

Virulence and Interactions among Soilborne Pathogens: Implications for Chile Wilt Management



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Road Map

- **Anatomy and diagnosis of wilting in chile**
- **Complicating factors**
 - Interactions among pathogens**
 - Virulence groups**
- **Implications**

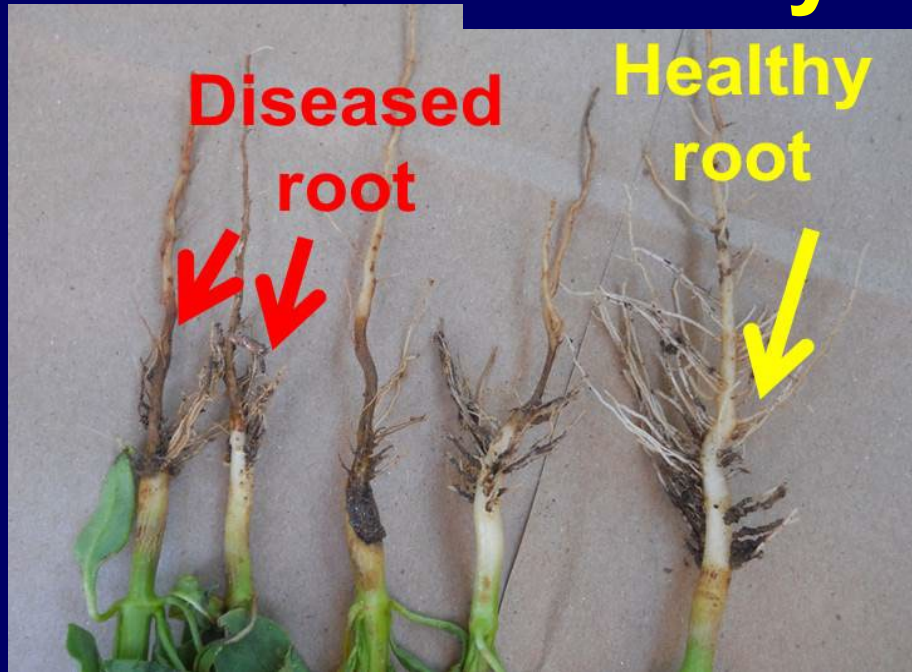
Anatomy of wilting



Anatomy of wilting



Root dysfunction



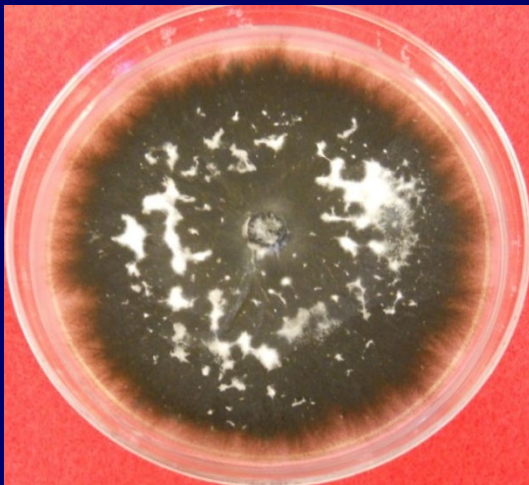
Root dysfunction / Root-knot nematode



Stem dysfunction

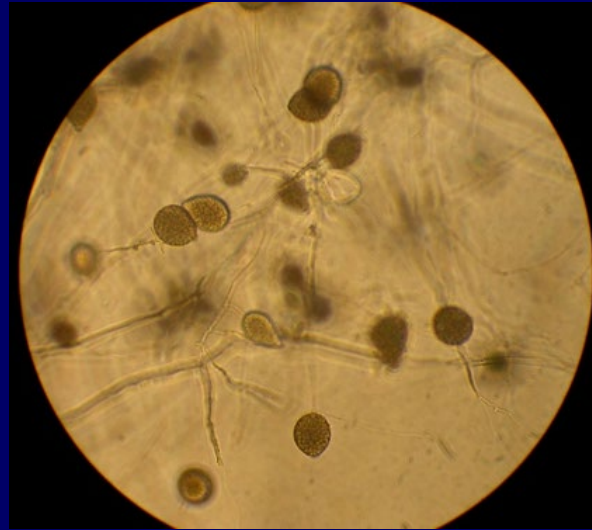


Verticillium wilt



Vascular dysfunction

Phytophthora blight



Root and stem dysfunction

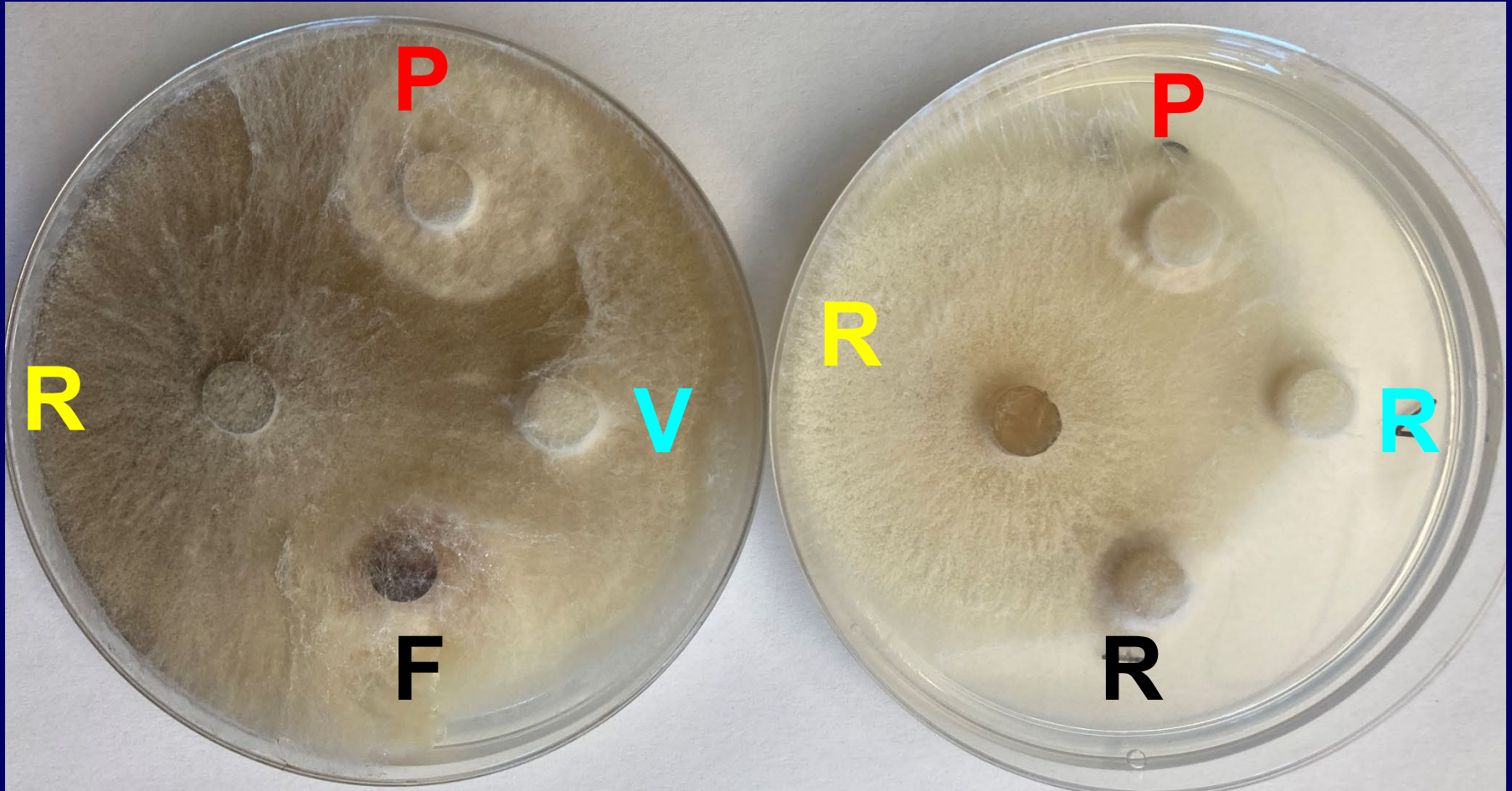
Fusarium/Rhizoctonia root rot



Summary Profile

	Phytophthora Root Rot	Rhizoctonia Root Rot	Verticillium Wilt	Fusarium Wilt
Symptoms				
Wilt	Yes	Yes	Yes	Yes
Stunting	No	Yes	Yes	Yes
Root Rot	Yes	Yes	No	Yes
Defoliation	No	No	Yes	No
Vascular necrosis	No	No	Yes	Yes

Complicating factor 1: Pathogenic Interactions



20C

33C

Interaction Chart

	PHYTO	VERT	RHIZOC	FUSA	NEMA
Symptoms					
Phytophthora (PHYTO)		Xs	Xob	Xob	Xob
Verticillium (VERT)			Xob	Xob	Xs
Rhizoctonia (RHIZOC)				Xob	Xs
Fusarium (FUSA)					Xob
Nematodes (NEMA)					

Xs=observed and studied; **Xob**=observed, but not yet studied

Interaction of *Phytophthora capsici* and *Verticillium dahliae*

Interactive Effects of Two Soilborne Pathogens, *Phytophthora capsici* and *Verticillium dahliae*, on Chile Pepper

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Accepted for publication 10 July 2006.

ABSTRACT

Sanogo, S. 2007. Interactive effects of two soilborne pathogens, *Phytophthora capsici* and *Verticillium dahliae*, on chile pepper. *Phytopathology* 97:37-43.

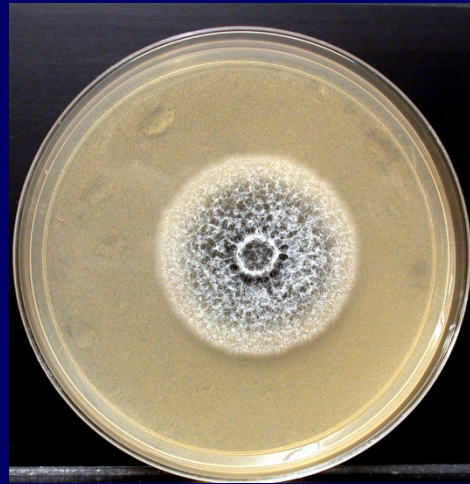
Phytophthora capsici and *Verticillium dahliae* are two mycelial microorganisms that cause diseases in *Capsi-*

erved in plants inoculated with both *P. capsici* and *V. dahliae* by 21 days after inoculation. These symptoms were not observed in control plants or plants inoculated with *V. dahliae* alone. The frequency of recovery of *V. dahliae* from stems was ≈ 85 to 140% higher across inoculum levels when plants were inoculated with both *P. capsici* and *V. dahliae* than when plants were inoculated by *V. dahliae* alone. Similarly, the frequency of recovery of *V. dahliae* from roots was ≈ 13 to 40% higher across inoculum levels when plants were inoculated with both *P. capsici* and *V. dahliae* than when plants were inoculated by *V. dahliae* alone. The results suggest synergistic antagonism between the two pathogens when they are present together. In general, when *P. capsici* and *V. dahliae* are present together, the symptoms caused by *V. dahliae* are more severe than when *V. dahliae* is present alone.

Interaction of *Phytophthora capsici* and *Verticillium dahliae*



Pc



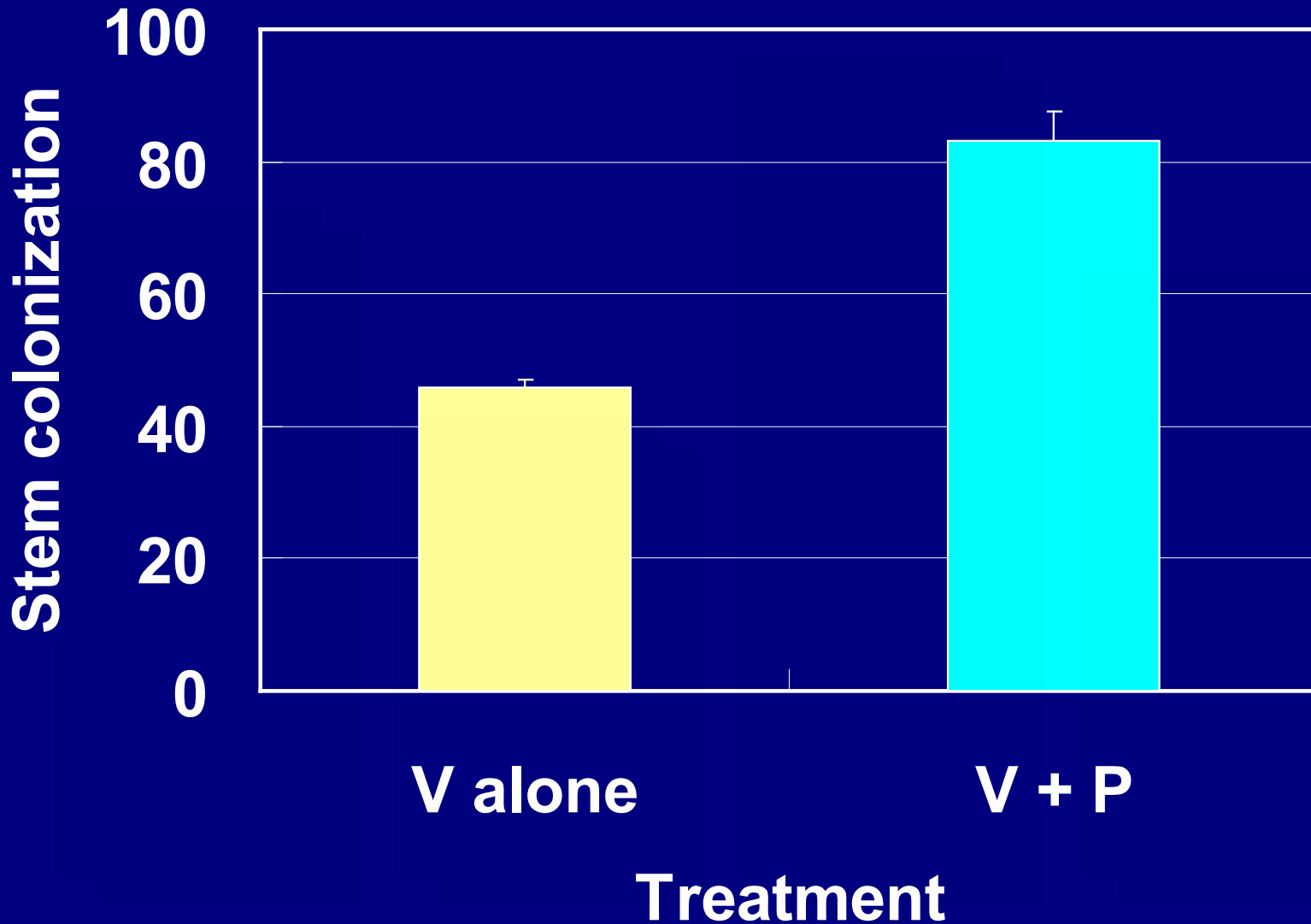
Vd



Pc + Vd

Pc=Phytophthora capsici; Vd=Verticillium dahliae

Interaction Chile Wilt Pathogens



P=Phytophthora capsici; V=Verticillium dahliae

Interaction of *Verticillium dahliae* and *Meloidogyne incognita*

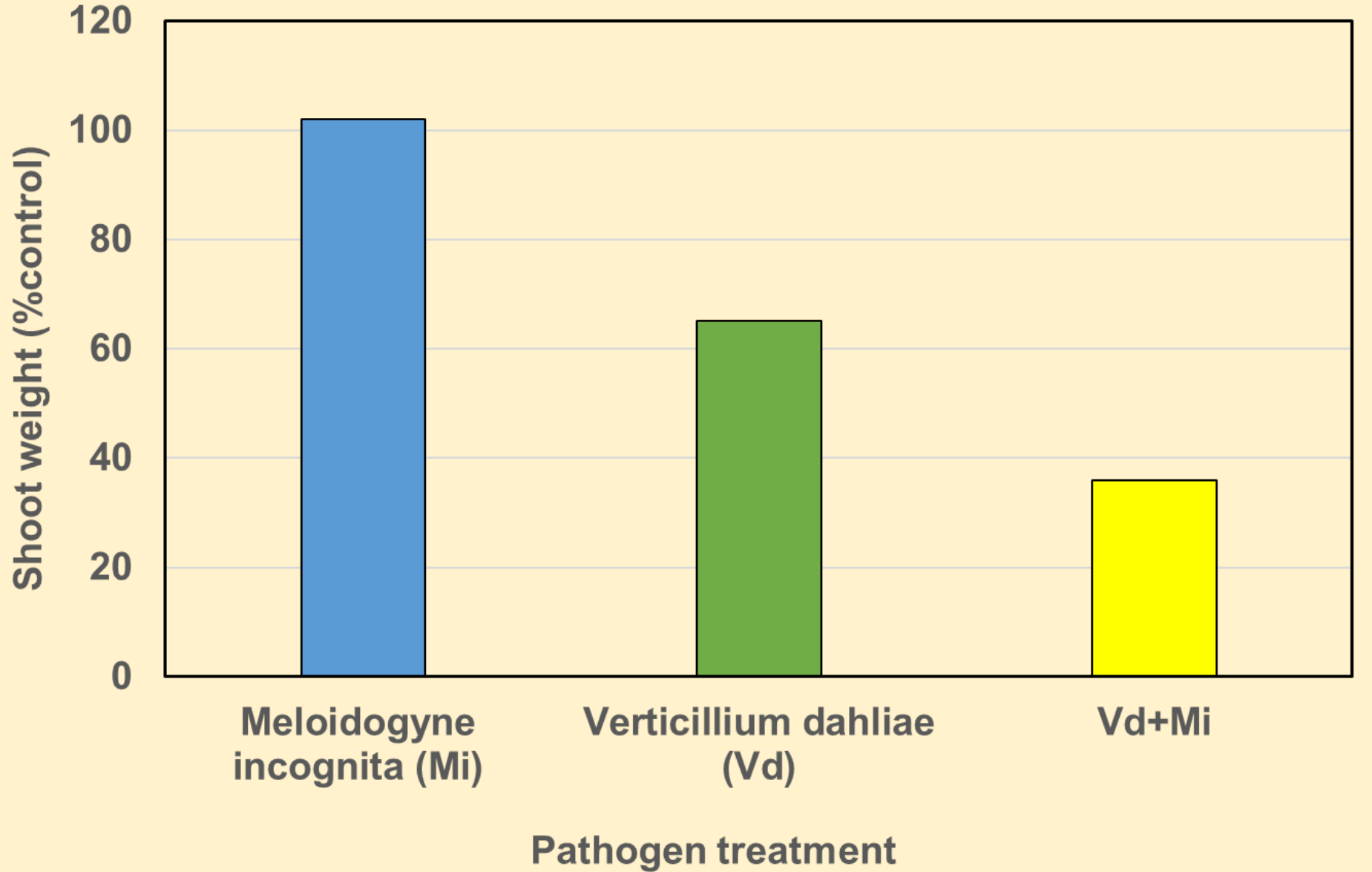
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Accepted for publication 17 July 2013. Published 20 September 2013.

Weed Species Not Impaired by *Verticillium dahliae* and *Meloidogyne incognita* Relationships that Damage Chile Pepper

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and Weed Science, New Mexico State University, Las Cruces, NM
Department of Statistics, Kansas State
Midt, College Professor,
International

Interaction Chile Wilt Pathogens



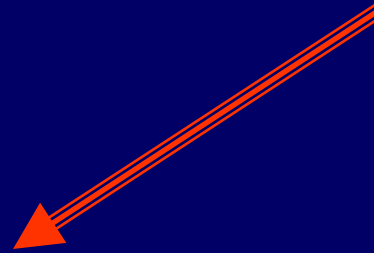
Complicating factor 2: virulence groups

PATHOGENICITY
Ability to cause disease

NO → **Non-pathogenic**

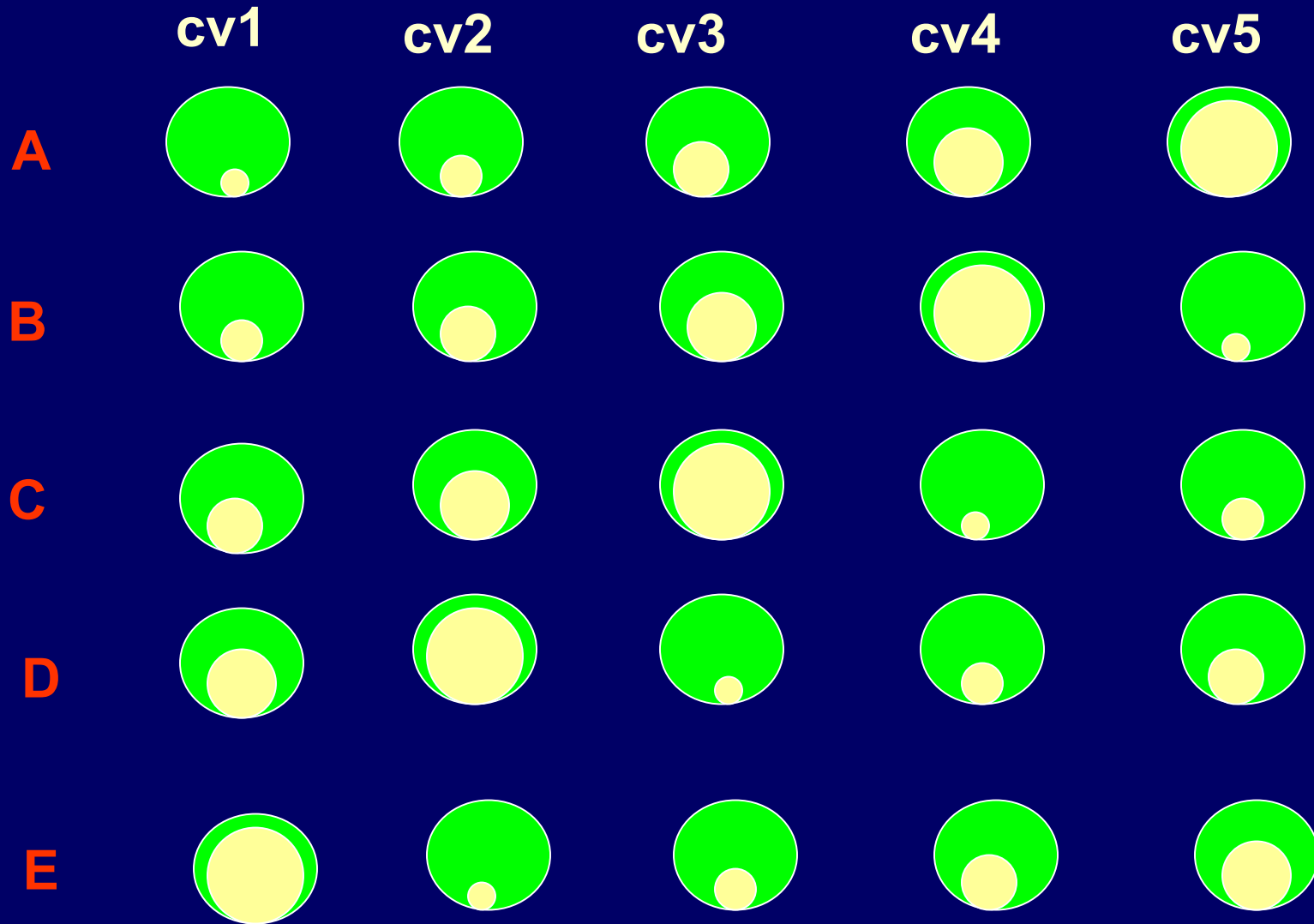
YES → **Pathogenic
(pathogen)**

VIRULENCE
Variation in ability to cause disease



→ **Races, strains,
or biotypes**

Complicating factor 2: virulence groups



Cv=cultivars (1 through 5); A through E =isolates of a pathogen

Green=areas of healthy plant tissue; yellow areas=amount of disease caused by an isolate of a pathogen

Virulence groups in *Phytophthora capsici*

Plant Health

Using Recombinant Inbred Lines to Monitor Changes in the Race Structure of *Phytophthora capsici* in Chile Pepper in New Mexico

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Accepted for publication 3 December 2015. Published 17 December 2015.

ABSTRACT

Jiang, L., Sanogo, S., and Bosland, P. W. (2015). Using recombinant inbred lines to monitor changes in the race structure of *Phytophthora capsici* in chile pepper. *Plant Health*, 95, 1-10. doi:10.1111/PHIP-RS-15-0034.

including their disease reactions, and hence, are invaluable as *P. capsici* differentials. A resistance index that ranges from 0 to 1 with 1 being the most resistant was developed in this study. Among all the differentials, NMRIL (NMRIL-R) had a low

Virulence groups in *Phytophthora capsici*

TABLE 3

New *Phytophthora capsici* race designation using New Mexico recombinant inbred lines (NMRILs).

Race designation	22	23	24	25	26	27	28	29	30	31	32		33
Isolate PWB entry	106	173	174	175	176	177	178	179	180	181	182	183	184
Host accessions	Host reactions												
NMRIL-A	R ^a	R	R	S	R	R	R	S	R	R	R	R	R
NMRIL-E	S ^b	S	R	S	S	S	S	R	R	S	R	R	R
NMRIL-H	R	R	R	S	S	S	S	S	S	S	S	S	S
NMRIL-I	R	S	R	S	S	S	S	R	R	S	R	R	S
NMRIL-R	S	S	R	S	S	S	S	S	S	S	R	R	S
NMRIL-Z	R	R	R	S	R	S	S	R	R	R	R	R	R
NMRIL-AD	R	R	R	S	S	S	R	R	R	R	R	R	R

^aResistant reaction.

^bSusceptible reaction.

Virulence groups in *Phytophthora capsici*



Race 25 causes more severe root damage than race 1

Jiang et al. 2015

Virulence groups in *Phytophthora capsici*



Race 25

Race 1

Race 25

Race 1

Race 25 causes more severe root damage than race 1

Jiang et al. 2015

Determination of virulence groups of *Phytophthora capsici*

Race survey



**Collection of isolates from
Several locations**



**Testing and determination
of races using RILs**

Monitoring plots



**RILs planted at
several locations**



**Disease monitored
throughout season**

Virulence groups in *Verticillium dahliae*

Plant Health Progress ♦ 2021 ♦ 22:575–577

Plant Health

Extra*

New Mexico Chile Pepper Producers Are Affected by a Diverse *Verticillium dahliae* Population That Includes Many Race 2 Strains That Break *Ve1*-Mediated Resistance

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Accepted for publication 20 April 2021.

Keywords: *Verticillium dahliae*, *Capsicum annuum*, *Solanum lycopersicum*, Verticillium wilt, genetic resistance

Chile pepper is an important crop in New Mexico and its cash crop. Verticillium wilt is a major disease of chile peppers in New Mexico.

Seventy-eight independent isolates of *V. dahliae* were obtained from chile pepper plants showing signs of Verticillium wilt. Each isolate came from a different plant taken from one of four commercial chile fields across southern NM. Race testing was performed on 38 isolates by inoculating the isolates onto chile peppers (NM-1000) and race 1 resistant tomato (Bonny Best), and race 1 resistant tomato (Bonny Best). Plants were inoculated with 10⁶ spores of the isolates.

Virulence groups in *Verticillium dahliae*

TABLE 1
Percentage of *Verticillium dahliae* isolates causing disease or death^a

Observed result	Chile (NM-64)	Tomato (Bonnie Best)	Tomato (Ace 55 VF)
Causing symptoms	76	55	39
Causing death	57	27	10

^a Thirty-eight isolates of *V. dahliae*, isolated from chile pepper plants showing Verticillium wilt symptoms, were tested for the ability to infect chile pepper (NM-64), a tomato line susceptible to *V. dahliae* race 1 (Bonnie Best), or a tomato line resistant to *V. dahliae* race 1 (Ace 55 VF). Plants were rated for 8 weeks postinoculation with the percentage of isolates causing symptoms or death shown.

Spatial variation



Factors to consider in spatial variation in wilting:
Players (diversity of pathogens), Interactions, and Virulence

Management Chart

	PHYTO	VERT	RHIZOC	FUSA	NEMA
Symptoms					
Phytophthora (PHYTO)	X	X	X	X	X
Verticillium (VERT)		X	X	X	X
Rhizoctonia (RHIZOC)			X	X	X
Fusarium (FUSA)				X	X
Nematodes (NEMA)					X

Complexity of management evolving from one pathogen (X) to all pathogens (X) present in a field

Acknowledgments

- ✓ *New Mexico Ag Experiment Station*
- ✓ *New Mexico Chile Association*
- ✓ *New Mexico Chile Commission*
- ✓ *Dave Lowry et al., Leyendecker PSRC*
- ✓ *Vince Hernandez, Biad Chili Co.*
- ✓ *All chile producer and crop consultant/adviser cooperators in Dona Ana, Luna, and Sierra Counties*