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Litchi tomato is expected not to be a significant inoculum source for *V. dahliae* and *Colletotrichum coccodes.*

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The Pale Cyst Nematode (PCN, *Globodera pallida*) is an important potato pathogen. PCN was identified in southeastern Idaho in 2006 and has become the focus of quarantine and eradication efforts (Dandurand, 2013). Exudates from potential host roots are necessary for PCN eggs to hatch. Plants that release root exudates which stimulate nematode egg hatch, but are not a host to the nematode, are a possible nonchemical control measure. These plants are referred to as trap crops. Litchi tomato (*Solanum sisymbriifolium*) has been determined to be a trap crop for PCN (Dandurand, 2013; Timmermans et al. 2007).

Employing a trap crop such as litchi tomato as part of a PCN eradication strategy may have unintended effects on populations of other soilborne potato pathogens. Two such pathogens are *Verticillium dahliae* and *Colletotrichum coccodes*, which are the causes of Verticillium wilt and black dot, respectively. *Verticillium dahliae* infects a wide range of plants, making it one of the most important pathogens of dicotyledonous crop plants. Despite the wide host range of *V. dahliae*, individual isolates vary in aggressiveness when introduced to different plant hosts. These isolates are called host-adapted pathotypes (Bhat and Subbarao 1999). The host-adapted pathotype is sometimes shortened to pathotype for ease of explanation; for example a *V. dahliae* isolate that is aggressive on potato is referred to as the potato pathotype.

The complete host range of *Colletotrichum coccodes* is not known (Lees and Hilton 2003). Solanaceous crops such as potato, tomato and weeds from Cucurbitaceae, Fabaceae, and Solanaceae are known hosts (Lees and Hilton 2003). Damage caused by *C. coccodes* infection was considered to be a minor problem until 1990, when observations of yield losses began (Tsror and Hazanovsky 1999).

The pathogenicity of *V. dahliae* against litchi tomato was considered in Greece for grafting eggplant with litchi tomato as a rootstock, and litchi tomato was considered resistant to *V. dahliae* (Blestsos et al. 2003). However, the work from Greece should be expanded to include the susceptibility of litchi tomato to *V. dahliae* in North America. Specifically, it is imperative to determine the response of litchi tomato to aggressive pathotypes of *V. dahliae* from the Columbia Basin, and to quantify microsclerotia production of *V. dahliae* in litchi tomato relative to susceptible potato cultivars. Microsclerotia are a key structure in continuing the disease in that they enable the pathogen to survive in soil and infect future crops. An understanding of an increase of *C. coccodes* or *V. dahliae* on litchi tomato is important, if litchi tomato is going to be employed as a trap crop, to avoid increasing pathogenic fungal populations that could infect future potato crops.

Quantification of *V. dahliae* and *C. coccodes* in potato and litchi tomato.
Methods. Greenhouse trials were established in 2013 and 2014 to determine the response of litchi tomato to *C. coccodes* and aggressive pathotypes of *V. dahliae* from the Columbia Basin. Two isolates of *V. dahliae* (potato and mint pathotypes) and an isolate of *C. coccodes* were selected for experimentation, as well as the potato cultivars Alturas, Ranger Russet, and Russet Norkotah as resistant, moderately resistant, and susceptible hosts, respectively, to *V. dahliae*. Microsclerotia (30 CFU/g) of *V. dahliae* or *C. coccodes* were mixed with soilless potting mix and litchi tomato seedlings and sprouted potato tubers were planted into the infested potting mix. Plants were arranged in the greenhouse in a completely randomized design and allowed to grow for four months before plants were dried to facilitate the formation of microsclerotia. Dried plants were ground and 1g was placed on a semiselective medium designed for *V. dahliae*. Colony Forming Units (CFUs) derived from microsclerotia of both pathogens were counted.

Results. Greater numbers of CFUs were recorded for the *V. dahliae* potato pathotype than the mint pathotype for all potato cultivars (Ranger Russet, Alturas, and Russet Norkotah) in the greenhouse in 2013 ($P \leq 0.05$, Table 1). The number of *V. dahliae* CFU of the potato pathotype was less in litchi tomato than each of the potato cultivars Ranger Russet, Alturas, and Russet Norkotah in 2013 ($P \leq 0.05$, Table 1). Litchi tomato planted in soilless mix infested with either pathotype of *V. dahliae* was infected, but no difference in CFU's was observed between either pathotype in litchi tomato (Table 1).

Greater numbers of *V. dahliae* CFU were observed from Russet Norkotah and Ranger Russet roots for the potato than the mint pathotype in 2014 ($P \leq 0.05$, Table 2). Otherwise, there were no differences in the number of *V. dahliae* CFU in Alturas, Russet Norkotah, and Ranger Russet stems, regardless of pathotype, which is inconsistent with results in 2013. Greater numbers of *V. dahliae* potato pathotype CFUs were observed in stems and roots of Russet Norkotah than litchi tomato ($P < 0.0001$, Table 2). Otherwise, the amount of *V. dahliae* CFU did not differ between any potato cultivar and litchi tomato, regardless of *V. dahliae* pathotype. This is in contrast to Litchi tomato having fewer *V. dahliae* CFU of either pathotype than all potato cultivars in 2013 (Table 1).

The number of observed CFU of *C. coccodes* from stems was significantly lower in litchi tomato than Ranger Russet, Alturas, and Russet Norkotah in 2013 ($P \leq 0.05$, Table 1). Fewer *C. coccodes* CFU were also observed in stems of litchi tomato than for Alturas and Russet Norkotah in 2014 ($P \leq 0.05$, Table 2). No differences were noted between the *C. coccodes* CFU from roots of any of the potato cultivars and litchi tomato in 2014 (Table 2).

Evaluation of litchi tomato susceptibility to *V. dahliae* and *C. coccodes* under field conditions.
Methods. Field trials were conducted to confirm the susceptibility of litchi tomato to *V. dahliae* and *C. coccodes*, and the relative amounts of microsclerotia produced from infection in litchi tomato compared to potato cultivars. Field soil was naturally infested (5-15 *V. dahliae* or *C. coccodes* microsclerotia/g). Litchi tomato transplants were planted in a randomized complete block design in Othello, WA (2014) and Prosser, WA (2015) with potato cultivar Ranger Russet or Russet Burbank. Litchi tomato plants were also planted in a completely randomized design in Powell Butte, OR (2015). Litchi tomato and potato plants were allowed to grow from April-August, when they were harvested and dried. Dried plants were ground and the number of CFU/g of both *V. dahliae* and *C. coccodes* were determined.
Results. Greater numbers of *V. dahliae* CFU were observed in stems of Ranger Russet than litchi tomato at Othello, WA in 2014 ($P < 0.0001$, Table 3), although *V. dahliae* CFU in roots did not differ between Ranger Russet and litchi tomato. Significantly greater numbers of CFUs of both pathogens were observed from roots of Russet Burbank than from litchi tomato at Prosser, WA ($P \leq 0.05$, Table 3). The *C. coccodes* CFU did not differ between stems of either plant at Prosser, WA. Both pathogens were infected and produced microsclerotia in litchi tomato in Powell Butte, OR in 2015 (Table 3).

Discussion:

Litchi tomato was confirmed as a host for both *V. dahliae* and *C. coccodes,* as indicated by the presence of both pathogens in stems and roots of test plants. Microsclerotia production of *V. dahliae* in litchi tomato was consistently less than in Russet Norkotah and equivalent to less than the production in Ranger Russet. Additionally, infected litchi tomato contained fewer *V. dahliae* microsclerotia than Ranger Russet and Russet Burbank potatoes planted next to them in the field. Ranger Russet is moderately resistant and Russet Burbank is moderately susceptible to *V. dahliae*. The number of microsclerotia in litchi tomato did not differ for the mint and potato pathotypes of *V. dahliae*. Consequently, if litchi tomato is used in rotation with potato, more microsclerotia of *V. dahliae* should not be produced of both the mint and potato pathotypes than on susceptible and moderately susceptible potato cultivars. Widespread planting of litchi tomato will likely return microsclerotia of *V. dahliae* to soil, but less than susceptible potato cultivars.

Numbers of microsclerotia in soil are important for disease development in future potato crops. Substantially greater or fewer microsclerotia will lead to more or less disease, respectively. An increase of microsclerotia in soil was documented with the cultivation of the susceptible potato cultivar, Kennebec over several years in the Red River Valley of North Dakota and Minnesota. The buildup of soil propagules likely led to an increase in disease incidence (Slattery, 1981). Environmental factors, plant stress, and the susceptibility of the potato cultivar will also contribute to disease development in future potato crops.

Russet Norkotah is susceptible to *V. dahliae*, which explains why this cultivar consistently had the greatest numbers of *V. dahliae* microsclerotia. Observations of fewer microsclerotia in litchi tomato stems in 2013 and roots in 2014 compared to Russet Norkotah led to initial conclusions that litchi tomato is resistant to *V. dahliae*.

Different sets of litchi tomato plants were evaluated in the experiments in 2013 and 2014, and they likely varied in resistance to the two pathotypes of *V. dahliae*. The difference in litchi tomato susceptibility to the *V. dahliae* potato pathotype could be attributed to the lack of genetic uniformity in seed. This is because each litchi tomato plant is unlikely to be genetically uniform because the litchi tomato seeds used for the experiment were from open pollinated plants grown in the field.

The observation of few *C. coccodes* microsclerotia generated in infected litchi tomato was consistent with the absence of black dot symptoms on inoculated plants. The consistency in fewer *C. coccodes* microsclerotia in litchi tomato stems compared to Alturas and Russet Norkotah indicates partial resistance to the black dot pathogen in some individual litchi tomato plants as plants were infected, but with quantitatively less inoculum than susceptible potato cultivars and visible disease symptoms were also not evident. Only selections of litchi tomato resistance to both *V. dahliae* and *C. coccodes* should be used as a trap crop for nematodes.

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Table 1: Mean number of *Verticillium dahliae and Colletotrichum coccodes* microsclerotia from stems of three potato cultivars Alturas, Russet Norkotah, and Ranger Russet, and litchi tomato in a greenhouse in 2013.

Pathogen	Pathotype	Mean CFU / g Stem [a]			
		Alturas	Russet Norkotah	Ranger Russet	Litchi Tomato
V. dahliae	Potato	97.0 a	107.8 a	72.0 a	11.1 d
	Mint	46.3 b	20.5 c	4.5 d	0.8 d
	Noninoculated[b]	5.0 d	18.5 c	0.2 d	0.6 d
C. coccodes[d]	*C. coccodes*	40.5 a	19.8 b	19.8 b	3.0 c
	Noninoculated[c]	0	0	0	0

[a] Values with the same letter are not significantly different according to Tukey's Honestly Significant Difference test for all pairwise comparisons for *V. dahliae* CFU counts across columns and rows ($P \leq 0.05$).
[b] Noninoculated controls did not have microsclerotia of either pathogen buried in soilless mix.
[c] No *C. coccodes* detected in non-inoculated control. No valid comparisons can be made by ANOVA between *C. coccodes* CFU counts on potato or litchi tomato to noninoculated control because the noninoculated control had a mean and standard error of 0.
[d] Values with the same letters are not significantly different according to Tukey's Honestly Significant Difference test for all pairwise comparisons across row for *C. coccodes* CFU counts ($P \leq 0.05$). Each pathogen was analyzed separately.

Table 2: Mean number of *Verticillium dahliae* and *Colletotrichum coccodes* CFU from stems and roots of three potato cultivars and litchi tomato (*Solanum sisymbriifolium*) in a greenhouse in 2014.

Plant Part	Pathogen	Pathotype	Mean CFU / g Plant Part			
			Alturas	Russet Norkotah	Ranger Russet	Litchi tomato
Stem	*V. dahliae*	Potato [a]	40.8 abc	88.4 a	25.4 abcd	6.1 cdef
		Mint [a]	22.5 abcd	19.5 abcde	6.2 def	12.4 ef
		Noninoculated[a]	2.3 f	2.0 f	0.6 f	1.1 f
	C. coccodes	Noninoculated[b]	0	0	0	0
		C. coccodes [c]	56.0 ab	77.0 a	28.8 abc	14.8 c
Root	*V. dahliae*	Potato [a]	57.8 ab	87.4 a	30.4 ab	20.5 b
		Mint [a]	31.7 ab	17.8 bc	3.6 cd	22.0 b
		Noninoculated[a]	2.3 cd	0.3 d	1.4 cd	1.9 cd
	C. coccodes[c]	Noninoculated[b]	0	0	0	0
		C. coccodes	56.0 a	79.3 a	33.0 a	46.1 a

[a] Noninoculated controls did not have microsclerotia of either pathogen buried in soil. Values with the same letters are not significantly different according to Tukey's Honestly Significant Difference test for all pairwise comparisons for *V. dahliae* CFU counts across columns and rows ($P \leq 0.05$).
[b] *C. coccodes* detected in non-inoculated control. No valid comparisons can be made by ANOVA between *C. coccodes* CFU counts on potato or litchi tomato to noninoculated control because the noninoculated control had a mean and standard error of 0.
[c] Values with the same letters are not significantly different according to Tukey's Honestly Significant Difference test for all pairwise comparisons across row for *C. coccodes* CFU counts ($P \leq 0.05$). Each pathogen was analyzed separately.

Table 3: Mean number of *Verticillium dahliae* or *Colletotrichum coccodes* CFU from stems of potato and litchi tomato (*Solanum sisymbriifolium*) in the 2014 field trial in Othello, WA and the 2015 field trial in Prosser, WA and Powell Butte, OR.

Year	Location	Plant	Stem *V. dahliae* [a]	Stem *C. coccodes* [a]	Root *V. dahliae* [a]	Root *C. coccodes* [a]
2014	Othello, WA	Potato [b]	22.4 a	18.9 [f]	16.8 a	23.3
	Othello, WA	Litchi tomato	1.0 b	0	1.1 a	0
2015	Prosser, WA [c]	Potato [e]	26.6 a	7.6 a	49.6 a	19.6 a
	Prosser, WA [c]	Litchi tomato	5.4 b	2.3 a	18.91 b	1.6 b
	Powell Butte, OR [d]	Litchi tomato	20	43.3	3.3	30

[a] Letters denote mean separation by Tukey's Honestly Significant Difference test for all pairwise comparisons down columns only ($P \leq 0.05$). Each pathogen, year, and each plant part were analyzed separately. For example, greater numbers of *V. dahliae* CFU were observed in stems of Ranger Russet than litchi tomato at Othello, WA in 2014. Comparison of the *V. dahliae* from the stems and root of Ranger Russet than litchi tomato at Othello, WA in 2014 was not conducted because each plant part was analyzed separately, and because we were no interested if more *V. dahliae* was found in the stems or roots in the potatoes grown in the field for this study.
[b] Potato cultivar Ranger Russet
[c] Field sites 1 and 2 combined
[d] No statistical test conducted (no comparison with potato at this site)
[e] Potato cultivar Russet Burbank
[f] No valid comparisons can be made by ANOVA between *C. coccodes* on potato or litchi tomato in Othello, WA because of a mean and standard error of 0 *C. coccodes* CFU in litchi tomato.