Upping the Game: Strategies to Improve Pre-Plant Soil Fumigation

SWFREC Virtual Growers Meeting – June 18th, 2020

UF UNIVERSITY of FLORIDA
IFAS - GCREC

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UF/IFAS Gulf Coast REC
Wimauma, FL

Why do we fumigate?

* Soil Fumigation:

  Reduce soil levels of

  * Weeds
  * Nematodes
  * Soilborne pathogens

  to an acceptable level that limits crop losses.

21 year Phase Out Timeline & Development of Alternatives

MeBr Detected atmosphere

Class A Ozone Depleter

Problem Definition Phase
'No Stand Alones'
1994-1996

Emissions Reduction
Nonchemical / Physical
Cultivar evaluations

Comprehensive evaluation
of new fumigant chemistry
Application & VIF technologies
Gas Phase Soil movement

Grower Demo Trialing
Technology Transfer
Transition Strategies

25% 50% 70% 100%

1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2013

The End

1993
Experimental
Advanced Film
Technologies

1994
Methyl
Iodide
Drip 1,3-D

1996
Drip Fumigation

1998
Propylene Oxide
Propargyl Bromide
Ozone
Enzone
New 2005
Phaseout Schedule
Harmonized with
Developed Countries

1999
VIF
MULCH
IR-4 Program

2000
Yetter
Coulter
biofumigation

2001
Sodium Azide
Solarization
Propargyl bromide

2003
DMDS

2005
CUE's
Begin

2006
USDA ARS
Areawide

2008
TIF
Mulches

2009
MeBr
Supply
shortages

Slide credit: J. Noling

21 year Phase Out Timeline & Development of Alternatives

MeBr Detected atmosphere

Class A Ozone Depleter

Problem Definition Phase

Emissions Reduction

Comprehensive evaluation of new fumigant chemistry Application & VIF technologies Gas Phase Soil movement

Grower Demo Trialing

ransfer

ategies

100%

1992

2013

The End

2009 MeBr upply ortages

Exp Adva Technologies

Propylene Oxide
Propargyl Bromide
Ozone
Enzone
New 2005 Phaseout Schedule Harmonized with Developed Countries

2001
Sodium Azide
Solarization
Propargyl bromide

Begin

TIF Mulches

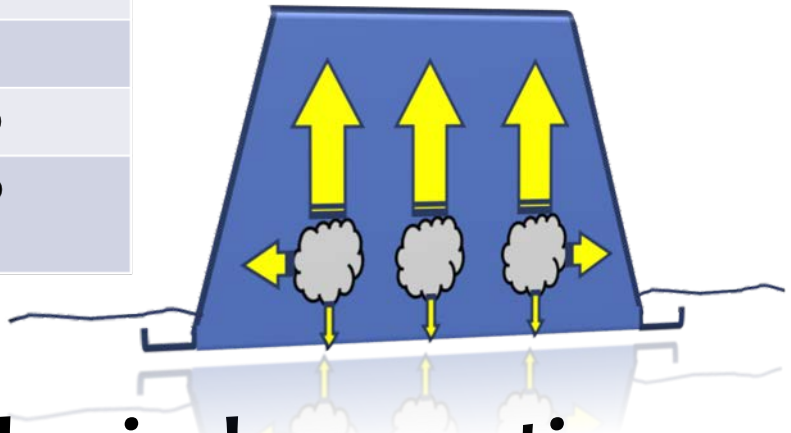
Since transitioning away from MBr growers have observed:

- ↑ Diseases caused by soilborne pathogens
- ↑ Nematodes
- ↑ Weeds (nutsedge)
- ↓ Crop vigor (lucky to get 3 picks off a tomato crop)
- ↓ Multiple cropping of prepared land

Slide credit: J. Noling

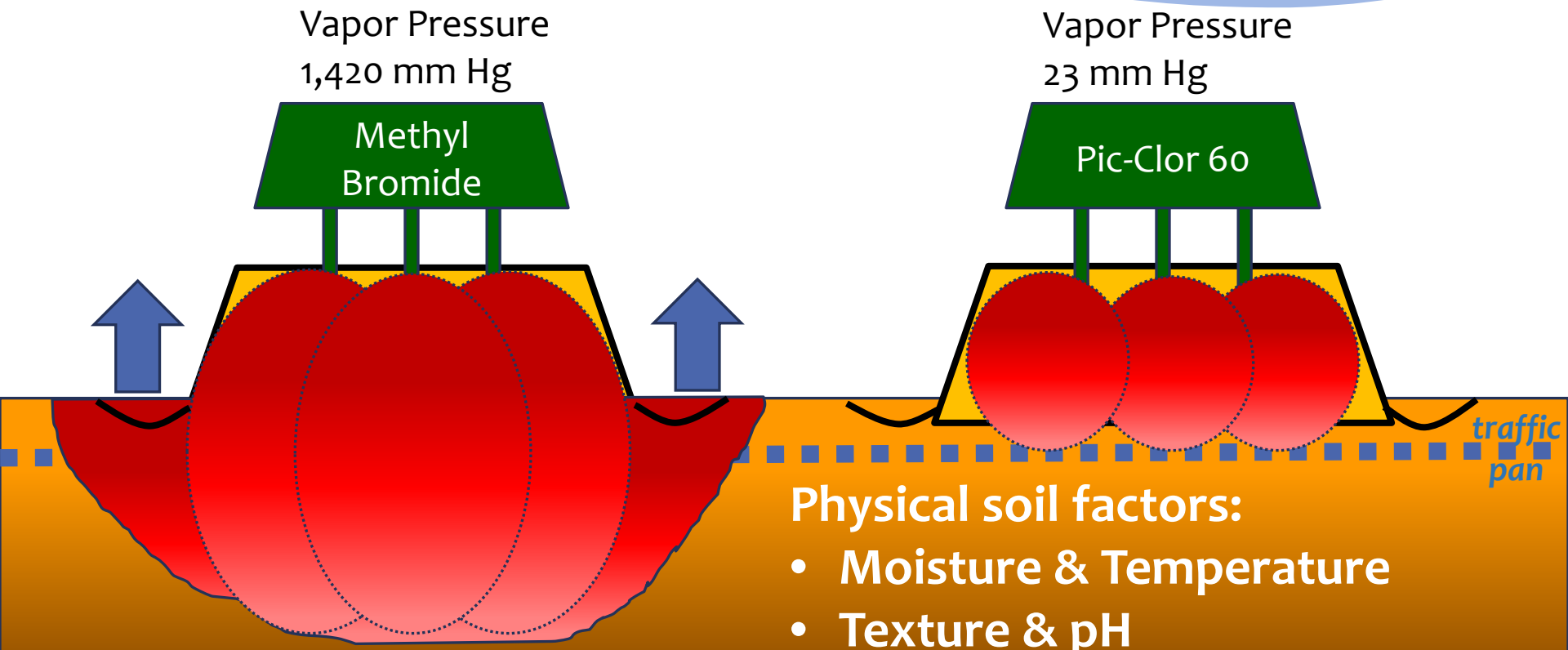
Identify weaknesses in current fumigation systems

Fumigant	Vapor pressure (mm Hg)	Boiling point (°C at 1 atm)
Methyl bromide (100%)	1,420 (20 °C)	4
Chloropicrin (100%)	18.3 (20 °C)	112
1,3-Dichloropropene (98%)	23.0 (20 °C)	107
Dimethyl disulfide (100%)	28.6 (25 °C)	109
Metam potassium (54%)	24 (25 °C)	97
Allyl isothiocyanate (94%)	4 (20 °C)	150
Water	17.5 (20 °C) 23.8 (25 °C)	100



Differences in fumigant physical properties influences volatility and dispersal within soil

Identify weaknesses in current fumigation systems



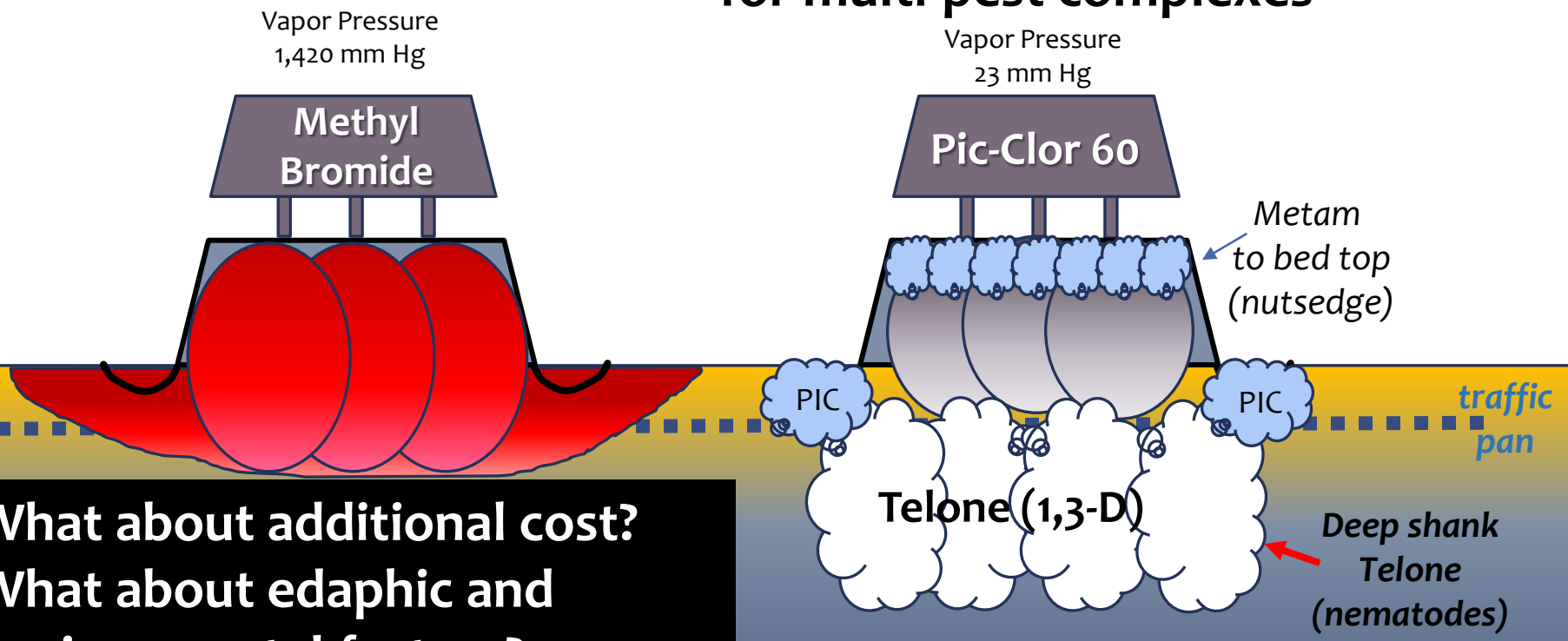
Physical soil factors:

- **Moisture & Temperature**
- **Texture & pH**
- **Organic matter & Compaction**

Vertical Management Zones

Noling, Vallad, & Boyd Contributions

A prescription-based system…
for multi-pest complexes



What about additional cost?
What about edaphic and environmental factors?

Yield Increases of 25% and more

3 WAY Economics- Fumigants Florida Tomato

Cost Comparison 2010 vs 2020

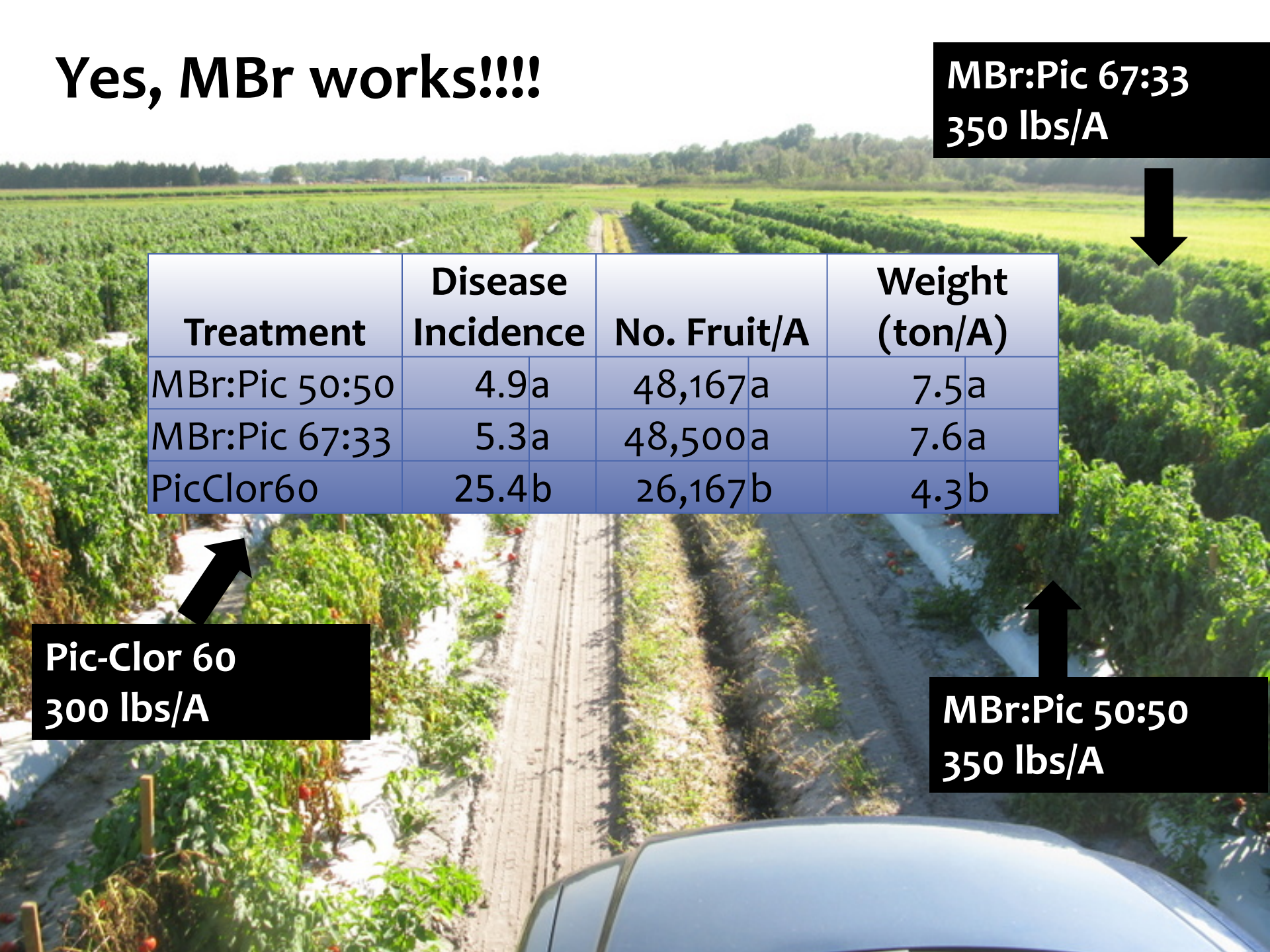
Material & Rate T- 12 gal/A Pic- 150 lb/A PC60- 250 lb/A Kpam- 60 gal/A	3-WAY Traditional **2010** ($25/gal T) ($2.60/lb Pic) ($7.25/gal K)	3-WAY Traditional **2020** ($27.40/gal T) ($4.15/lb Pic) ($9.00/gal K)	3-WAY with PicClor 60 **2010** ($2.80/lb) ($7.25/gal K)	3-WAY with PicClor 60 **2020** ($4.25/lb) ($9.00/gal K)
Fumigant	563	746	568	801
VIF	381	372	381	372
Total	951	1118	949	1173
Percent Increase	-	17.6%	-	23.6%

Assumes 36" bed , 50% of acre treated, chloropicrin applied at the equivalent of 150 lb/ta


Spring 2013 – Tomato Field with Fusarium Wilt –
Manatee Co. FL – *after 4 years of Pic-Clor 60*

Yes, MBr works!!!!

Yes, MBr works!!!!



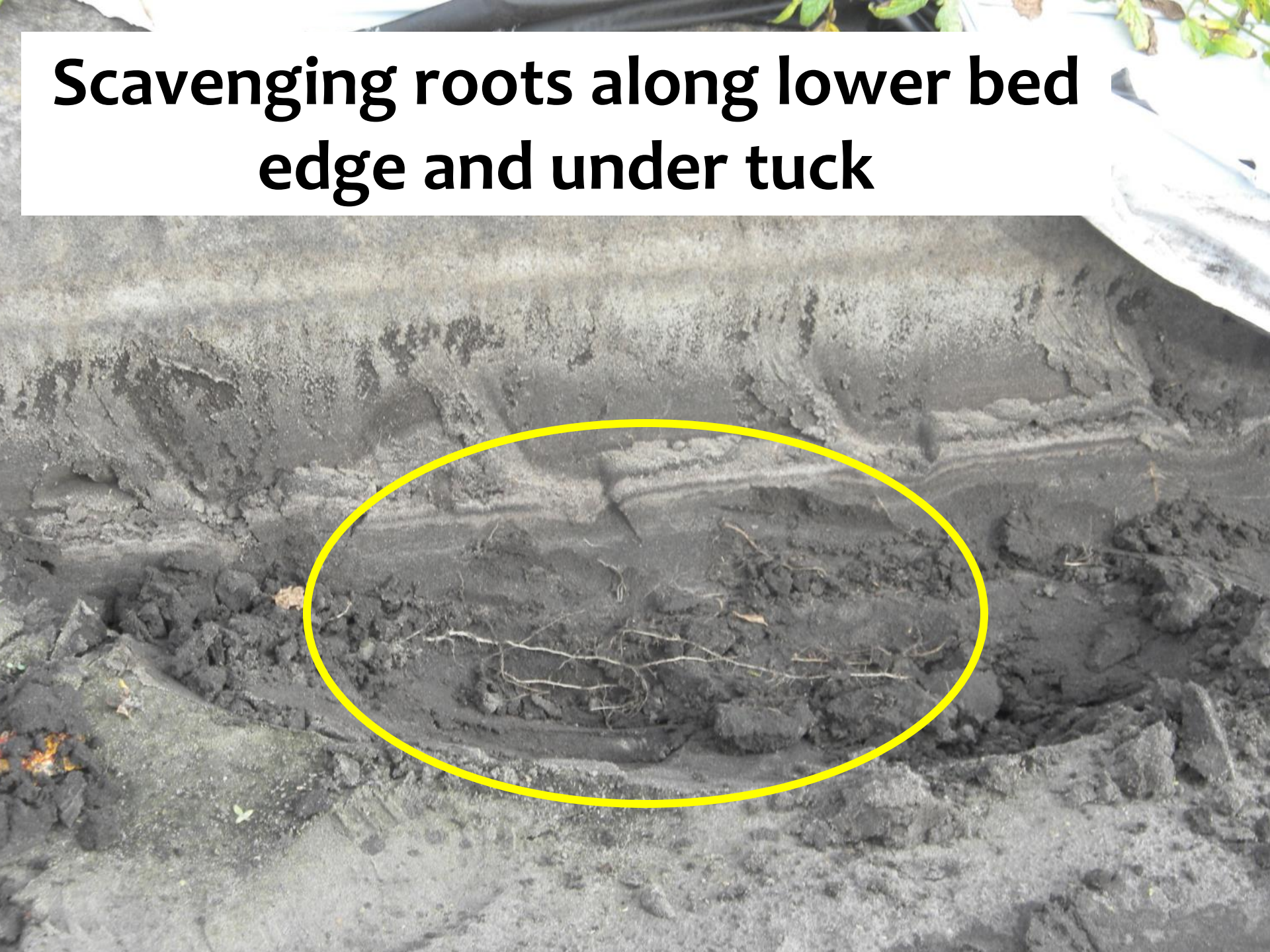
MBr:Pic 67:33
350 lbs/A

Treatment	Disease Incidence	No. Fruit/A	Weight (ton/A)
MBr:Pic 50:50	4.9a	48,167a	7.5a
MBr:Pic 67:33	5.3a	48,500a	7.6a
PicClor60	25.4b	26,167b	4.3b

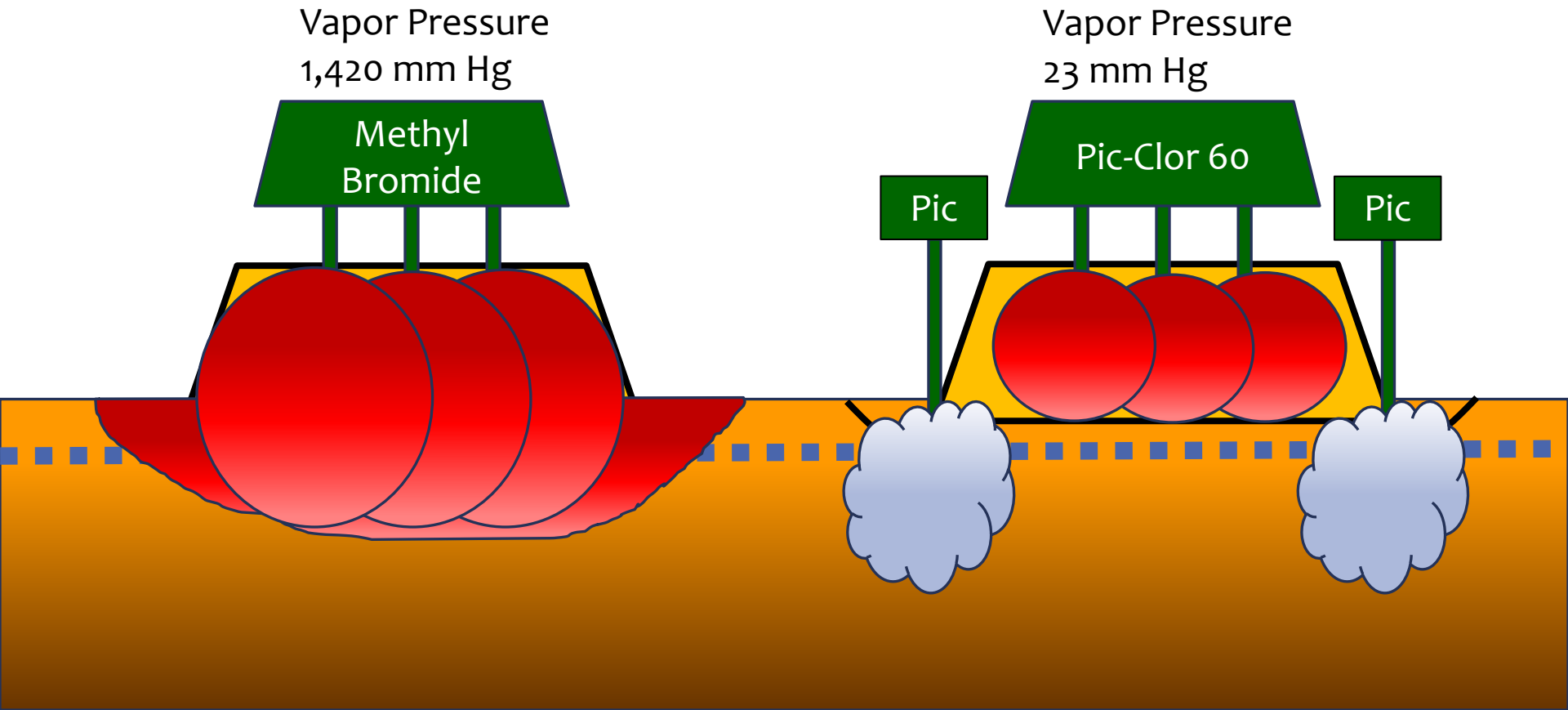
Pic-Clor 60
300 lbs/A

MBr:Pic 50:50
350 lbs/A

Scavenging roots along lower bed edge and under tuck



Identify weaknesses in current fumigation systems.



Supplemental Fumigation Strategy for Managing Fusarium Wilt

Treatments:

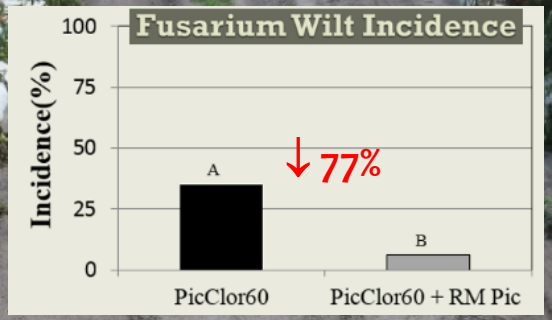
1) PicClor60 @ 300 lbs/tA
2) PicClor60 @ 300 lbs/tA
   + Pic100 @ 200 lbs/tA

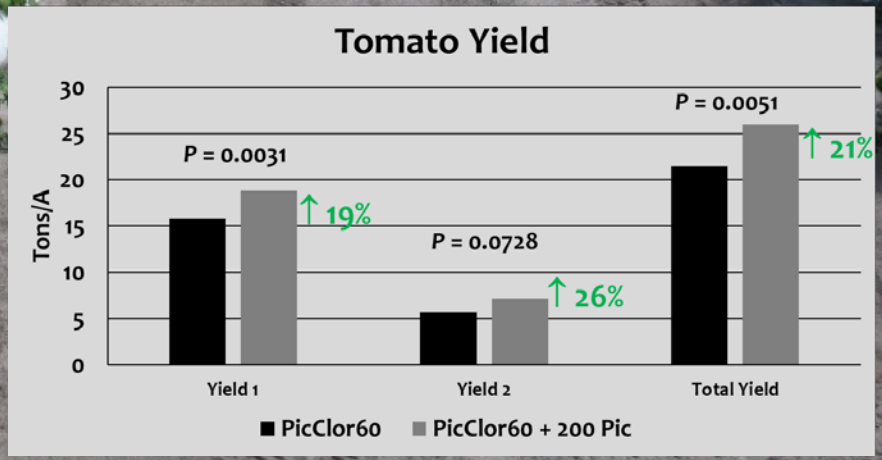
Yetter coulters placed along bed edge prior to laying mulch. Chloropicrin applied under mulch and > 10” below final soil-air interface.


Without Supplemental Pic100
With Supplemental Pic100

Without Supplemental Pic100

With Supplemental Pic100



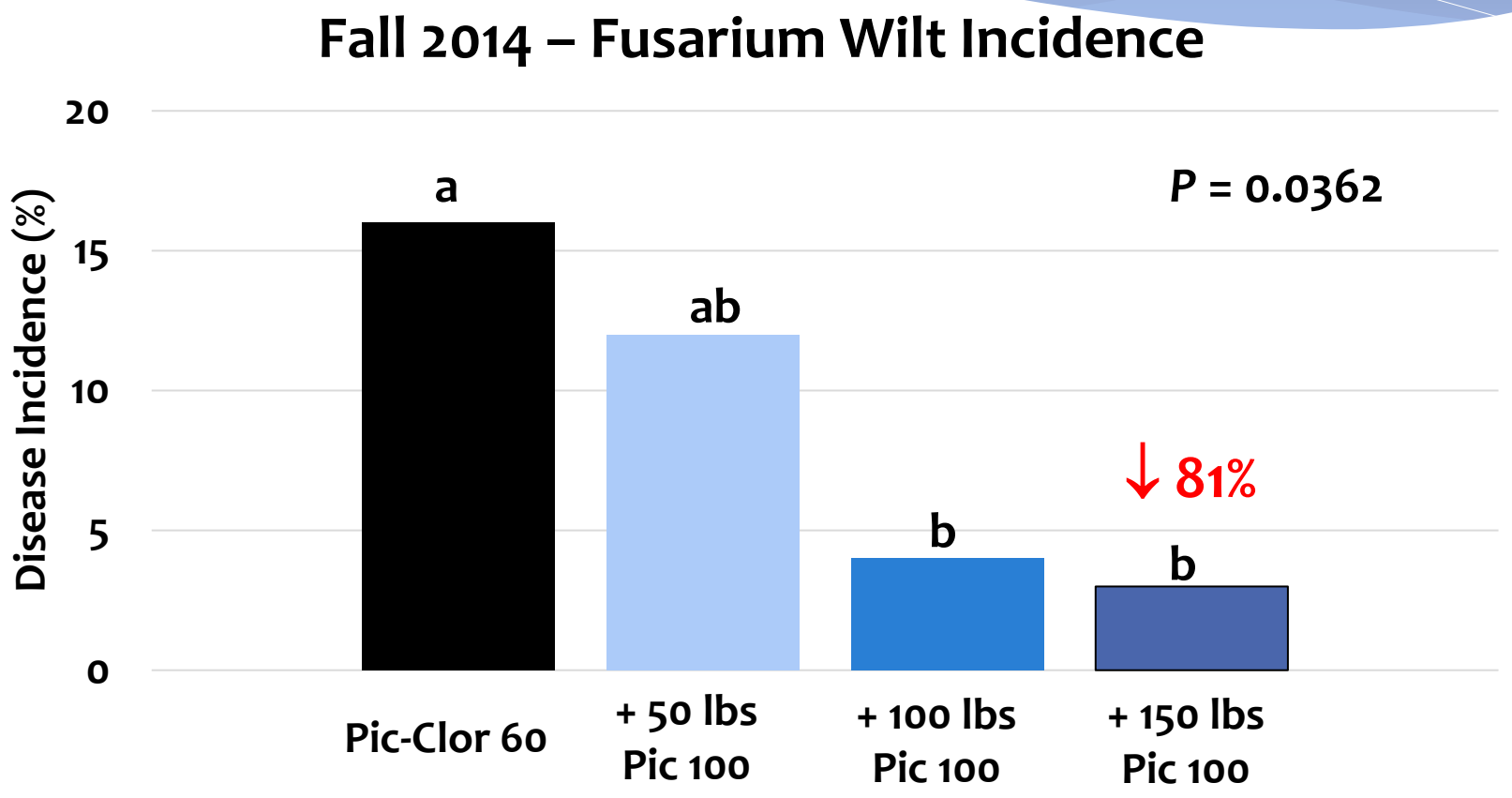


PicClor60 + Supplemental Pic*

PicClor60

* Supplemental Pic increased root mass by nearly 200%

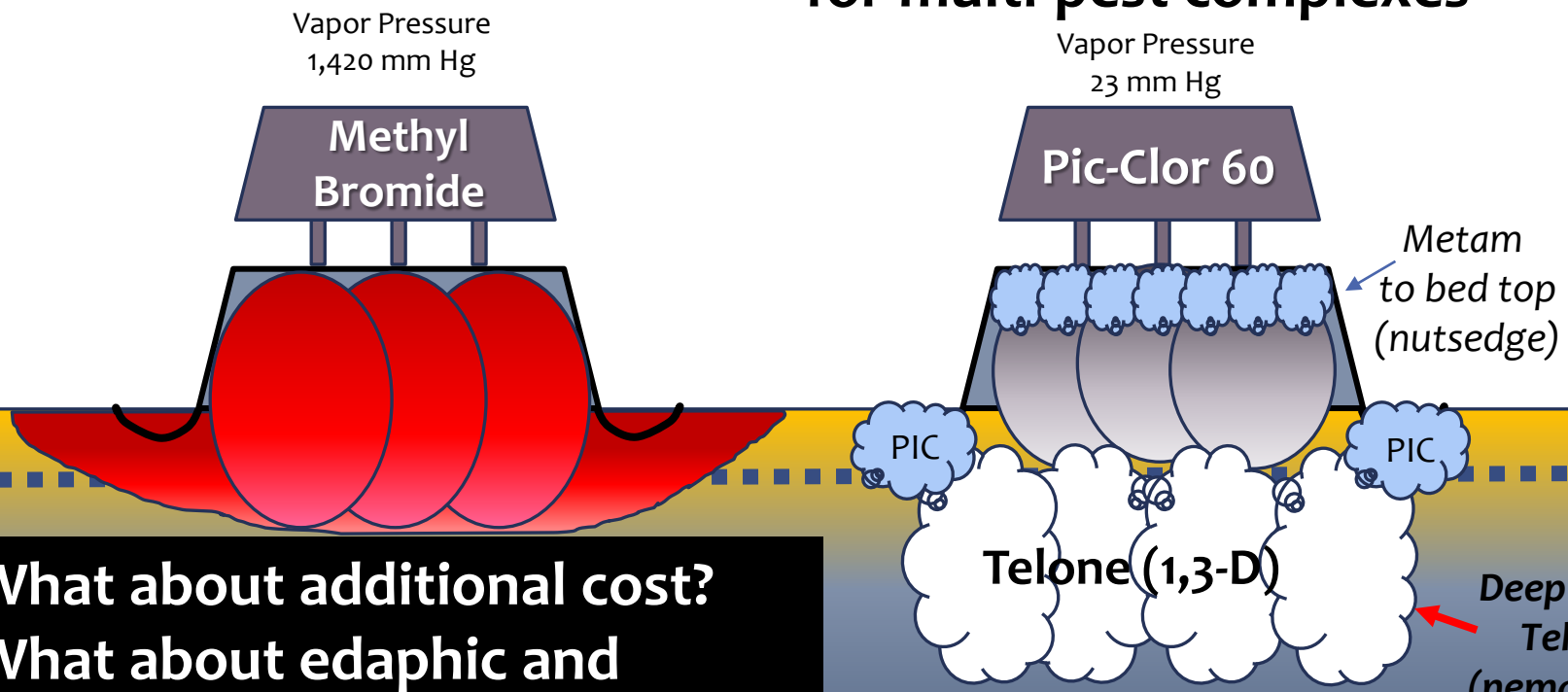
On-Farm Rate Study - Fall 2014



Vertical Management Zones

Noling, Vallad, & Boyd Contributions

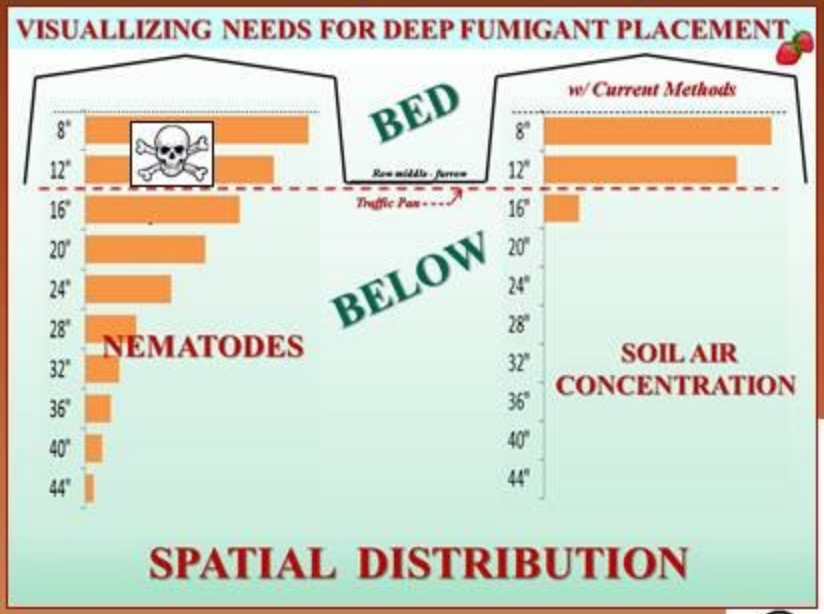
A prescription based system…
for multi-pest complexes



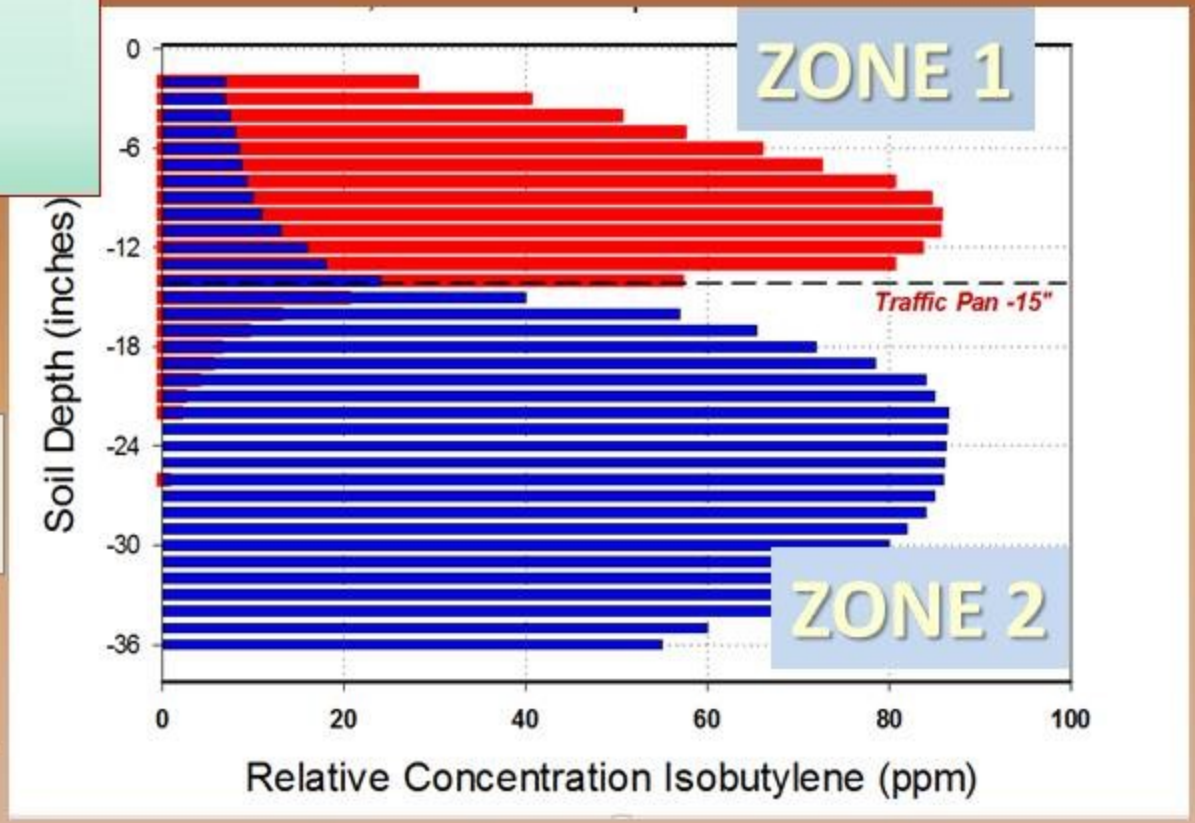
What about additional cost?
What about edaphic and environmental factors?

Yield Increases of 25% and more

Restructuring Nematode Control As a Composite of Vertical Management Zones



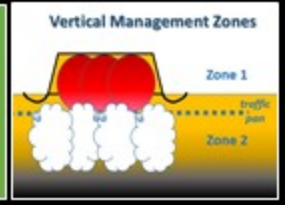
Fumigant Placement Above & Below Traffic Pan

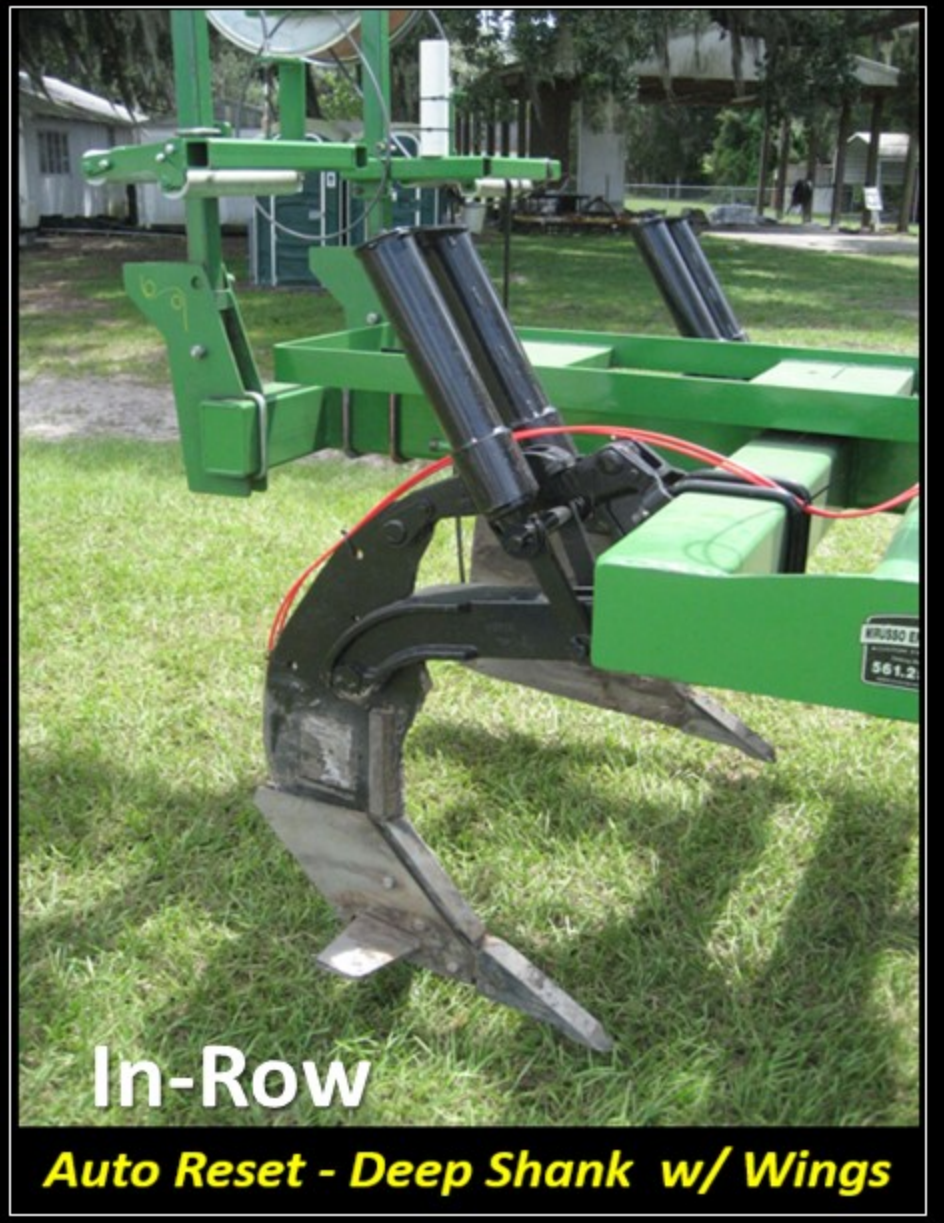


- Every berry field has a Traffic Pan at 8-10" depth
- Nematodes well distributed to soil depths of 48" (or more)
- Fumigant gases do not diffuse beyond Traffic Pan

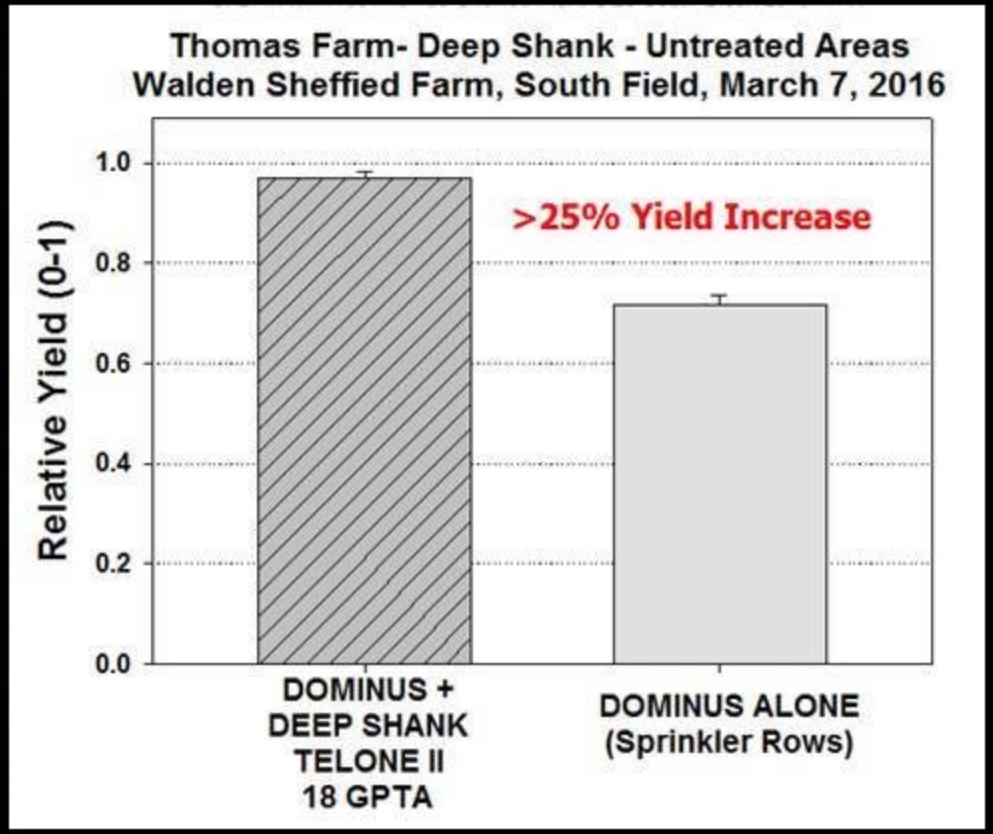
Slide credit: J. Noling

Deep Shank Telone II was either broadcast or In-Row applied at 18 gpta in advance or at bedding using resettable chisel plows to a 16-18” depth.



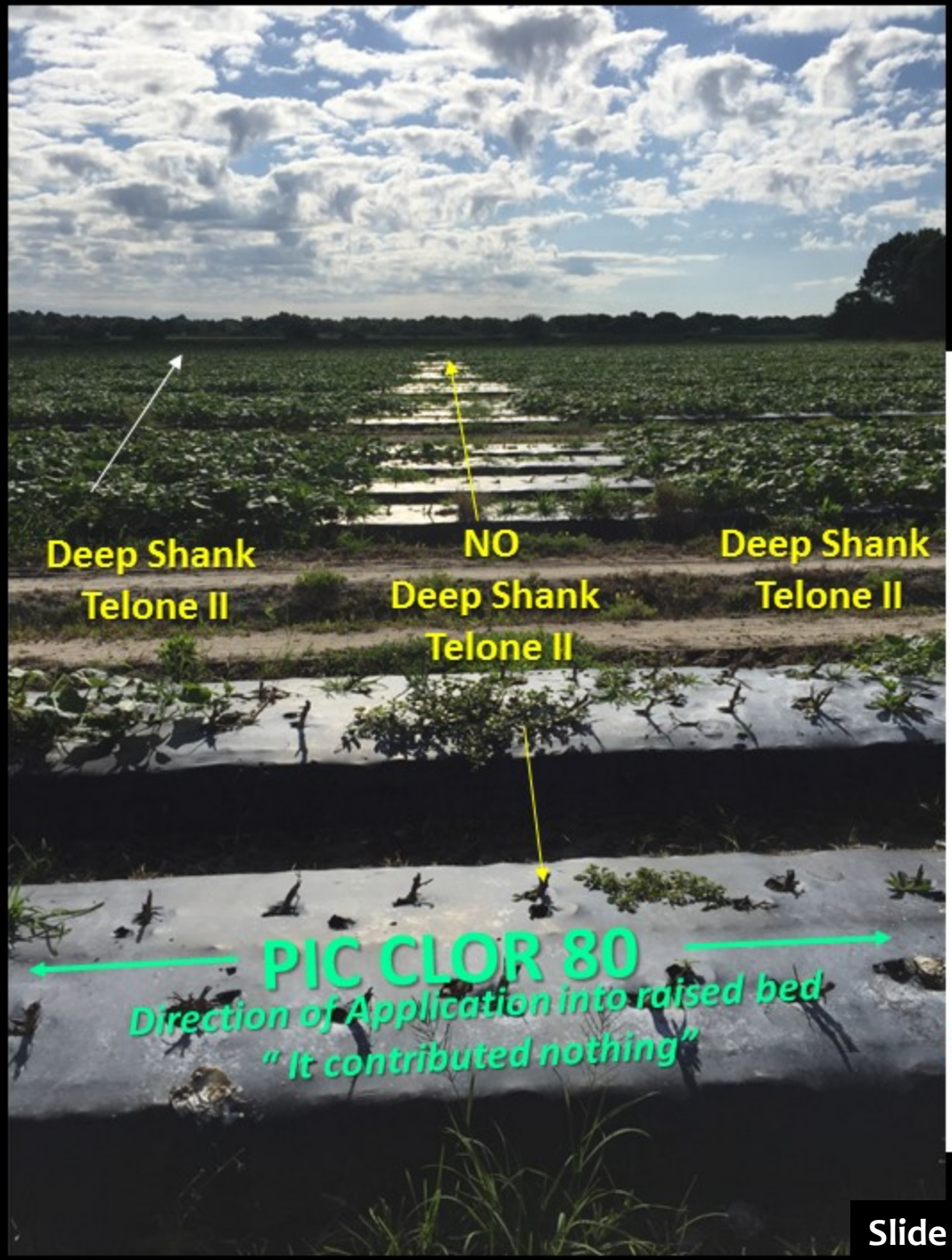


Thomas South Field -Spring 2016

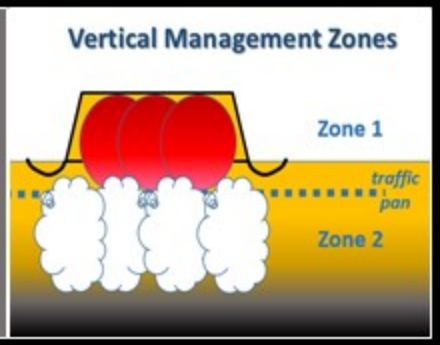


25% Increase in Yield

Slide credit: J. Noling



50 acre field
Pickling Cucumbers
Parrish, FL
Feb 2017



A strip across a field of pickles which received No broadcast Deep Shank fumigate treatment prior to receiving the in-bed applied PIC CLOR 80 fumigant treatment at bedding. Root knot nematode is the causal agent for such death & destruction.

A clear demonstration of the absence of nematodes in the bed, and value of deep shank treatment and origins of nematodes.

Slide credit: J. Noling


What about tomato fields impacted
by multi-pest complexes?
Fusarium wilt and root knot nematodes?

Deep Shank Telone - Nematodes

Deep Shank Telone II broadcasted (12 GPTA) in strips 1-month prior to bedding. Field received > 6” of rain 2 days afterwards!!

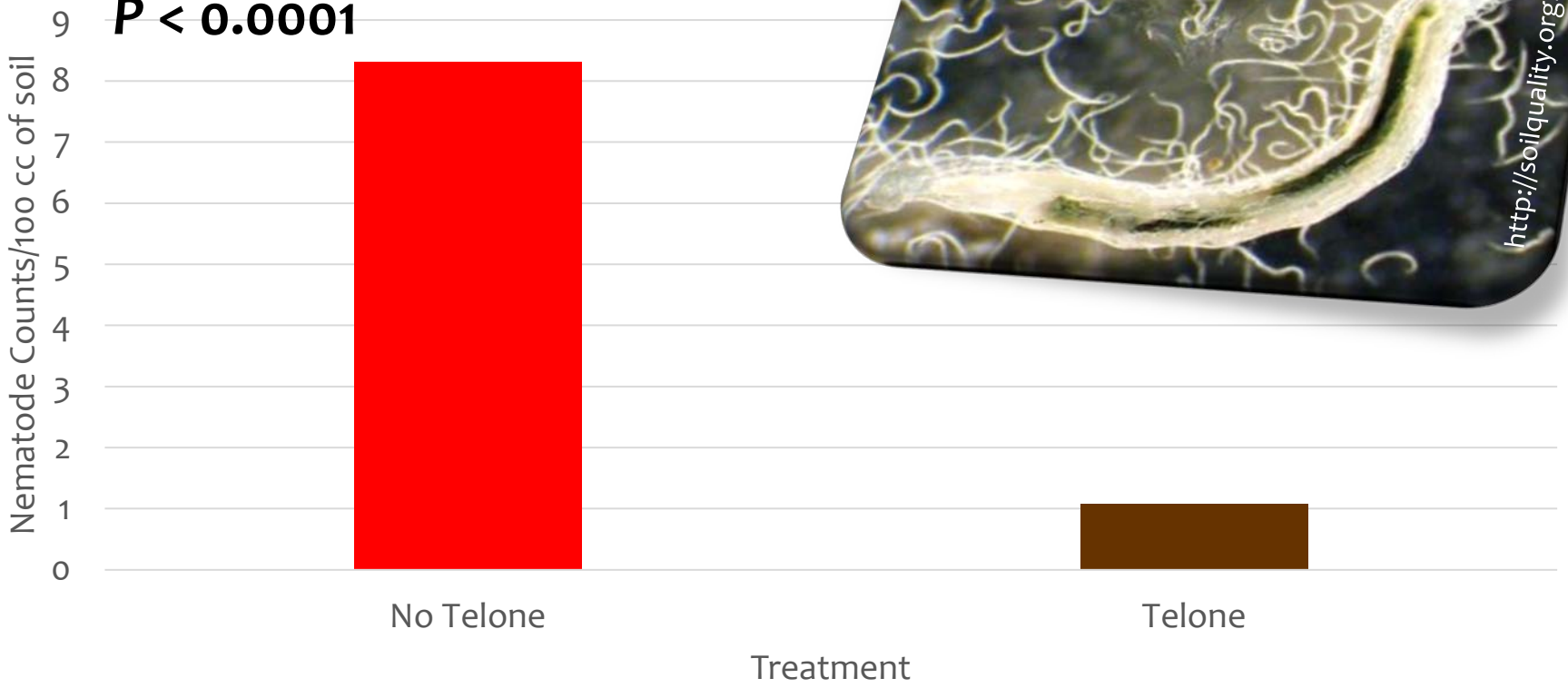
Deep Shank Telone - Nematodes

- Replicated trials on four separate ~20 Acre fields
- Treatments
  - Deep Shank Telone (12 gpta) – 50 ft strips
  - Non-treated Control
- Pre-plant soil cores were taken two weeks after Telone applications
- Cores averaged about 2.5 feet deep
- Cores were sent away for nematode counts

Deep Shank Telone - Nematodes

Pre-Plant Soil Cores

***P* < 0.0001**



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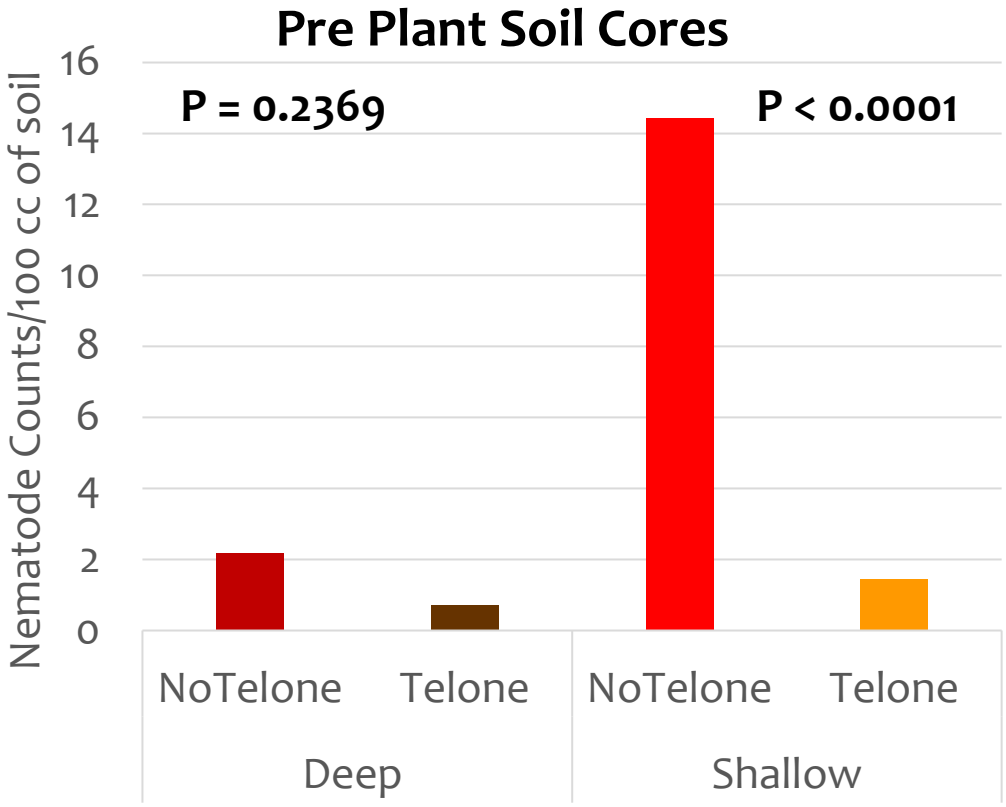
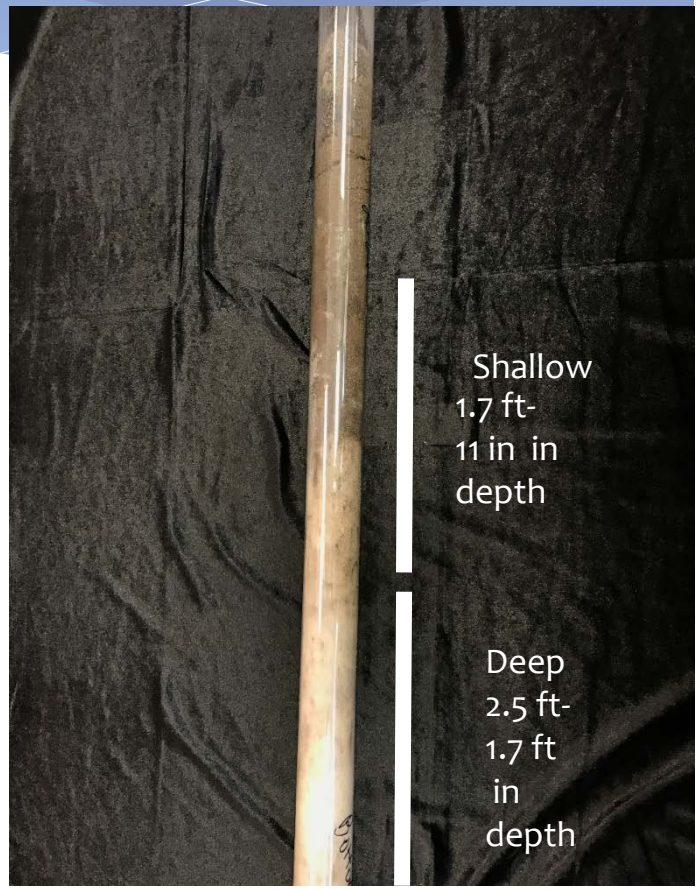




Deep Shank Telone - Nematodes

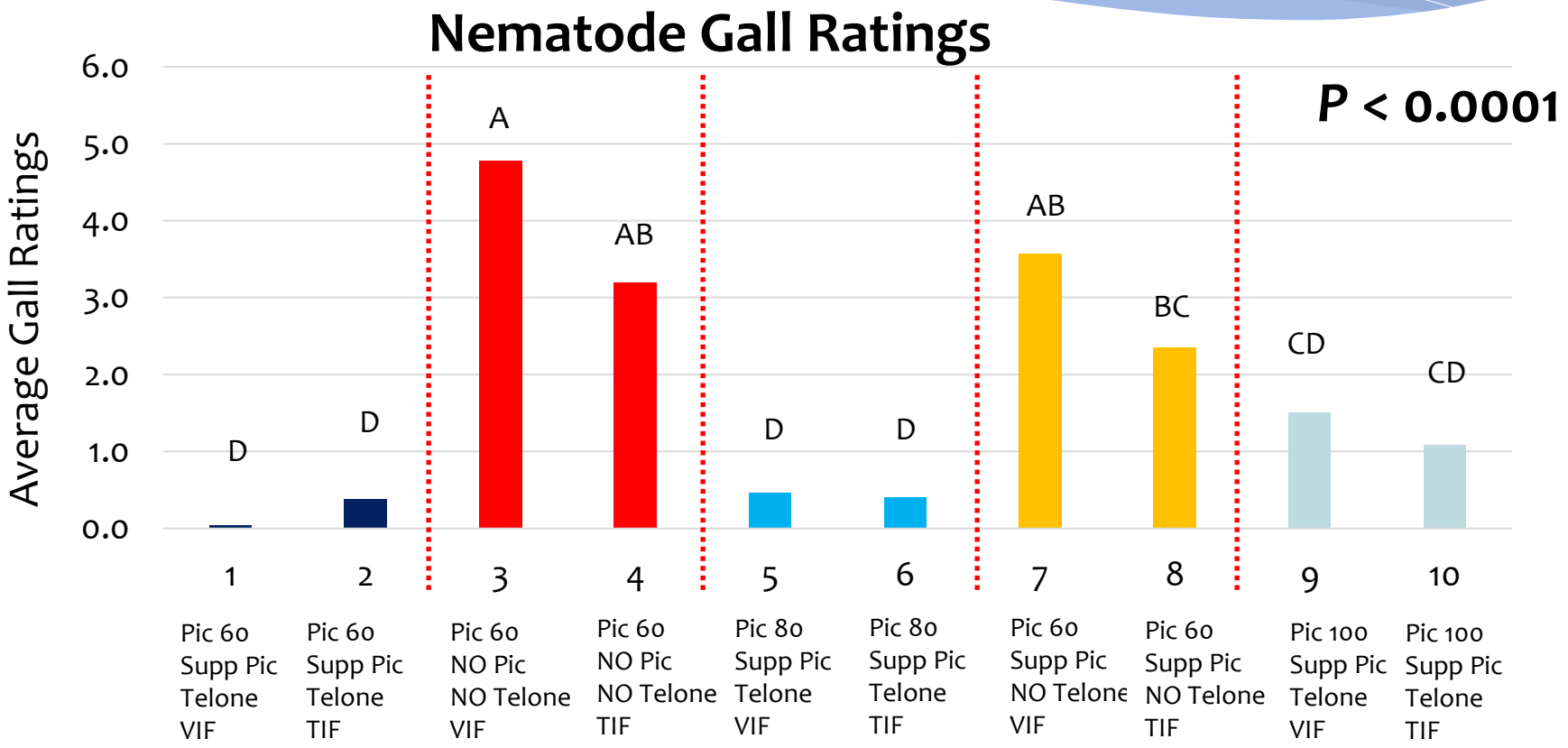
Systems Field Trials

Treatment	In Bed Fumigant	Supplemental Chloropicrin	Deep Shank Telone	Film
1	PicChlor 60	+	+	VIF
2	PicChlor 60	+	+	TIF
3	PicChlor 60	-	-	VIF
4	PicChlor 60	-	-	TIF
5	PicChlor 80	+	+	VIF
6	PicChlor 80	+	+	TIF
7	PicChlor 60	+	-	VIF
8	PicChlor 60	+	-	TIF
9	Pic 100	+	+	VIF
10	Pic 100	+	+	TIF

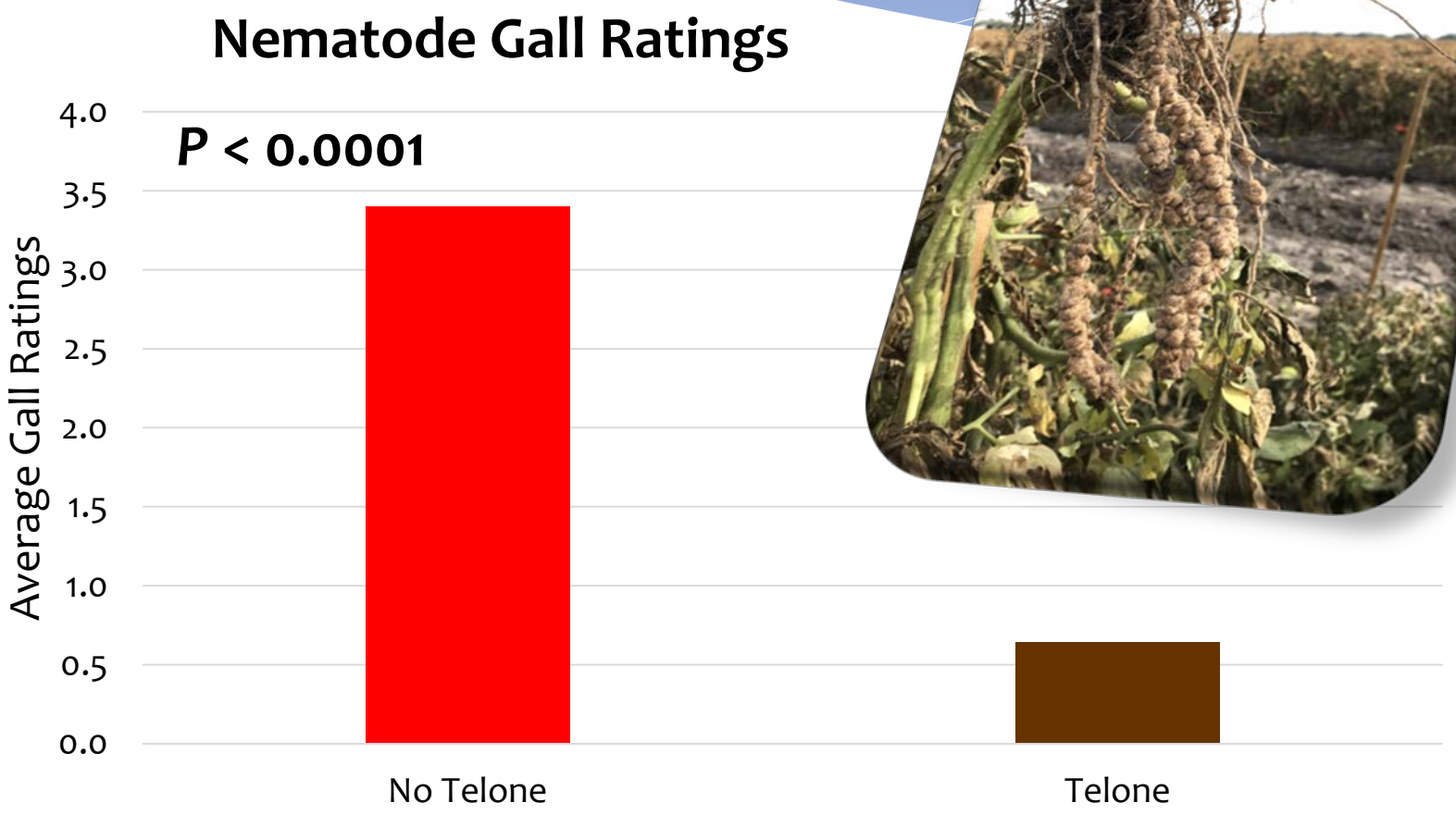
Systems Field Trials

* Plots consisted of three rows that were ~600 ft in length (1/4 Acre)
* Plots were laid out in a randomized complete block design and replicated 5 times
* Fusarium wilt Incidence, Nematode Gall Ratings and Yields were collected

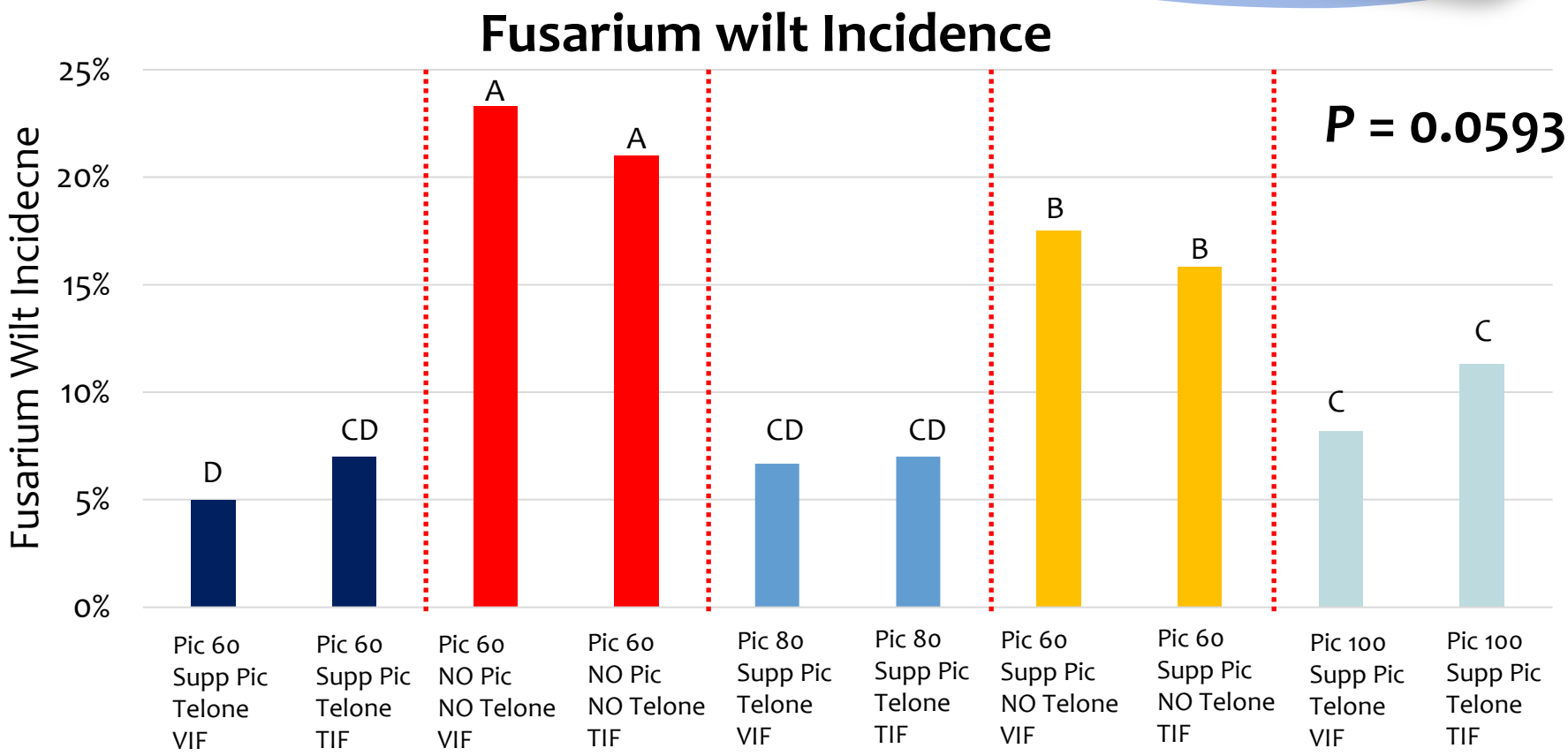
Systems Field Trials



Deep Shank Telone - Nematodes



Systems Field Trials



Deep Shank Telone - Nematodes

Systems Trials

- Deep shank Telone applications reduced nematode counts and gall ratings… AS EXPECTED
- PicChlor 60 or 80 with Supplemental Pic and Deep Shank Telone application are the best at reducing Fusarium wilt… UNEXPECTED

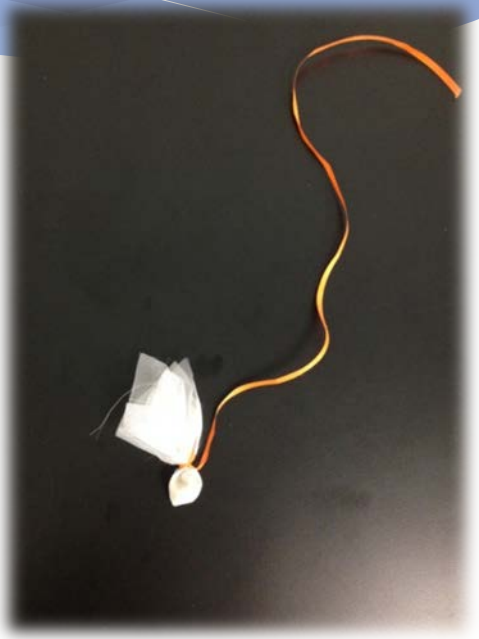
Deep Shank Telone - Nematodes

Systems Trials

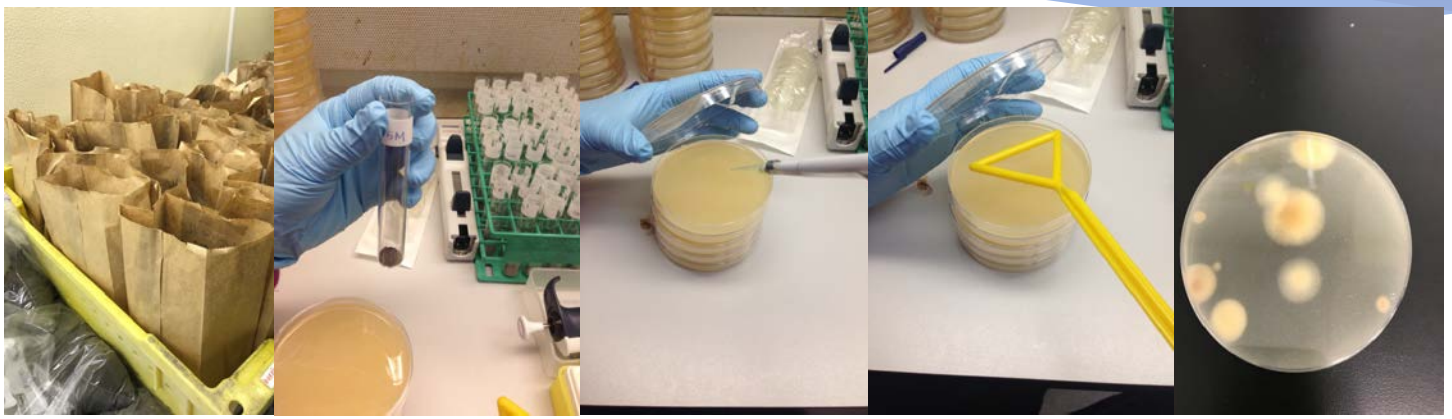
- Deep shank Telone applications reduced nematode counts and gall ratings… AS EXPECTED
- PicChlor 60 or 80 with Supplemental Pic and Deep Shank Telone application are the best at reducing Fusarium wilt… UNEXPECTED
- Telone also reduced Fusarium wilt incidence… not sure why?
  - Direct: Is Telone II fungicidal?
  - Indirect: Due to a reduction in nematode activity?

Evaluating the fungicidal activity of Telone II against Fusarium oxysporum

* Jar Experiment with pasteurized soil
* Fumigation rates were calculated based on the volume of treated soil
* Rates tested were
  * 100% - 25.0 GPA
  * 75.0% - 18.8 GPA
  * 50.0% - 12.5 GPA
  * 37.5% - 9.4 GPA
  * 25.0% - 6.3 GPA
  * 12.5% - 3.1 GPA



Evaluating the efficacy of Telone II to Fusarium wilt



* Bags are dried and levels of viable FOL determined by plating serial dilutions onto a semi-selective media

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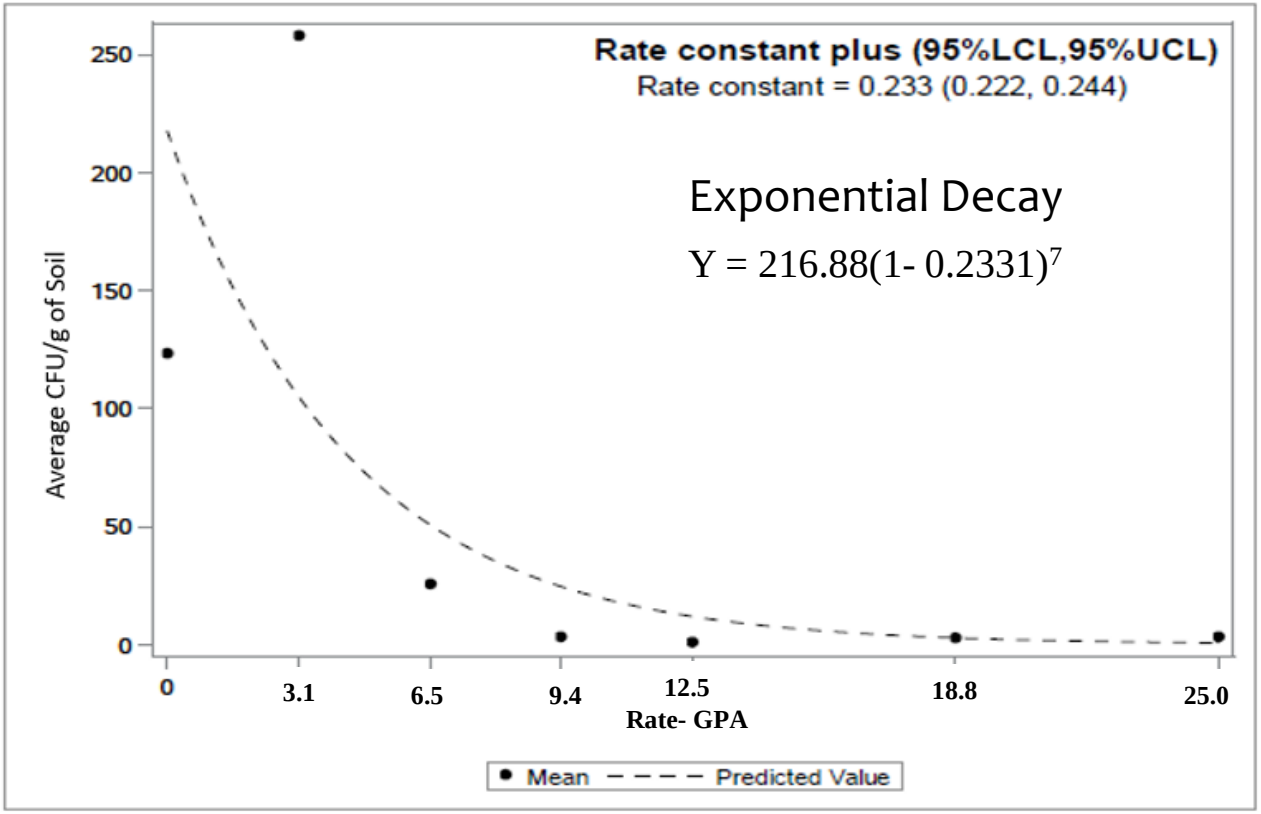


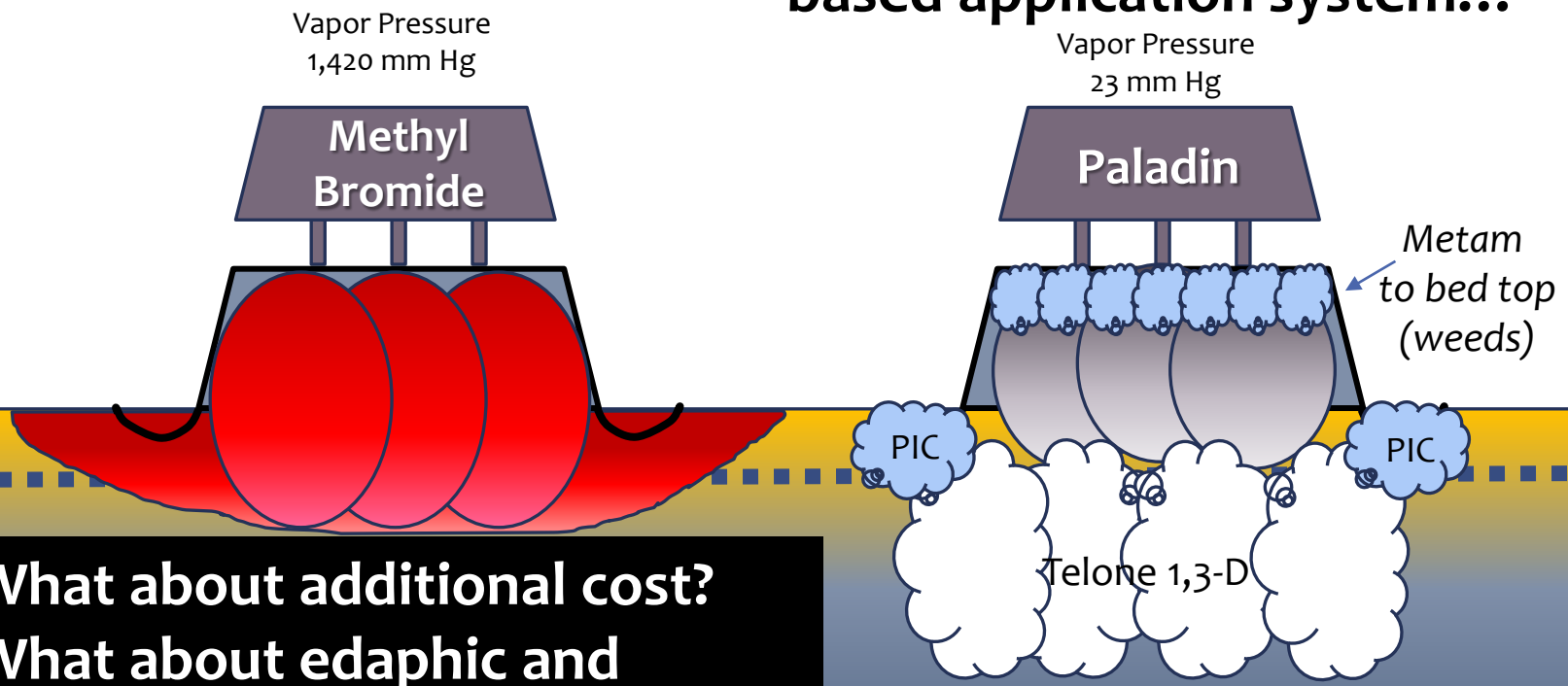
Telone II is fungicidal to *Fusarium oxysporum!*

Parameter	Estimate	Standard Error	DF	tValue	Probt	Alpha	Lower	Upper
Y Intercept[1]	217.77	4.8921	53	44.51	0.0001	0.05	212.94	223.81
Slope (b)[2]	0.2331	0.005642	53	41.32	0.0001	0.05	0.219	0.2297
Residual	5.3474	4.4282	53	1.21	0.2326	0.05	-3.534	14.2292

Vertical Management Zones

Noling, Vallad, & Boyd Contributions

A prescription, precision-based application system…



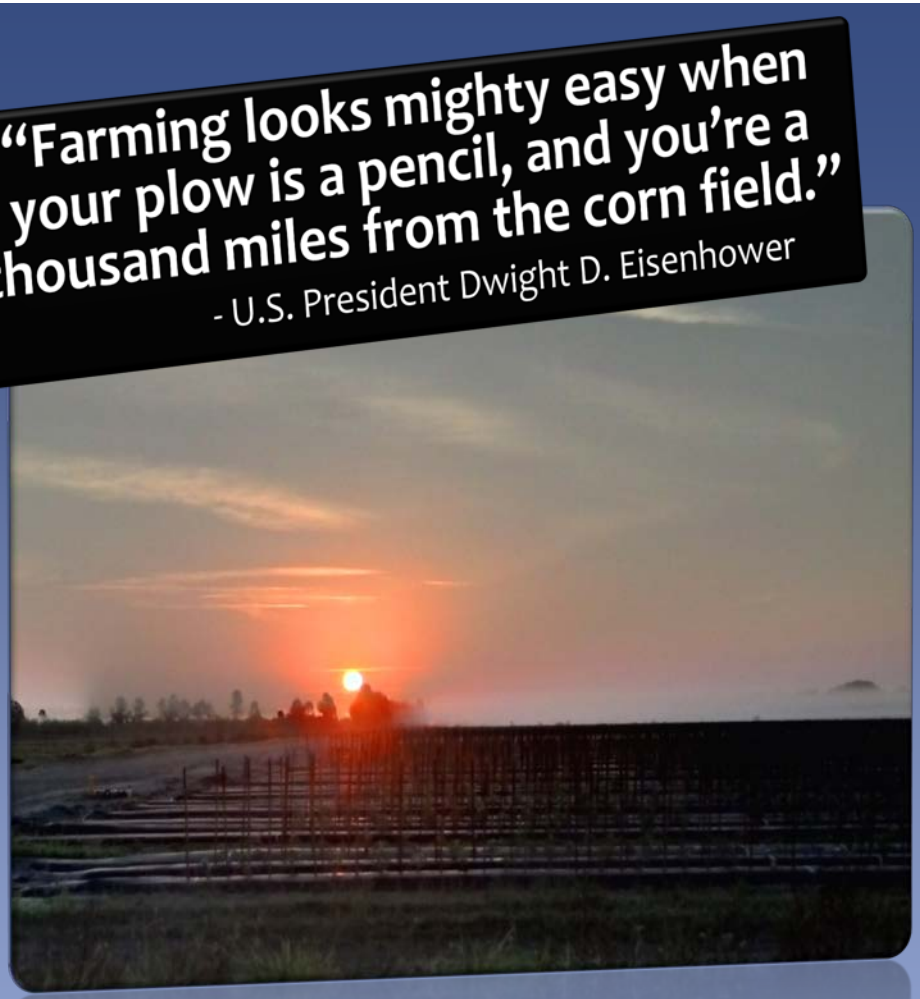
What about additional cost?
What about edaphic and environmental factors?

Yield Increases of 25% and more

ADOPTION of NEW EQUIPMENT for PRECISION PLACEMENT APPLICATIONS

Investment in new equipment!

Slide credit: J. Noling



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