***VERTICILLIUM DAHLUE* SOIL POPULATION ANALYSIS FROM PEPPERMINT VARIETY TRIALS IN CENTRAL OREGON (1994-98) AND THE WILLAMETTE VALLEY (1995-99)**

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Abstract

Changes in initially uniform soil populations of *Verticillium dahliae* (VD) were related to wilt incidence, cultural practices, and region with respect to mint variety trials. Similar wilt occurred for all varieties in the first season after planting in both Central Oregon (CO) and the Willamette Valley (WV). In subsequent years, wilt incidence in Black Mitcham increased over years in the untitled and unflamed WV trial, but remained similar for all other varieties. Soil VD populations remained similar for all varieties in the WV trial. In CO, wilt incidence remained similar for all varieties until after tillage was initiated, at which time wilt incidence in Black Mitcham greatly increased. Soil VD populations in the CO trial greatly increased in Black Mitcham plots after tillage compared with plots of other varieties. Along with earlier greenhouse inoculation data which indicated equal varietal susceptibility, these data seem consistant with the hypotheses that Black Mitcham is not more susceptible to VD but that VD is more likely to carry over in rhizomes and reproduce in stems of Black Mitcham than other varieties. It is suggested that infected rhizome carryover of VD may be diminished in CO because of winter kill of weakened and infected rhizomes, but that such carryover is enhanced in the milder WV.

Introduction

Variety trials conducted 1994-1998 in Central Oregon-Madras (Crowe 1995, 1996, 1997, 1998, and 1999b) and conducted 1995-1999 in the Willamette Valley-Corvallis (Gingrich & Mellbye 1997, 1998, and 1999) included both uniformly Verticillium wilt infested plots and non-infested plots, located in soil previously free of mint strains of *Verticillium dahliae.* For the trials discontinued in 1998 at Madras, experimental design, mint performance, and wilt ratings have been reported in previous years, but soil populations of *V. dahliae* are reported here through 1999. Experimental design, mint performance, and wilt incidence are reported elsewhere for the continuing Corvallis trials (see Gingrich & Mellbye, 1999 Research Reports, MIRC, to be published 2000), but soil population analysis of *V. dahliae.* is reported below for 1998 and 1999. Interpretation of results is incomplete, but suggests that varietal, management, and perhaps some regional differences may account for population changes measured in the two regions.

Materials & Methods

For detailed trial design, refer to reports from previous years for Madras (Crowe 1995, 1996, 1997, 1998, and 1999b), and for Corvallis (Gingrich & Mellbye 1997, 1998 and 1999; Gingrich & Mellbye, 1999 Research Reports, M1RC, to be published 2000).

<u>Madras:</u> To create infested plots, 2.5 microsclerotia/g soil were tilled into the top 15 cm soil in the fall of 1994, after mint establishment from rooted cuttings in the

summer of 1994. Soil was not disturbed further until the fall of 1996. Following harvest in 1996 and 1997, infested plots were not post-harvest flamed but were roto-tilled in the fall. Following final harvest of peppermint in 1998, fall regrowth was treated with glyphosate to kill the mint. Plots were tilled in mid-July and watered through 1999 to maintain biological activity. Soil samples were collected in July or August of 1997 through 1999, and assayed in the lab for the number of colonies of *V. dahliae* recovered per gram of soil (Harris et al., 1993).

Corvallis: To create infested plots, 3.5 microsclerotia/g soil were tilled into the top 15 cm soil prior to establishment of rooted cuttings in the spring of 1995. Plots were maintained without flaming or tillage through 1999. Soil was sampled and assayed from infested plots in September 1999, but samples excluded the approx. 1.5 cm layer of surface organic matter created from decaying stems and leaves.

Results

For overall mint performance at both locations, refer to previous or continuing reports.

Madras: During the 1995 and 1996 seasons, soil had not been disturbed in infested plots, and presumably soil populations had not changed much during this period, although this was not measured. Wilt incidence was similar in 1995 and 1996 for all six mint varieties, including Black Mitcham (Fig. 1). Greenhouse root dip inoculation tests (reported in previous years) also suggested equal varietal responses to wilt infection. Fall tillage without post-harvest propane flaming in 1996, 1997, and 1998 was expected to intensify wilt (Horner & Dooley, 1965; McIntyre & Horner, 1973), presumably by incorporation of stem-produced microsclerotia into the soil. Soil populations from plots of all varieties except Black Mitcham were similar in 1997 and 1998 (Fig. 3), and CFU recovered from soil in Black Mitcham plots was 4 to 5 times larger in both years than from plots of other varieties. In 1999, the mean pathogen population recovered from Black Mitcham plots was 3 to 5 times larger than from T84-5, M83-7, and Murray plots, and about double that from Todds and Roberts. Wilt incidence for the variety Black Mitcham increased in 1997 and 1998, but was lower among other varieties (Fig. 1).

Corvallis: Wilt incidence is shown in Fig. 2 for Willamette Valley plots (Gingrich & Mellbye, 1996, 1997, and 1998). *V. dahliae* soil populations were similar for all varieties for both 1998 and 1999 (Fig. 4).

Discussion/Conclusions

That mint performance and wilt incidence were comparable among all varieties at Madras in 1995 and 1996 (Crowe, 1996; Crowe, 1997), supported by greenhouse inoculation studies (Crowe, 1999a), suggests less difference in varietal susceptibility than is commonly believed.

Varietal separation in wilt incidence occurred at Madras after plots were tilled without flaming. Because *V. dahliae* soil populations were greater in Black Mitcham plots in conjunction with an increase in wilt in comparison to other varieties, much of the wilt increase might be attributable to the increase in CFU of *V. dahliae* for this variety. At Madras, all other varieties continued to manifest only moderate wilt through 1998. Because all infested plots were tilled, it is unclear whether wilt would eventually have increased in Black Mitcham without tillage.

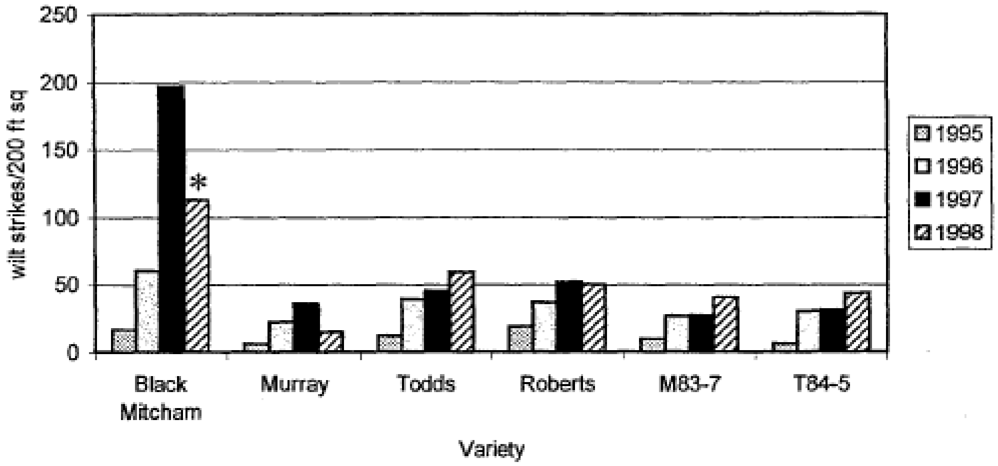

Figure 1. Verticillium wilt incidence in infested plots at the central Oregon peppermint variety trial, Madras, Oregon, 1995-98. *Not corrected for 40% spring stand reduction in 1998.

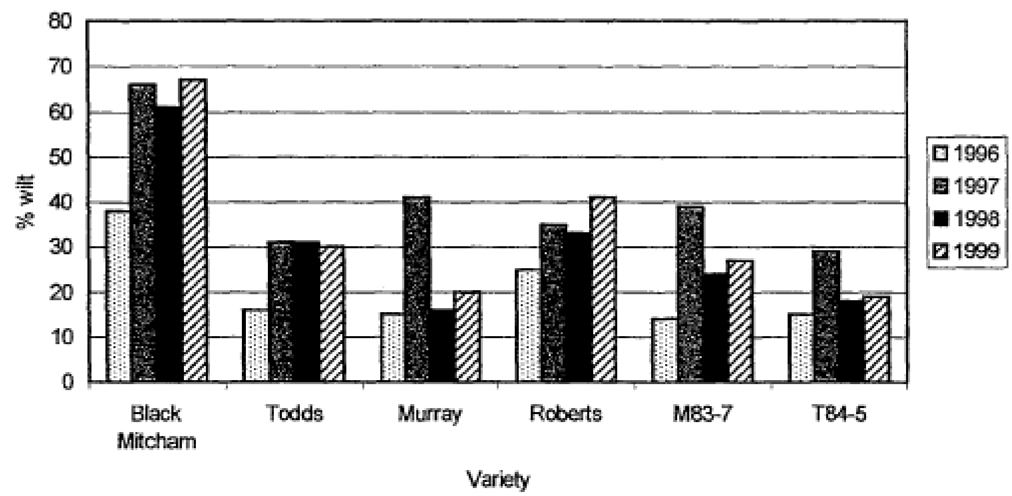

Figure 2. Verticillium wilt incidence in infested plots at the Willamette Valley peppermint variety trial, Corvallis, Oregon, 1996-99.

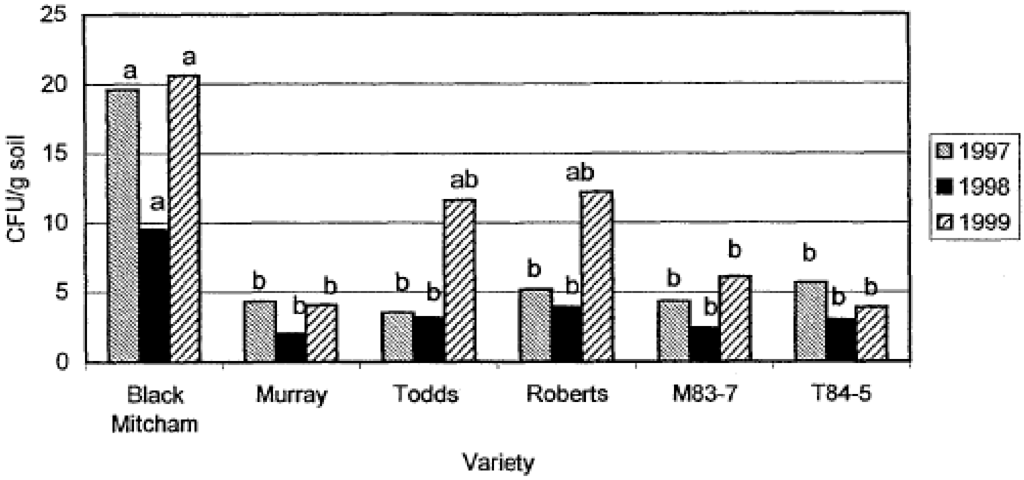

Figure 3. *Verticillium dahliae* soil populations (colony forming units per gram of soil) in infested plots at the central Oregon peppermint variety trial, Madras, Oregon, 1997-99. Means were separated with Fisher's least significant difference test (LSD). Within years, means labeled with the same letter are not significantly different according to $P \leq 0.05$.

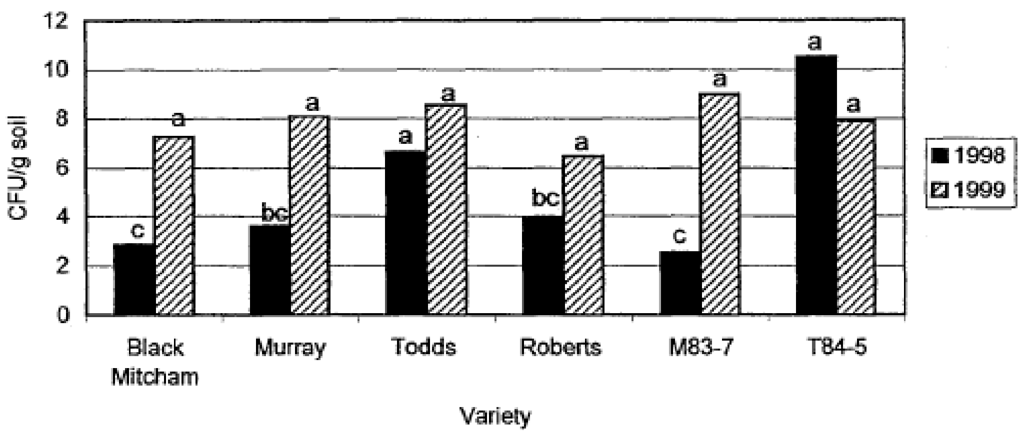

Figure 4. *Verticillium dahliae* soil populations (colony forming units per gram of soil) in infested plots at the Willamette Valley peppermint variety trial, Corvallis, Oregon, 1998-99. Means were separated with Fisher's least significant difference test (LSD). Within years, means labeled with the same letter are not significantly different according to $P \leq 0.05$.

A similar lack of difference in wilt incidence among the same peppermint varieties was reported for the first harvest season at Corvallis. At Corvallis, no tillage occurred and *V. dahliae* soil populations remained similar for all varieties. Nevertheless, wilt increased disproportionately for Black Mitcham each year after the first season.

Immediately following exposure to *V. dahliae,* Black Mitcham was no more susceptible than other varieties when infested equally in the field or inoculated equally in the greenhouse. Nevertheless, over several years, differences in wilt incidence between Black Mitcham and other varieties accumulated in the field at Madras and Corvallis. While soil populations in Black Mitcham plots increased compared to other varieties at Madras, soil populations remained similar among all varieties at Corvallis.

The capacity of *V. dahliae* to infect roots is well understood. It is known, also, that *V. dahliae* also can be disseminated via rhizomes (Nelson, 1950). It seems most likely that accumulation of wilt over several years occurred primarily by increase in rhizome carryover, as wilt was uniform among varieties in the first season, and soil *V. dahliae* populations remained uniform among varieties during the course of the trial. We suggest that accumulation of wilt at Madras, and particularly the sudden increase in wilt between 1996 and 1997, resulted primarily from increase in soil population of *V. dahliae,* perhaps in addition to carryover of *V. dahliae* in rhizomes. However, rhizomes infected with V *dahliae* may be reduced in vigor and thus may be more susceptible to winter kill in cold regions (Crowe 1992), which might reduce the importance of rhizome carryover relative to soil infection in cold regions.

In the future, it may be worthwhile designing experiments to clarify the relative contribution of soil vs. rhizome carryover among varieties and regions. This is not easily done within the experimental design and management constraints of standard variety trials.

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