

**Project Title: Verticillium efforts on spinach  
CLGRB Progress Report  
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**Project Summary**

Efforts continue to examine the genetic and phenotypic diversity of *Verticillium* and *Verticillium*-like species on spinach. Greenhouse inoculation assays are being optimized to evaluate the pathogenicity and virulence of isolates under controlled conditions. Lime treatments to soil under greenhouse conditions appear to increase *Verticillium* wilt disease severity (Table 1). All isolates of *V. dahliae* that originated from spinach or spinach seed were confirmed to be pathogenic on spinach, whereas some isolates that originated from other hosts were not pathogenic on spinach or weakly virulent (Table 1). Isolates of *V. tricorpus* and *G. nigrescens*, recovered from spinach, and *V. albo-atrum*, and *L. fungicola* were not pathogenic on spinach (Table 1). These results indicate that *Verticillium* and related species associated with spinach display substantial variability in parasitic ability, virulence, and pathogenicity.

**Table 1.** Mean disease incidence and severity of spinach line AC1 inoculated with a wildtype and a “marker” *nit* mutant strain of *Verticillium dahliae* treated with lime recorded 22 days after inoculation<sup>a</sup>

Isolate	Species	Host	Origin	Treatments			
				Disease Severity <sup>b</sup>		Disease Incidence <sup>c</sup>	
				Lime <sup>d</sup>	No-Lime <sup>e</sup>	Lime <sup>d</sup>	No-Lime <sup>e</sup>
VD4	<i>V.dahliae</i>	Spinach	USA	1.9	1.2	73.3	73.3
VD4/54 <sup>f</sup>	<i>V.dahliae</i>	Spinach	USA	3.3	2.2	80.0	53.3
Control				0	0	0	0

<sup>a</sup> Inoculated on 1/28/10.

<sup>b</sup> Mean disease severity rating (scale 0-6) of 3 plants per pot and 5 pots per treatment (in greenhouse) 22 days after inoculation.

<sup>c</sup> Mean disease incidence per treatment on day 22 after inoculation

<sup>d</sup> Lime treatment (5 g/L) applied once per week.

<sup>e</sup> No lime treatment applied.

<sup>f</sup> Nitrate non-utilizing mutant of VD4 isolate of *Verticillium dahliae*.

**Table 1.** Disease incidence, severity and plant dry weight of spinach line AC1 inoculated with different isolates of *Verticillium* recorded 54 days after inoculation.<sup>a</sup>

Isolate Name	Species <sup>b</sup>	Host	Origin	VCG <sup>c</sup>	Disease severity <sup>d</sup>	Disease incidence <sup>e</sup>	Dry weight (g) <sup>f</sup>
Control	---	---	---	---	0.0	0.0	1.23
LD9	<i>V. albo-atrum</i>	Alfalfa	USA	n.d.	0.0	0.0	1.41
LD10	<i>G. nigrescens</i>	Spinach seed	USA	n.d.	0.0	0.0	1.48
USDA 95	<i>G. nigrescens</i>	Spinach seed	USA	n.d.	0.0	0.0	1.38
LD8	<i>V. tricorpus</i>	Peppermint	USA	n.d.	0.0	0.0	1.50
USDA 11	<i>V. tricorpus</i>	Spinach seed	USA	n.d.	0.0	0.0	1.21
USDA 29	<i>V. tricorpus</i>	Spinach seed	USA	n.d.	0.0	0.0	1.61
<i>L. fung.</i>	<i>L. fungicola</i>	Mushroom	USA	n.d.	0.0	0.0	1.44
LD1	<i>V. dahliae</i>	Peppermint	USA	2B	0.0	0.0	1.57
VD4	<i>V. dahliae</i>	Spinach	USA	4B	0.4	16.7	1.53
WSU 541	<i>V. dahliae</i>	Spinach	Netherlands	2B	1.1	16.7	1.51
WSU 107	<i>V. dahliae</i>	Spinach	Denmark	2B	1.4	41.2	1.69
WSU 523	<i>V. dahliae</i>	Spinach	Netherlands	2B	1.4	50.0	1.30
JD4	<i>V. dahliae</i>	Spinach	USA	n.d.	1.4	33.3	0.95
RV1	<i>V. dahliae</i>	Radish	USA	4B	1.6	58.8	1.82
WSU 509	<i>V. dahliae</i>	Spinach	Netherlands	4B	1.7	70.6	0.99
USDA 25	<i>V. dahliae</i>	Spinach seed	USA	n.d.	1.9	76.5	1.25
WSU 139	<i>V. dahliae</i>	Spinach	USA	4B	2.1	64.7	1.56
VD1	<i>V. dahliae</i>	Spinach	USA	2B	2.2	55.6	1.16
WSU 268	<i>V. dahliae</i>	Spinach	USA	2B	2.3	82.4	1.32
JD1	<i>V. dahliae</i>	Potato	USA	2B	2.5	50.0	1.29
WSU 311	<i>V. dahliae</i>	Spinach	Denmark	4B	2.5	82.4	0.93
WSU 49	<i>V. dahliae</i>	Spinach	USA	4B	2.8	88.9	1.09
JD6	<i>V. dahliae</i>	Spinach	USA	n.d.	2.8	100.0	1.14
WSU 384	<i>V. dahliae</i>	Spinach	USA	2B	2.9	88.9	1.29
WSU 210	<i>V. dahliae</i>	Spinach	Denmark	2B	3.1	77.8	0.90
LD2	<i>V. dahliae</i>	Mint	USA	2B	3.4	77.8	0.87
JD4 ss4	<i>V. dahliae</i>	Spinach	USA	n.d.	3.4	94.4	0.82
WSU 359	<i>V. dahliae</i>	Spinach	Denmark	4B	3.5	94.4	0.78
JD2	<i>V. dahliae</i>	Potato	USA	4B	3.5	83.3	0.76
WSU 511	<i>V. dahliae</i>	Spinach	Netherlands	4B	3.9	82.4	0.54
JD4 ss2	<i>V. dahliae</i>	Spinach	USA	n.d.	4.1	94.4	0.45

<sup>a</sup> Inoculated on 12/17/09. Planting on trays on 11/18/09. Transplanting: 12/09/09.

<sup>b</sup> *Verticillium* species designation based on ITS.

<sup>c</sup> Vegetative compatibility group; n.d. = not determined.

<sup>d</sup> Mean disease severity rating (scale 0-6) of 3 plants per pot and 6 pots per treatment (in greenhouse) 54 days after inoculation.

<sup>e</sup> Disease incidence per treatment on day 54 after inoculation.

<sup>f</sup> Mean dry weight of three replications (each replication with three plants) per treatment. Plants within replication weighed individually.