Evaluation of Fungicides to Control Verticillium Wilt in Mint

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Introduction

Verticillium wilt is a severe disease problem in peppermint production and is likely a major limiting factor to broader production in Oregon and throughout the United States. Control of this disease with fungicides has been difficult because of the persistent nature of Verticillium microsclerotia in the soil and the perennial production practices for peppermint. Research conducted by Crowe and Simmons (2007) showed that some newer fungicides reduced Verticillium wilt symptoms on peppermint. In particular, a strobilurin fungicide, azoxystrobin (Quadris®), prevented all visual wilt symptoms. Based on those results it seemed possible that a fungicide could be used to control Verticillium wilt. It also seemed possible that other newer fungicides that had not yet been tested might also be effective on Verticillium wilt. However, in order to screen a larger number of fungicides, Crowe and Simmons' experiment was not conducted under normal field conditions. Therefore the fungicide efficacy observed in that trial may not accurately reflect fungicide efficacy in the field. Also, the application technique used in their experiment was not readily adaptable to commercial production practices.

The objective of our research was to evaluate fungicides to control or prevent symptoms from Verticillium wilt under representative field conditions in newly planted and established peppermint.

Methods and Materials

Two field trials were conducted in central Oregon, one in newly planted and one in established peppermint. The trial in newly planted peppermint was conducted at the Central Oregon Agricultural Research Center (COARC) near Madras in a field with no history of peppermint or potato production. Prior to planting peppermint, the site was inoculated with laboratory-grown Verticillium at a rate of two microsclerotia per gram of soil. After spreading the inoculum on the soil surface, the microsclerotia were incorporated with a roto-tiller to a depth of 6 inches. The peppermint roots planted in the trial were dug from a field near Heppner, Oregon with no history of Verticillium wilt. The roots were dug on April 7, 2009 and placed in refrigerated storage at COARC on April 8, where they were kept until the site preparation for the trial was finished. The roots had begun to sprout when they were taken out of storage, but were estimated to still be in good condition for planting.

On May 21, 2009 'Black Mitcham' root stock was planted as follows:

- Furrows were made with a tractor-mounted implement; furrow spacing was 20 inches.
- Peppermint roots were hand-planted in the furrows at a rate of approximately 8.7 tons/acre.
- Fungicide treatments were applied over the top of the roots and on the sides of the furrow in a 12-inch-wide band. Application volume in the band was 31 gal/acre.
- Peppermint roots were covered by hand-raking soil back into the furrows.
- The trial was sprinkler irrigated 1 hour after planting.

Another trial was conducted in a field of established peppermint near Culver, Oregon that had a history of Verticillium wilt. The peppermint was entering the third production year. Fungicide treatments were broadcast over emerged peppermint shoots on May 19, 2009, 2 days prior to the first irrigation of the spring. At the time of application the mint was 1 to 2 inches tall and covered 10 to 30 percent of the soil surface. Since some of the peppermint had already emerged, these fungicide treatments were applied with a non-ionic surfactant at 0.25 percent v/v. The soil surface was dry at the time of application and the field had been subsoiled and tilled the previous fall.

Both trials consisted of six replications. Plot size in the new peppermint at COARC was 10 by 10 ft and plot size in the established peppermint at Culver was 16 by 16 ft. In each trial 5 soil cores were collected to a depth of 6 inches from each plot prior to inoculating/fungicide application. The cores were combined into one sample per plot and were then assayed to determine existing levels of Verticillium wilt.

The treatments for both trials were as follows:

- Azoxystrobin (Quadris) at 0.25 lb ai/acre
- Pyraclostrobin (Headline®) at 0.2 lb ai/acre
- Tebuconazole + trifloxystrobin (Absolute™) at 0.26 lb ai/acre
- Prothioconazole (Proline®) at 0.18 lb ai/acre
- Untreated check

Data collection for both trials consisted of visual evaluations of Verticillium wilt symptoms on the peppermint at three timings, followed by measurements of the average shoot height and fresh weights collected at early bloom.

Results and Discussion

None of the fungicides significantly lowered the incidence of Verticillium wilt or increased peppermint fresh weights compared to the untreated check, as indicated by the high *F*-test scores in Tables 1 and 2. However, a combined ranking of each treatment across all five data collection parameters and both trials shows that the fungicides Proline, Headline, and Quadris generally lowered the severity of wilt symptoms on the peppermint (Fig. 1).

In each trial there were different factors that limited our ability to detect differences between treatments. In the new peppermint at COARC, the field inoculation seemed to work well because there were clear symptoms of wilt beginning in late June; furthermore, wilt symptoms seemed to be uniform throughout the trial. However, there was variability in the stand that likely related to the vigor of the roots. We attempted to plant enough roots to overcome this variability but some plots still had a much better stand of peppermint than others. In the established peppermint at Culver the incidence of wilt was not uniform throughout the trial area; the blocking scheme for the experiment helped account for this variability, but there were still some plots that were excessively affected by wilt and the effect did not seem to be treatment related. At Culver there was also a moderate amount of hail damage that occurred shortly before harvest. The hail damage certainly lowered the fresh weight yield and may have also diminished any differences there may have been between treatments.

The soil sampling and assay technique that was conducted to set up each trial was probably inadequate to detect Verticillium wilt. The results of the assay revealed negligible amounts of Verticillium microsclerotia at both field locations (data not shown). As the season progressed the established peppermint at Culver had obvious signs of a moderate to high level of wilt in the crop.

We understood at the beginning of these trials that limiting variability of Verticillium wilt in peppermint in the field is difficult. Having six rather than four replications in each trial was intended to overcome that variability. Unfortunately the difference between treatments in these trials was too little to overcome the variability described above, which in turn prevents us from making any optimistic conclusions about control of Verticillium wilt. It could be that both trials started with too much Verticillium wilt, and that a similar evaluation of fungicides across a longer period with less inoculum would yield different results.

However, at this point it seems unlikely that these fungicides as a stand-alone treatment will effectively control Verticillium wilt in peppermint under field conditions.

Acknowledgements

We would like to thank Jim Cloud for his advice in the planning stages of this project, along with Mike and Jeff Cloud for their cooperation in the field trial at Cloud Farms. We also thank Fred Crowe, Oregon State University Professor Emeritus, for his thoughtful input on the experimental design, methodology, and interpretation of the data. Finally we would like to thank Kurt Amoth, Aromatics, Inc., for donating and delivering the 'Black Mitcham' roots that were used for the trial at COARC.

Literature Cited

Crowe, F., and R. Simmons. 2007. Fungicide influence on Verticillium wilt and subsequent rhizome infection/infestation by *Verticillium dahliae*. Central Oregon Agricultural Research Center 2006 Annual Report. Special Report 1072:52-70. http://extension.oregonstate.edu/catalog/html/sr/sr1072-e/17a.pdf

Table 1. Incidence of Verticillium wilt symptoms and response of baby peppermint following fungicide applications at Central Oregon Agricultural Research Center, Madras, Oregon, 2009.

Treatment[1]	Rate	Incidence of Verticillium wilt symptoms[2]			Peppermint height[3]	Peppermint fresh wt.
		8/5/2009	8/14/2009	8/19/2009	8/19/2009	8/19/2009
	fl oz/A	0-5 scale			inches	lb/plot
Check	0	1.82	3.48	4.18	16.4	9.3
Quadris	15.5	1.77	3.33	3.98	17.1	10.2
Headline	12	1.55	3.18	3.72	16.9	8.6
Absolute	7.7	1.88	4.00	4.02	16.7	9.0
Proline	5.7	1.58	3.20	3.77	17.8	10.2
P value		0.56	0.17	0.58	0.41	0.62
CV		23.8	17.8	13.9	7.6	22.5

[1] Fungicides were applied in furrow at planting on 5/21/2009.
[2] Evaluation scale of 0 = no symptoms, 1 = 1 to 10% symptoms, 2 = 11 to 20% symptoms, 3 = 21 to 40% symptoms, 4 = 41 to 60% symptoms, and 5 = 61% or more symptoms.
[3]Three stems per plot were measured and averaged.

Table 2. Incidence of Verticillium wilt symptoms and response of established peppermint following fungicide applications near Culver, Oregon, 2009.

Treatment[1]	Rate	Incidence of Verticillium wilt symptoms[2]			Peppermint height[3]	Peppermint fresh wt.
		7/6/2009	7/17/2009	7/30/2009	7/10/2009	8/6/2009
	fl oz/A	0-5 scale			inches	lb/plot
Check	0	2.68	3.30	4.22	23.7	25.0
Quadris	15.5	2.37	2.87	3.98	23.7	26.2
Headline	12	2.33	2.92	3.92	24.6	26.9
Absolute	7.7	2.58	3.00	4.33	23.8	25.3
Proline	5.7	2.25	2.78	4.13	24.5	27.1
P value		0.41	0.35	0.24	0.49	0.81
CV		24.9	15.1	8.3	5.1	13.9

[1] Fungicides were broadcast on the soil surface and emerged shoots on 5/19/2009.
[2] Evaluation scale of 0 = no symptoms, 1 = 1 to 10% symptoms, 2 = 11 to 20% symptoms, 3 = 21 to 40% symptoms, 4 = 41 to 60% symptoms, and 5 = 61% or more symptoms.
[3]Three stems per plot were measured and averaged.

Figure 1. Combined ranking of five data collection parameters across two trials evaluating fungicide efficacy for Verticillium wilt in peppermint in central Oregon, 2009.