INVESTIGATION ON STRAIN BEHAVIOR OF *VERTICILLIUM DAHLIAE* ON MINT AND OTHER CROPS

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Abstract

Recent greenhouse studies with *Verticillium dahliae* mint isolates demonstrated that about 80 percent of the isolates were highly pathogenic to mint, and about 20 percent were only mildly pathogenic. *V. dahliae* from non-mint hosts (potato, echinacea, maple, cauliflower, and strawberry) generally did not incite wilt in mint. Instead, the mints sometimes grew more robustly by 20-200 percent in their presence (Crowe and Farris 1999). However, there were exceptions in which non-mint isolates incited mild to severe disease symptoms. In a 1999 greenhouse trial, mint and potato strains of *V. dahliae* were added to soil in pots planted with alfalfa, dry bean, red clover, sweet corn, ryegrass, wheat, potato, and mint Roots of all plant species were colonized by mint and potato strains; however, the potato strain tended to colonize all plants more abundantly. A stem population assay was inconclusive because of contamination during the assay procedure. The greenhouse experiment was repeated in 2000 with modified assay procedures. As in 1999, the *V. dahliae* isolates did not affect the stem height or biomass weight of any of the plants tested Similarly, senescence of the plants was not affected by either isolate. The mint isolate caused wilt symptoms only in mint Yet both isolates colonized roots of all plant species. As in 1999, the potato isolates colonized roots of all plants more abundantly than the mint isolate, including mint Both mint and potato isolates were recovered from mint and potato stem tissue. The mint isolate tended to be recovered more abundantly from mint tissue, and significantly more potato isolate colonies were recovered from potato tissue. Both isolates were recovered from stem tissue of alfalfa, dry bean, red clover, and ryegrass, but at low levels that were not statistically significant. There is no strong evidence from this greenhouse study to suggest that the mint or potato isolate of *V. dahliae* reproduces in stem tissue of non-hosts.

Introduction

Verticillium dahliae causes wilt on many different types of plants. Strain specificity of *V. dahliae* is a term used to associate pathogenic forms of the fungus with host specificity. For example, forms of the fungus that cause disease on mint may not elicit disease on potatoes, and forms of the fungus that attack potatoes may be benign when they infect mint Some strains preferentially attack certain varieties or cultivars within a species, such as in cotton or tomatoes. Earlier, we determined in the greenhouse that mint-aggressive strains of *V. dahliae* do not vary substantially in their variety and/or species preferences within cultivated mints (Crowe and Farris 1999). We also determined in the greenhouse that isolates of *V. dahliae* recovered from non-mint hosts were limited in their ability to incite wilt symptoms on mint.

The concept of strain specificity needs to be qualified with respect to *V. dahliae.* There is evidence that most strains can infect root surface cells of most plants. There is limited and preliminary evidence from the field (discussed further below) that strains which do not cause

symptoms may nevertheless systemically invade stems and even reproduce at modest levels in the stems of non-host plants, although with diminished capacity compared to strains pathogenic on that plant host (Davis et al. 2000). Further, there is evidence that many strains may also cause mild to extensive vascular discoloration of non-host roots (Bhat and Subbarao 1999). Specificity, then, may refer strictly to an absolute or relative capacity of a strain to cause wilt symptoms or other symptoms and reproduce at high levels in the preferred host plant.

Do the isolates or strains that attack mint also cause disease on other plants? What is the reproductive capacity of mint strains in non-mint plants that manifest no symptoms? Similarly, are mint plants being infected by non-mint strains and allowing inoculum increase in soil? Answers to these questions could substantially influence crop rotation decisions. Nelson (1950) and Horner (1954) suggested that mint and other strains of *V. dahliae* might reproduce in non-hosts, but little information, other than that provided by Green (1967) with corn, potatoes, and canary grass, has been available to consider crop rotational influences. Cauliflower isolates of *V. dahliae* caused various degrees of wilt on a wide range of crops from artichoke to watermelon in the greenhouse. And alternately, the isolates from that same range of crops induced wilt on cauliflower (Subbarao et al. 1995). Recent investigations (Davis et al. 2000) suggest that potato strains of *V. dahliae* can reproduce significantly in stems on a wide variety of broad-leafed and grass hosts without causing wilt symptoms. It remains unclear whether the range of non-hosts in which mint strains of *V. dahliae* might reproduce is similar to that of potato or other strains.

We envisioned 1999 and 2000 as years to develop techniques and gather preliminary data toward answering these questions. In general, these answers are relevant to crop rotational issues for mint and other crops.

Materials and Methods

Alfalfa (var. Henricks) dry bean (var. Ember) solid red clover, corn (var. Golden Cross Bantam F1) peppermint (var. Black Mitcham), potato (cv. Russet Norkotah), ryegrass, and white spring wheat (var. Dirkwin) were selected. All plants were grown from true seed except mint, which was transplanted as rooted cuttings, and potatoes grown from cut seed tubers.

V. dahliae microsclerotia inoculum of a mint strain and a potato strain was grown on agar plates overlain with cellophane (Puhalla, 1979). Ground inoculum was mixed with potting soil in a 3-ft^3 cement mixer to obtain an inoculum density of 30 colony-forming-units (CFU)/g potting soil. Non-infested potting soil was used as the control treatment for a total of three treatments.

Corn and potatoes were grown in 10-inch-diameter plastic pots. All other plants were grown in 6-inch-diameter plastic pots. One plant was grown in each pot and was considered a replication. Ten replications per treatment per plant type were represented for a total of 30 pots per plant and arranged in a randomized complete block design on greenhouse benches. Each plant type was considered a separate experiment.

Half of the plants were destructively harvested at 4 wk postemergence. Response variables included stem height, biomass dry weight, and *V. dahliae* root and stem populations. The remaining plants were used for disease assessment and harvested at maturity according to number of days post-emergence (alfalfa, clover, corn, mint, potatoes) or complete senescence (beans, ryegrass, wheat). Weekly percent senescence and wilt ratings (mint only) were measured for 5 wk beginning at the onset of symptoms. As a measure of disease severity, the area under the senescence progress curve (AUSPC) (Shaner and Finney 1977) was calculated using the formula:

$$AUSPC=E[((\%\ senescence\ (time(_x+i) + (\%\ senescence\ (time(_x))))/2*(time_{(x+i)} - time_{(X)})].$$

AUSPC therefore represents the rate of senescence over time. This is an accepted unit of disease severity for Verticillium wilt of potato because the most common disease symptoms, chlorosis and necrosis of leaves, are indistinguishable from normal senescence. As disease symptoms were not expected in the non-host plants in the greenhouse, AUSPC was chosen to determine whether infected plants senesced at a different rate from the non-infested control.

Within 24 hours after destructive sampling, roots were rinsed with water to remove adhering soil. Roots were hand-cut into 1-cm-long segments and a total of 80 root segments per sample were plated on NP-10, an agar medium semi-selective for *Verticillium*. Colonies growing from root pieces were counted after 10 days incubation at 20 ^{0}C in the dark using a dissecting microscope. Root populations were estimated as colony-forming units per root length (CFU/cm). Stem populations of *V. dahliae* were assayed from the base of the stem of each sampled plant. Approximately 1 inch of basal stem was cut, rinsed, and air-dried at room temperature for 1 month. After 1 month drying, CFU recovered from stems likely would be from microsclerotia, because conidia die within this drying time. Thus our sampling was geared toward finding evidence of microsclerotia production. This tissue was ground in a Thomas Wiley mill. All non-inoculated treatments, were ground first, followed by inoculated treatments with mint and potato stems ground last to avoid cross contamination. Using an Andersen air sampler, 0.08 g dried stem tissue was plated onto a *Verticillium* semi-selective agar growth medium (NP-10). After 10 days of incubation in the dark at room temperature, *V. dahliae* colonies were counted and CFU/g dried stem tissue was calculated. Response variables underwent an analysis of variance (ANOVA) using the general linear model, PROC GLM, of SAS, version 7.0 (SAS Institute 1988). Means were separated by Fisher's protected least significant difference (LSD) test.

Results & Discussion

Growth of each host, measured by stem height and dry biomass weight, was not affected by the mint or potato strain of *V. dahliae* compared to a non-infested control (Tables 1-8). Although the dry weight of bean, ryegrass, and wheat was different among the treatments at 5 wk postemergence, this effect was not consistent among the treatments and was not observed at 10 wk post emergence. The crop yield of each plant, measured as dry biomass, bean pod, corn ear, potato tuber, or seed head weight, did not significantly differ among

treatments. *V. dahliae* was isolated from roots of all plants grown in infested soil (Tables 1-8). Root populations of the mint strain did not significantly ($P > 0.05$) differ from the non-infested control in any plant. Yet, potato strain populations were larger ($P < 0.05$) than the mint isolate and control treatments in each plant on at least one sampling date. This trend, though not always significant, was seen on both sampling dates for all plants except red clover, in which both isolates were recovered in nearly equal numbers on the first sampling date. *V. dahliae* was recovered only once, from ryegrass roots, in an non-inoculated control treatment. This was most likely caused by inadvertent contamination either during sampling or root plating in the laboratory.

Although not statistically significant, *V. dahliae* was recovered from stems of non-host plants. *V. dahliae* was recovered only twice, and in low populations, from non-inoculated treatments, in dry bean and potato. From these untreated plants, the pathogen was recovered on only one plate from one replication. This was likely caused by contamination during the grinding or plating process and not to a true colonization of the stem tissue. Similar to the root population results, there was a trend of more frequent and larger populations of the potato isolate recovered among the plants. The *V. dahliae* potato isolate was recovered at both sampling dates from alfalfa, which is known host of V. *albo-atrum,* and the mint isolate only once. Although a relatively high population of the potato isolate was recovered from red clover on the second sampling date, it was obtained from only one replication out of five and the mean population did not significantly differ from the untreated control. Similarly, the mint isolate was recovered from ryegrass only once and only from one replication. The mint isolate was also recovered from peppermint and potato. Although not statistically different ($P = 0.4036$), the recovered mint isolate population in mint tissue was larger than that of the potato isolate at 10 wk post-planting. That the mint isolate was not recovered abundantly in mint stems was surprising because wilt symptoms were evident at the time of sampling. This suggests that microsclerotia had not formed at this time; any conidia present at harvest likely would have died by the time stem tissue was plated. At this second sampling, the mint isolate was recovered from potato tissue as well although the recovered population of the potato isolate was larger ($P = 0.0867$). Similarly, on the first sampling date, the potato isolate population in potato was significantly larger ($P = 0.0252$) as well.

The *V. dahliae* mint isolate alone produced wilt symptoms in peppermint ($P = 0.004$). Although there were differences in *V. dahliae* root and stem populations, AUSPC, in all plants except wheat, was not affected by either strain compared to the non-infested control. This result is consistent with the first year of this experiment. The mint isolate increased the senescence rate of wheat ($P = 0.0207$). Although this result can be associated with a low level of root infection, it cannot be associated with any microsclerotia reproduction in the stem. As alfalfa, bean, clover, corn, ryegrass, and wheat are not considered hosts of *V. dahliae,* AUSPC was not expected to differ among treatments.

Table 1. Influence of mint and potato strains of *Verticillium dahliae* on alfalfa var. Henricks in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V dahliae* root population (cfu/cm)[a]		*V dahliae* Stem population (cfu/g stem)[b]		AUSPCC
V. dahliae strain	12 Jun	17 Jul	12 Jun	17 Jul	12 Jun	17 Jul	12 Jun	17 Jul	
Non-infested	28.8	77.2	0.29	9.66	0.00 Bd	0.00	0.00	0.00	262
Mint	35.0	76.7	1.02	6.86	0.01 B	0.03	0.00	0.22	263
Potato	28.4	72.7	0.77	7.36	0.04 A	0.07	0.44	4.00	264
P-value[e]	0.3331	0.5913	0.3045	0.4675	0.0039	0.3499	0.2747	0.4894	0.0001
Strain	0.6281	0.7739	0.1311	0.3904	0.0007	0.0988	0.1296	0.3875	0.1296
Block	0.2222	0.4274	0.5292	0.4507	0.1073	0.7991	0.4609	0.4820	0.0001

'Colony-forming-units per cm root.
[b]Colony-forming-units per gram dried stem tissue.
'Area Under the Senescence Progress Curve.
[d]Means followed by the same letter are not significantly different at P 0.05 according to Fisher's protected least significant difference test.
'Probability of obtaining F.0,05.

Table 2. Influence of mint and potato strains of *Verticillium dahliae* on dry bean var. Ember in a greenhouse study at OSU-COARC, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V. dahliae* root population (cfu/cm)a		*V dahliae* stem population (cfu/g stem)[b]		dry bean (g)	AUSPCC
V. dahliae Strain	12 Jun	17 Jul	12 Jun	17 Jul	12 Jun	17 Jul	12 Jun	17 Jul	17 Jul	
Non-infested	25.9	33.0	5.96 A[d]	2.50	0.00 B	0.00	2.22	0.00	28.5	179 B
Mint	26.1	33.5	6.02 A	1.90	0.02 AB	0.05	0.00	0.00	38.7	277 A
Potato	24.4	33.0	2.94 B	2.56	0.07 A	0.15	0.00	0.00	34.3	301 A
P-value[e]	0.6767	0.9422	0.0018	0.1893	0.0690	0.3627	0.4852		0.1294	0.0552
Strain	0.8395	0.9671	0.0012	0.2777	0.0133	0.1708	0.4096		0.1467	0.0288
Block	0.4980	0.8240	0.0084	0.1649	0.5466	0.5521	0.4609		0.1454	0.1461

'Colony-forming-units per cm root.

[b]Colony-forming-units per gram dried stem tissue.

'Area Under the Senescence Progress Curve.

[d]Means followed by the same letter are not significantly different at P 5 0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining $F_{0.05}$.

Table 3. Influence of mint and potato strains of *Verticillium dahliae* on solid red clover in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V dahliae* root population (cfu/cm)[a]		*V. dahliae* stem population (cfu/g stem)[b]		AUSPCC
V dahliae Strain	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	
Non-infested	16.0	78.2	0.52	13.1	0.00	0.00 B[d]	0.00	0.00	33.5
Mint	16.0	63.2	0.88	9.64	0.04	0.01 B	0.00	0.00	29.4
Potato	14.6	70.1	0.50	12.1	0.02	0.08 A	0.00	57.1	39.3
P-value[e]	0.1352	0.0269	0.2355	0.0149	0.6288	0.0434		0.4852	0.0334
Strain	0.5166	0.1730	0.2150	0.1089	0.3681	0.0072		0.4096	0.7202
Block	0.0806	0.0181	0.2574	0.0106	0.7033	0.5459		0.4609	0.0149

'Colony-forming-units per cm root.
tolony-forming-units per gram dried stem tissue.
'Area Under the Senescence Progress Curve.
[d]Means followed by the same letter are not significantly different at P 0.05 according to Fisher's protected least significant difference test.
'Probability of obtaining F5-0.05.

Table 4. Influence of mint and potato strains of *Verticillium dahliae* on corn var. Golden Cross Bantam Fl in a greenhouse study at Oregon State University, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V. dahliae* root population (cfu/cm)[a]		*V. dahliae* stem population (cfu/g stem)[b]		Ears (g)	AUSPC'
V. dahliae Strain	12 Jun	9 Aug	12 Jun	9 Aug	12 Jun	9 Aug	12 Jun	9 Aug	9 Aug	
Non-infested	50.8	159	33.0	132	0.00 B[d]	0.00 B	0.00	0.00	133	75.1
Mint	53.6	147	37.8	109	0.02 B	0.01 B	0.00	0.00	123	111
Potato	53.8	158	41.0	148	0.11 A	0.02 A	0.00	0.00	171	130
P-value[e]	0.4083	0.1307	0.2595	0.3535	0.0496	0.0786			0.5221	0.2297
Strain	0.4065	0.3620	0.1863	0.1292	0.0075	0.0375			0.3211	0.0809
Block	0.3658	0.0902	0.6242	0.6592	0.6849	0.2024			0.6009	0.5172

[a]Colony-forming-units per cm root.

[b]Colony-forming-units per gram dried stem tissue.

Area Under the Senescence Progress Curve.

[d]Means followed by the same letter are not significantly different at P 0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining F0.05.

Table 5. Influence of mint and potato strains of *Verticillium dahliae* on ryegrass in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V. dahliae* root population (cfu/cm)[a]		*V. dahliae* stem population (cfu/g stem)"		seed heads (g)	AUSPCC
V. dahliae Strain	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	18 Jul	
Non-infested	39.1 B[d]	127	4.68 B	18.9	0.01 B	0.00	0.00	0.00	14.4	177
Mint	61.0 A	140	9.08 A	21.7	0.04 AB	0.00	0.00	2.86	13.9	226
Potato	44.7 B	136	5.78 B	20.5	0.13 A	0.04	0.00	0.00	12.4	195
P-value[e]	0.0446	0.0305	0.0221	0.8438	0.1303	0.2653		0.4852	0.1955	0.5101
Strain	0.0310	0.2635	0.0033	0.6820	0.0440	0.1050		0.4096	0.7414	0.7842
Block	0.0967	0.0180	0.4768	0.7796	0.3942	0.5205		0.4609	0.1078	0.3468

'Colony-forming-units per cm root.

"Colony-forming-units per gram dried stem tissue.

'Area Under the Senescence Progress Curve.

[d]Means followed by the same letter are not significantly different at P 0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining $F_{0.05}$.

Table 6. Influence of mint and potato strains of *Verticillium dahliae* on peppermint var. Black Mitcham in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V. dahliae* root population (cfu/cm)[a]		*V. dahliae* stem population (cfu/g stem)[b]		Wilte
V. dahliae Strain	16 Jul	9 Aug	16 Jul	9 Aug	16 Jul	9 Aug	16 Jul	9 Aug	9 Aug
Non-infested	60.2	70.9	16.2	27.7	0.00	0.00 B[d]	0.00	0.00	0.0 B
Mint	62.5	70.1	17.9	29.8	0.02	0.01 B	0.00	635	2.6 A
Potato	50.0	71.9	20.8	26.3	0.16	0.09 A	1.33	1.33	0.0 B
P-value[e]	0.1591	0.5643	0.4163	0.9481	0.3902	0.1811	0.4852	0.4827	0.0244
Strain	0.1345	0.9799	0.4080	0.8914	0.2361	0.0597	0.4096	0.4036	0.0038
Block	0.2053	0.3572	0.3748	0.8639	0.4852	0.4895	0.4609	0.4616	0.4609

[a]Colony-forming-units per cm root.

[b]Colony-forming-units per gram dried stem tissue.

[c]Wilt estimated with a severity rating: 1-2 = mild symptoms, 3 = moderate symptoms, 4 = severe symptoms, 5 = dead.

[d]Means followed by the same letter are not significantly different at P0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining F0.05.

Table 7. Influence of mint and potato strains of *Verticillium dahliae* on potato cv. Russet Norkotah in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

	stem height (cm)		dry weight (g)		*V dahliae* root population (cfu/cm)[a]		*V. dahliae* Stem population (cfu/g stem)[b]		Tubers (g)	AUSPC[c]
V. dahliae Strain	16 Jul	1 Aug	16 Jul	1 Aug	16 Jul	1 Aug	16 Jul	1 Aug	1 Aug	
Non-infested	27.7	28.9	13.2	9.99	0.00 B[d]	0.00 B	0.00 B	3.16	152	352
Mint	27.4	29.7	10.4	7.77	0.02 B	0.01 B	0.00 B	11.6	168	299
Potato	31.5	27.4	11.6	5.47	0.41 A	0.68 A	1594 A	627	192	304
P-value[e]	0.5384	0.4058	0.9007	0.1993	0.1596	0.0146	0.0991	0.2238	0.8049	0.5365
Strain	0.5050	0.7729	0.8425	0.1674	0.0556	0.0021	0.0252	0.0867	0.7852	0.9047
Block	0.4712	0.3339	0.8202	0.2416	0.4305	0.4176	0.4609	0.4786	0.6739	0.3463

[a]Colony-forming-units per cm root.

[b]Colony-forming-units per gram dried stem tissue.

'Area Under the Senescence Progress Curve.

[d]Means followed by the same letter are not significantly different at P 0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining F0.05.

Table 8. Influence of mint and potato strains of *Verticillium dahliae* on white spring wheat var. Dirkwin in a greenhouse study at Oregon State University, Central Oregon Agricultural Research Center, Powell Butte, Oregon 2000.

stem height (cm)			dry weight (g)		*V dahliae* root population (cfu/cm)[a]		*V. dahliae* stem population (cfu/g stem)[b]		seed heads (g)	AUSPC[c]
V dahliae Strain	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	12 Jun	18 Jul	18 Jul	
Non-infested	36.8	53.3	4.46 B[d]	12.5	0.00	0.00 B	0.00	0.00	22.7	325 B
Mint	40.9	54.8	5.04 AB	13.0	0.04	0.06 AB	0.00	0.00	21.5	341 A
Potato	37.3	57.4	5.82 A	13.1	0.09	0.09 A	0.00	0.00	27.8	328 B
P-value[e]	0.2081	0.4022	0.0153	0.0895	0.1991	0.0855			0.5134	0.0402
Strain	0.0731	0.5520	0.0232	0.7565	0.2164	0.0218			0.6354	0.0207
Block	0.4998	0.3025	0.0235	0.0436	0.2042	0.4242			0.3894	0.1182

'Colony-forming-units per cm root.

[b]Colony-forming-units per gram dried stem tissue.

'Area Under the Senescence Progress Curve.

[d]Means followed by the same letter are not significantly different at P 5 0.05 according to Fisher's protected least significant difference test.

'Probability of obtaining F0.05.

Horner, (personal communication) never identified the conditions that promote microsclerotia foirnation. Sometimes microsclerotia are present soon upon wilting, but not always. Conceivably, our greenhouse conditions did not favor microsclerotia development, whereas microsclerotia formation may have been favored in the field experiments of Davis and Huisman (2000). Our results do not support or confirm those obtained in the field by Davis and Huisman (2000) who measured moderate reproduction in non-host stems by potato isolates of *V. dahliae*. Differences in wilt severity in potato are known to depend on environmental influences such as temperature (Francl et al. 1990; Garber and Presley 1971). Similarly, wilt severity in greenhouse-grown mint is affected by environmental factors (Nelson 1950). Therefore, it is possible that the greenhouse environment is not optimal to elicit differences in senescence related to Verticillium wilt.

Our results neither refute nor confirm those of Bhat and Subbarao (1999) who found that root vascular systems of non-host plants commonly were discolored following root dip inoculations in spore suspensions of a wide range of *V. dahliae* strains. With such root-dip inoculation into elevated spore concentrations, normal barriers to root infection and systemic invasions likely are circumvented. Such inoculation may result in more severe and rapid disease development than natural infection. In our greenhouse experiments reported here, we relied on a more natural root infection (microsclerotia on undamaged roots), and our data might be expected to be more conservative than those of Bhat and Subbarao (1999).

At this time, we have not proposed continuation of these experiments in the field, or further investigating environmental factors in the greenhouse. We will assess progress in the field, along with mint industry interest in these issues, before possibly proposing future work in this area.

Conclusion

In summary, a mint or a potato strain of *V. dahliae* in this greenhouse trial did not influence the growth of mint and non-mint plants. The potato strain was recovered in larger populations from the roots of all hosts, including mint Yet, the AUSPC did not differ among treatments for any host. Mint inoculated with the mint strain was the only treatment to significantly exhibit wilt symptoms. *V. dahliae* was recovered from stem tissue of non-hosts, though not in populations significantly different from the non-infested control. Mint and potato strains were recovered from both mint and potato stem tissue. Similar to root populations, the potato strain tended to be isolated more frequently from stem tissue. There is no strong evidence from this greenhouse study to indicate that the mint or potato isolate of *V dahliae* reproduces in the stem tissue of non-hosts. But the results of this study suggest that *V dahliae* potato isolates behave differently, with respect to root and stem infections, compared to mint isolates.

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