Resistance Breaking Root knot nematode – Fusarium interactions

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Resistance breaking root knot nematodes

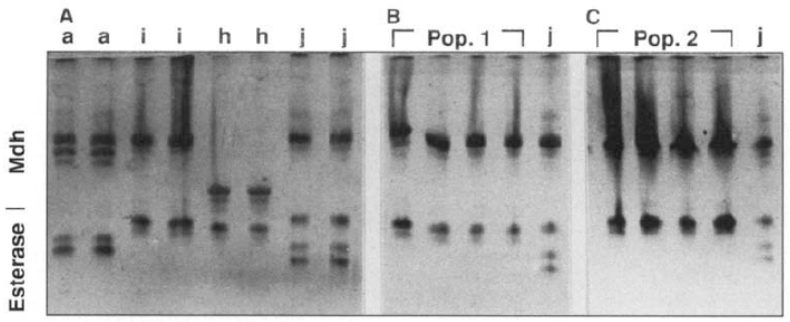

Fig. 1. Polyacrylamide gel showing the malate dehydrogenase (Mdh) and esterase phenotypes of single root-knot nematode females. Isozyme patterns of A) known isolates of *M. arenaria* (a), *M. incognita* (i), *M. hapla* (h), and *M. javanica* (j); B) resistance-breaking nematodes from Woodland population (pop. 1), and *M. javanica* (j); C) resistance-breaking nematodes from Kettleman City population (pop. 2), and *M. javanica* (j).

"Resistance-breaking" nematodes identified in California tomatoes

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ement at the nematode feeding site and to alterations in nutrient partitioning.

All resistance to root-knot nematodes present in commercial varieties of tomato is conferred by the *Mi* gene. This gene confers resistance to three species of root-knot nematodes, *M. arenaria*, *M. incognita* and *M. javanica*, the most common root-knot species found in tomato-growing areas in the United States. The resistance was originally identified in *Lycopersicon peruvianum*, a wild relative of cultivated tomato, and was introduced into cultivated tomato using embryo rescue of a cross of the wild species and cultivated tomato, *L. esculentum*, about 50 years ago. Embryo rescue is a tech-

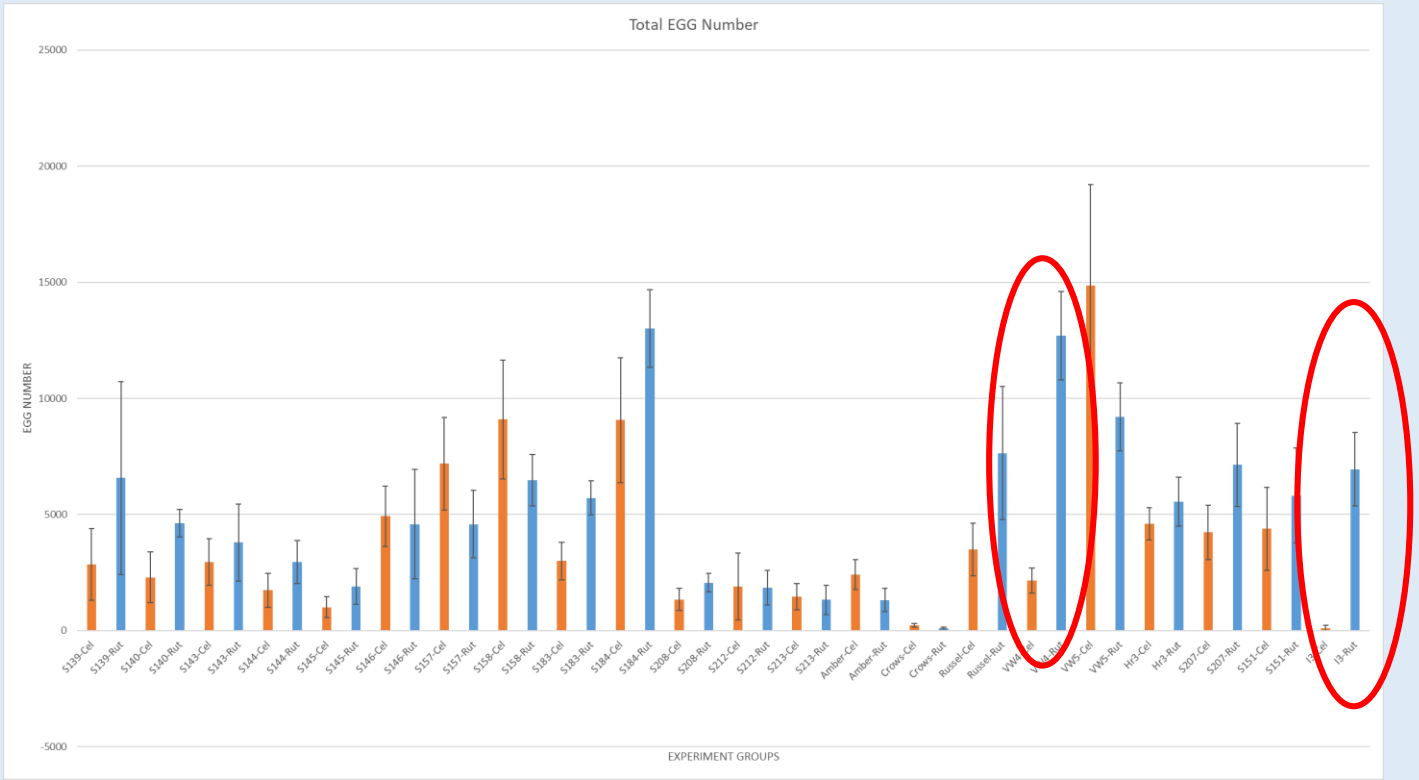
- Not a new problem – *California Agriculture* paper from 1996.
- Two populations noted (Yolo and Kings Co.).
- "The increasing reliance on resistance due to restricted use of nematicide treatments enhances the potential for selection of resistance-breaking populations in tomato fields."

Resistance breaking root knot nematodes

- 2021 Survey found RKN in 27/30 suspected fields (Mi gene).
- All *M. incognita* and *M. javanica* (not Fresno/Merced).
- Indicates fairly widespread problem.*
- Are these resistance breaking*? Possible explanations
    1. Mutations in RKN to overcome resistance.
    2. Heat breaking down Mi efficacy.

County	RKN + fields
Fresno	7
Merced	1
San Joaquin	1
Solano	2
Sutter	1
Yolo	15

- Previous assumption was that the Mi gene was sufficient and that breakthroughs were due to high temperature.
- But…. These nematodes are still able to infect plants with the *Mi* gene under controlled conditions (25 C).



	County	Isolate	% Root galling Celebrity' (*Mi* +)	Rutgers' (*Mi* -)
M. incognita	Yolo	139	33	31
	Yolo	140	44	32
	Yolo	143	23	27
	Yolo	144	35	33
	Yolo	145	19	28
	Yolo	146	30	37
	Yolo	213	6	7
	Yolo	R-R	43	44
	Solano	212	4.6	12
	Fresno	157	30	32
	Fresno	158	26	28
	Fresno	208	24	20
	Fresno	207	28	44
	Fresno	151	34	44
	Merced	183	28	38
	Sutter	A-S	46	37
M. javanica	Yolo	184	19	29
	Stanislaus	C-L	0	1

Controls

M. incognita	Hr3	36	29
M. incognita	I3	0	47
M. javanica	VW5	33	25
M. javanica	VW4	5	42

- Nearly all isolates reproduced on Mi+ ‘Celebrity’ as well as Mi- control ‘Rutgers’.
- Known resistance-breaking M. incognita (Hr3) caused > 29 % root galling on both cultivars.
- Control M. incognita (I3) was not able to reproduce on ‘Celebrity’ as expected.
- Known resistance breaking M. javanica (VW5) reproduced well on both cultivars, while control (VW4) showed very low galling with ‘Celebrity’.
- Establishes that nematode isolates have a genetic ability to overcome the Mi gene, and that field outbreaks are likely not due to Mi breaking down under heat stress.

But…it's not just the nematodes

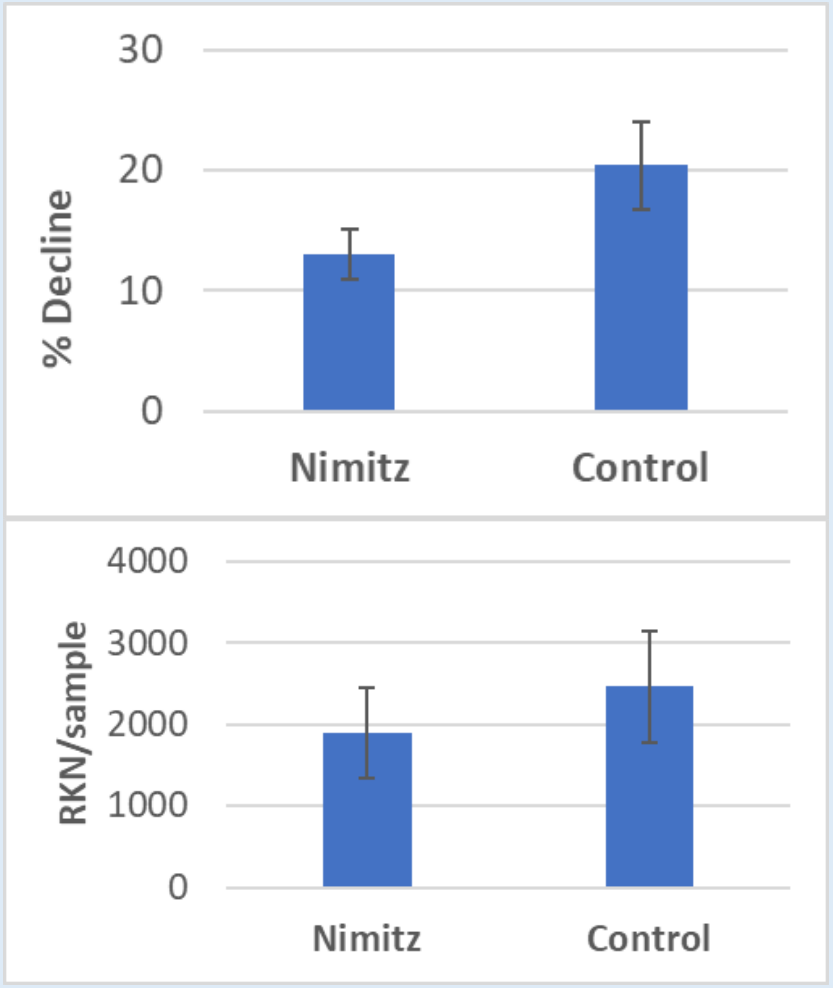
RKN-Pathogen Complexes

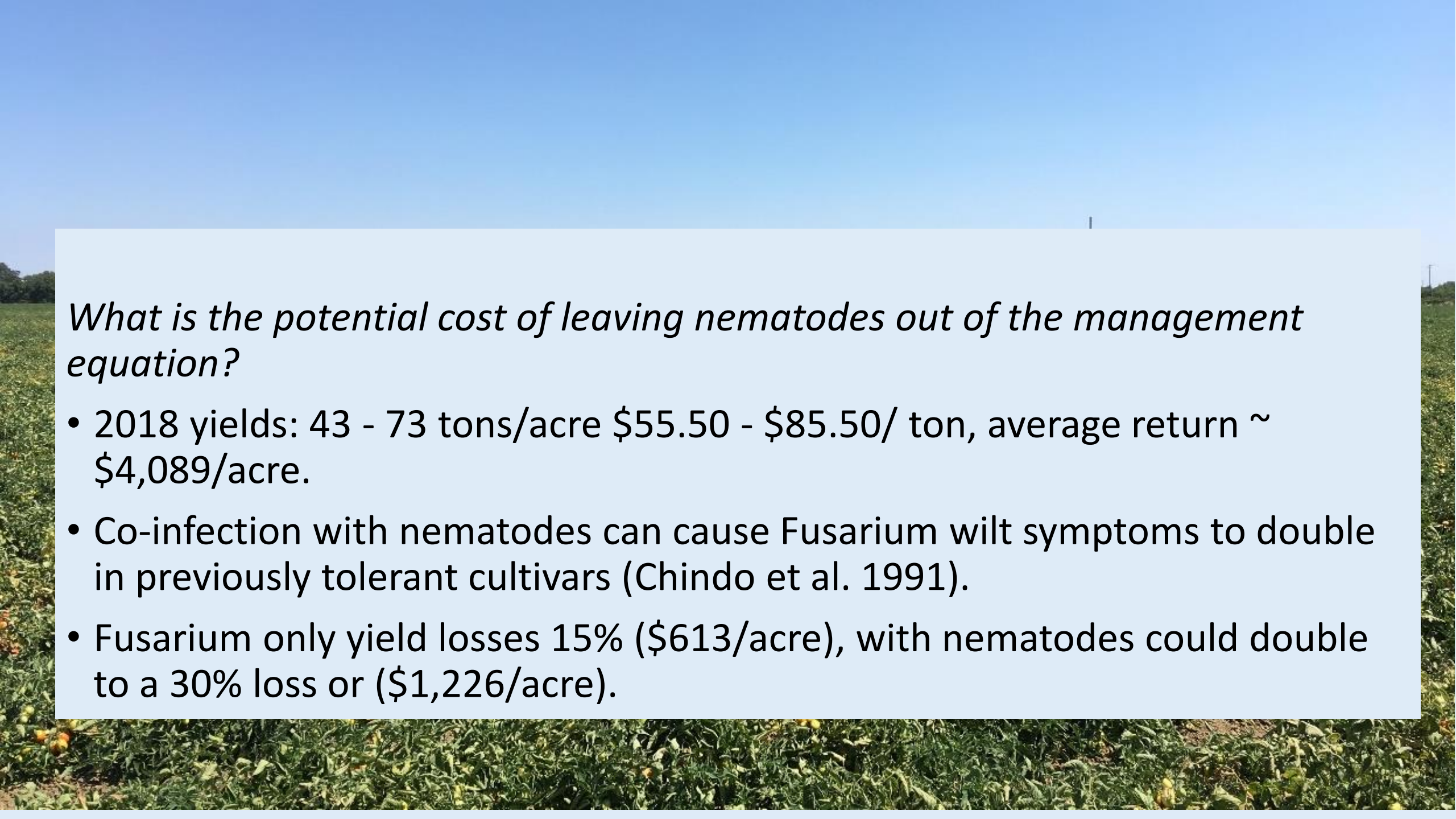
- RKN often co-occurs with Fusarium wilt and other diseases.
- Synergy may cause worse symptoms of both pathogens.
- 2021 data highlights RKN-Fusarium disease complexes as drivers of yield losses.
- Majority of fields with RKN also had Fusarium wilt.
- Of total F3-breaking cases, 63% also had RKN.
- Prior nematode infection can allow Fusarium to overcome resistance in F1 cultivars and likely F3.

	Diseases co-occurring with RKN in 27 fields	
1	Fusarium wilt (F. oxysporum f. sp. lycopersici-Fol)	55%
2	Fusarium falciforme vine decline	42%
3	Fusarium crown and root rot (F. oxysporum f. sp. radicis lycoerpsici - Forl)	38%

Strategies to manage RKN-pathogen disease complexes

- *2021 data from Tom Turini's Fresno Co. trial*
- Commercial field 'BOS811' (F2)
- Nimitz applied pre-plant at 4.11pts/acre vs. Controls
- Vine decline - *F. oxysporum* f. sp. *lycopersici* (suggests race 3).
- Level of disease in the treated plots would not have been commercially acceptable.
- Trends suggest nematicide could influence vine decline.





What is the potential cost of leaving nematodes out of the management equation?

- 2018 yields: 43 - 73 tons/acre $55.50 - $85.50/ ton, average return ~ $4,089/acre.
- Co-infection with nematodes can cause Fusarium wilt symptoms to double in previously tolerant cultivars (Chindo et al. 1991).
- Fusarium only yield losses 15% ($613/acre), with nematodes could double to a 30% loss or ($1,226/acre).

Future

- Need for research to characterize new “pathotypes” of RB – RKN. This can help breeders to build up *Mi* resistance or create the next generation of resistance genes.
- More detailed knowledge of how previous RKN infection affects Fusarium wilt and F. falciforme vine decline severity.
- Potential impacts of co-infection on yield.
- Efficacy of Fusarium disease-resistant cultivars.
- Effects of nematicides on disease co-occurance.

Thank you!

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Grower cooperators

Antoon Ploog

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- Amber Vinchesi-Vahl
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