spicata* MEN 218 when infected with virulent races (Table 3).

There was a significant interaction between rust isolates 90-6 and 90-9 and mint genotype ($P = 0.0001$). Isolate 90-9 had a significantly longer latent period than 90-6 in both *M.* × *gracilis* cv. Scotch spearmint ($P = 0.0001$) and *M.* × *gracilis* MEN 189 ($P = 0.0001$), but not in *M. canadensis* MEN 178 ($P = 0.6692$). Rust isolates could not be compared for latent period in mint species *M.* × *piperita* and *M. spicata*. There were significant differences among mint genotypes in latent period for isolate 90-6 ($P = 0.0391$) and 90-9 ($P = 0.0001$) (Table 4).

Mean latent periods varied from 9.5 to 14.5 days when mint genotypes were inoculated with isolates 91-1 and 91-5 (Table 4). There was a significant interaction between rust isolates 91-1 and 91-5 and mint genotypes. The confidence intervals for latent period at an overall level of 0.95 did not overlap when MEN 189 and Scotch spearmint were inocu-

Table 3. Size category on *Mentha* spp. inoculated with various isolates of *Puccinia menthae*

		Isolate																
***Mentha* spp.**		**88-1[a]**	**89-4[b]**	**89-4[c]**	**89-5[b]**	**89-6[b]**	**90-1[c]**	**90-2[b]**	**90-3[b]**	**90-4[c]**	**90-5[b]**	**90-6[b]**	**90-8[d]**	**90-9[d]**	**91-1[d]**	**91-4[b]**	**91-5[b]**	**92-1[c]**
M. spicata cv. Native spearmint	MEN 29	4[e]	–[f]	5[g]	4	4	4	4	4	4	4	4	NM[h]	NM	NM	4	4	3[i]
M. spicata	MEN 66	5	5	5	4	5	4	4	4	4	4	4	5	5	4	3	3	4
M. spicata	MEN 95	3	NM	NM	NM	3	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
M. × *gracilis* cv. Scotch spearmint	MEN 189	4	4	5	4	4	4	4	4	5	4	4	4	4	4	4	4	5
M. × *piperita* cv. Mitcham	MEN 133	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4	4	5	NM	NM	NM
M. piperita cv. Todd's Mitcham	MEN 199	NM	–	NM	NM	NM	NM	NM	NM	NM	NM	NM	4	4	4	NM	NM	NM
M. piperita cv. Murray Mitcham	MEN 200	NM	–	NM	NM	NM	NM	NM	NM	NM	NM	NM	3	3	4	NM	NM	NM
M. canadensis	MEN 171	5	4	4	4	4	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4
M. canadensis	MEN 174	NM	–	4	4	4	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5
M. canadensis	MEN 178	5	5	4	4	4	5	4	4	4	5	4	5	5	5	4	4	5
M. arvensis	MEN 162	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4	4	4	NM	NM	NM
M. crispa × *M. spicata*	MEN 218	3	3	3	3	3	3	3	3	3	3	NM	NM	NM	NM	NM	NM	NM
M. longifolia	MEN 17	3	5	4	4	4	NM	NM	NM	NM	4	NM	3	3	4	NM	3	NM
M. longifolia var. *typhoides*	MEN 20	3	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
M. × *villosa* var. *alopecuroide*	MEN 37	5	3	4	4	4	3	3	4	4	4	3	NM	NM	NM	3	3	4
M. gattefossei	MEN 4	4	–	4	4	4	NM	4	4	4	4	4	4	4	4	NM	4	4

[a] Isolate originally collected from *M. arvensis*.
[b] Isolate originally collected from *M. spicata*.
[c] Isolate originally collected from *M. gracilis*.
[d] Isolate originally collected from *M. piperita*.
[e] Uredinia 301–499 μ.
[f] No inoculation made.
[g] Uredinia equal to or larger than 500 μ.
[h] No measurement because of resistant infection types.
[i] Uredinia equal to or less than 300 μ.

lated with 91-1 or 91-5 but confidence intervals overlapped when MEN 17 and MEN 178 were inoculated with the two rust isolates. Confidence intervals for Black Mitcham and Native spearmint could not be constructed because of resistant infection types (either no reaction or flecking) produced by one of the rust isolates on each mint.

When mint genotypes were inoculated with isolate 91-1, mean latent periods of the following mint genotypes were significantly different based on the confidence intervals at an overall level of 0.95 not overlapping: MEN 17 and MEN 189, MEN 17 and Scotch spearmint, MEN 189 and Black Mitcham, and Black Mitcham and Scotch spearmint. Confidence intervals at an overall level of 0.90 did not overlap for mean latent period for MEN 178 and MEN 189, and MEN 178 and Scotch spearmint. Confidence intervals did overlap for the remaining four combinations when mint genotypes were inoculated with isolate 91-1 and for all 10 combinations when genotypes were inoculated with 91-5.

DISCUSSION

The high degree of physiologic specialization found in collections of *P. menthae* from *Mentha* spp. in this and previous studies (2,3,7,13) suggests much variation exists for virulence in the pathogen and resistance in host species. The isolates from *M.* × *piperita* composed one race, but only three isolates were collected from the same county in Oregon. Much more variation was found among isolates collected from *M. spicata* and *M.* × *gracilis*. Because of the variation for virulence and meiosis occurring annually in the population of the autoecious fungus, race-specific resistance for rust may not endure for an indefinite period in mint cultivars grown commercially.

The number of races found is often dependent on the number of host differentials. The hosts used here were chosen to differentiate races with respect to species of Mentha grown commercially in the Northwest and related *Mentha* spp. Detailed comparisons of races found in this and other studies were not made because investigators have used different hosts as differentials. *Mentha* spp. hybridize very readily and it is often difficult to identify and maintain the many clones that exist.

Earlier workers in the United States and England found that isolates from *M.* × *piperita* and *M. spicata* infected only their respective hosts (2,7,13). In New Zealand, a race from *M. spicata* did not infect *M.* × *piperita*, but a race from *M.* × *piperita* infected *M. spicata*. In this study, isolates from *M. spicata* infected *M.* × *gracilis* but not *M.* × *piperita*, and isolates from *M.* × *piperita* infected *M.* × *gracilis* and *M. spicata* MEN 66 but not commercial Native spearmint, and *M. spicata* MEN 29.

M. × *gracilis* was infected by all isolates. Isolates collected from *M.* × *gracilis* were more similar to isolates from *M. spicata* than were those from *M.* × *piperita* in that clone *M. spicata* MEN 29 was infected and *M.* × *piperita* was not. This may suggest that *M.* × *gracilis* is more closely related to *M. spicata* than to *M.* × *piperita*. Taxonomic studies suggest that *M.* × *gracilis* is a hybrid between *M. spicata* and *M. arvensis* (20,21).

Most of the hosts provided information on the population of *P. menthae*. However, infection types on the three cultivars of *M.* × *piperita* (Mitcham, Todd's Mitcham, and Murray Mitcham) were very similar for all isolates, and two of these clones could be deleted as differentials, especially when testing isolates from *M. spicata*. Some of the clones that were resistant (MEN 9, MEN 195, MEN 123) or susceptible (MEN 66 and 189) to all isolates could also be deleted as differentials, except to serve as controls. This would not preclude the use of these resistant clones as sources for resistant genes and then their later use as differentials.

These experiments were not designed to test for difference in size of uredinia. However, consistent observation of the small uredinia on MEN 218, when infection types were susceptible, suggests that a component of partial resistance may exist in MEN 218. However, the resistant infection types produced by seven of the isolates on MEN 218 demonstrated this clone also had race-specific resistance.

Latent period is a good indicator and an important component of slow rusting or partial resistance in several host-rust relationships (9–11). The latent period of cultivars of several hosts has been found to be race specific (11,14,15), as shown for mint clones infected with *P. menthae* in this study. However, the interaction in mint clones and rust isolates was caused by a longer latent period in *M.* × *gracilis* when infected with isolates from *M.* × *piperita* than when infected with isolates from *M. spicata*. Lengths of latent period on *M. spicata* and *M.* × *gracilis* were similar when infected with isolates from *M. spicata*. Because of the long latent period in *M.* × *gracilis* when infected with rust isolates from *M.* × *piperita*, plantings of *M.* × gracilis would probably not be seriously damaged by isolates of *P. menthae* originating from fields of *P.* × *piperita*.

Table 4. Latent period in days for mint genotypes infected with isolates of *Puccinia menthae* collected from either *Mentha spicata* or *M. piperita*

	Isolate and source			
	Experiment I[a]		Experiment II[b]	
Mint genotype	*M. spicata* 90-6	*M.* × *piperita* 90-9	*M. spicata* 91-5	*M.* × *piperita* 91-1
M. spicata cv. Native spearmint	9.6 x	R[c]	9.5	R
M. × *piperita* cv. Black Mitcham	R	9.9 x	R	9.5
M. × *gracilis* cv. Scotch spearmint	9.5 x	12.9 y	9.8	14.5
M. × *gracilis* MEN 189	9.9 xy	12.4 y	9.5	14.5
M. canadensis MEN 178	10.2 y	10.3 x	11.1	11.3
M. longifolia MEN 17	–[d]	–	11.6	10.9

[a]Values are means of 3 replications. Within a column, values with the same letter (x and y) are not significantly different, $P = 0.05$, according to linear contrasts.
[b]Values are means of 5 replications.
[c]Resistant infection type.
[d]No inoculation was made.

ACKNOWLEDGEMENTS

Plant Pathology New Series no. 0184, project 0678, College of Agriculture and Home Economics Research Center, Washington State University, Pullman, WA 99164.

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