SUPPLEMENTAL FUMIGATION STRATEGIES FOR THE MANAGEMENT OF SOILBORNE DISEASES IN TOMATO PRODUCTION

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Why do we fumigate?

* Soil Fumigation:

  Reduce soil levels of

  * Weeds
  * Nematodes
  * Soilborne pathogens

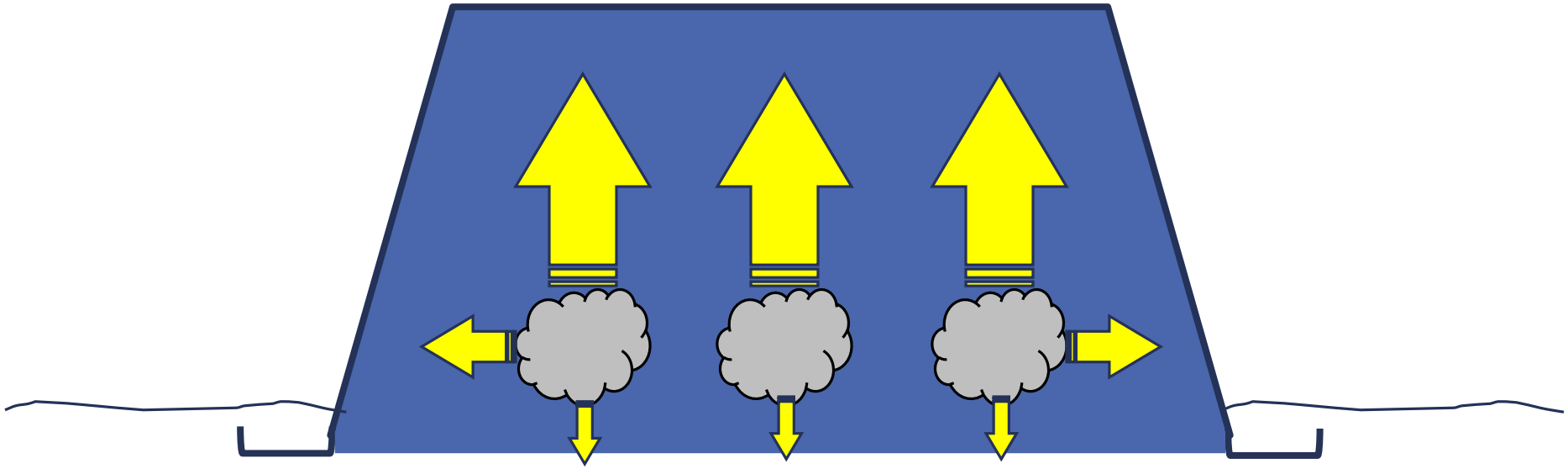
  to an acceptable level that limits crop losses.

Long-term Research Goals

* Since transitioning away from MBr growers have observed: (confirmed by UF investigators)
  * ↑ Diseases caused by soilborne pathogens
    * Fusarium wilt
    * Fusarium crown and root rot
    * Southern blight
  * ↑ Nematodes
  * ↑ Weeds (nutsedge)
  * ↓ Crop vigor (lucky to get 3 picks off a crop).

Spring 2013 – Tomato Field with Fusarium Wilt – Manatee Co. FL

Identify weaknesses in current fumigation systems.

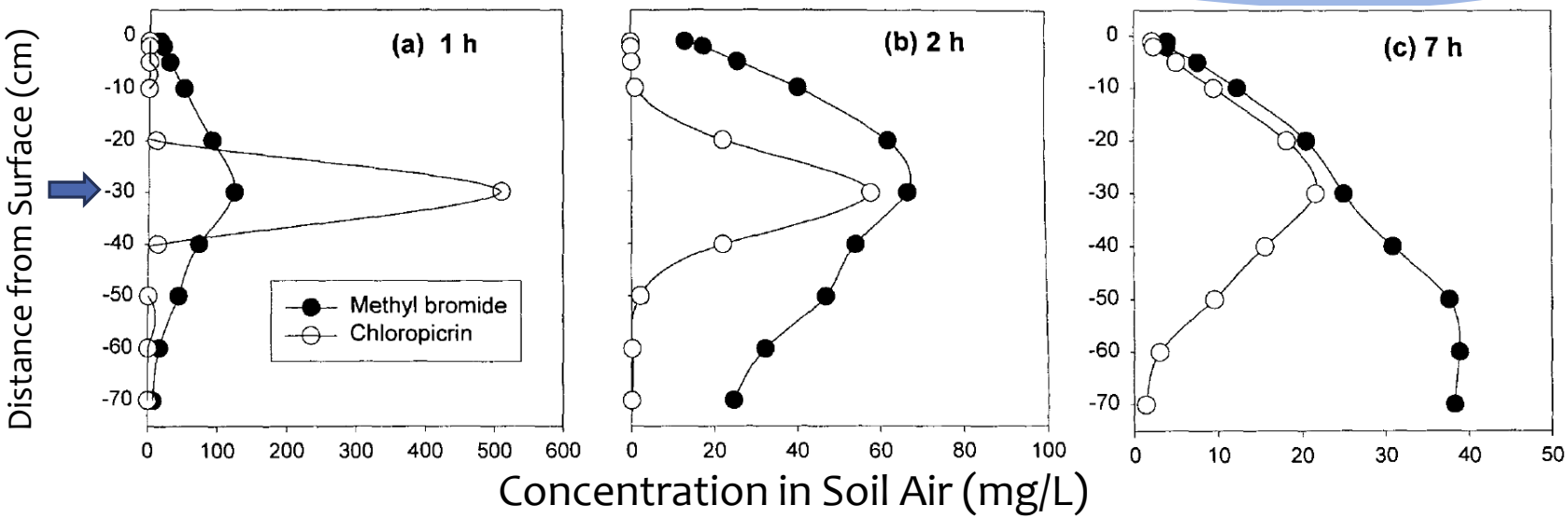


Identify weaknesses in current fumigation systems.

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

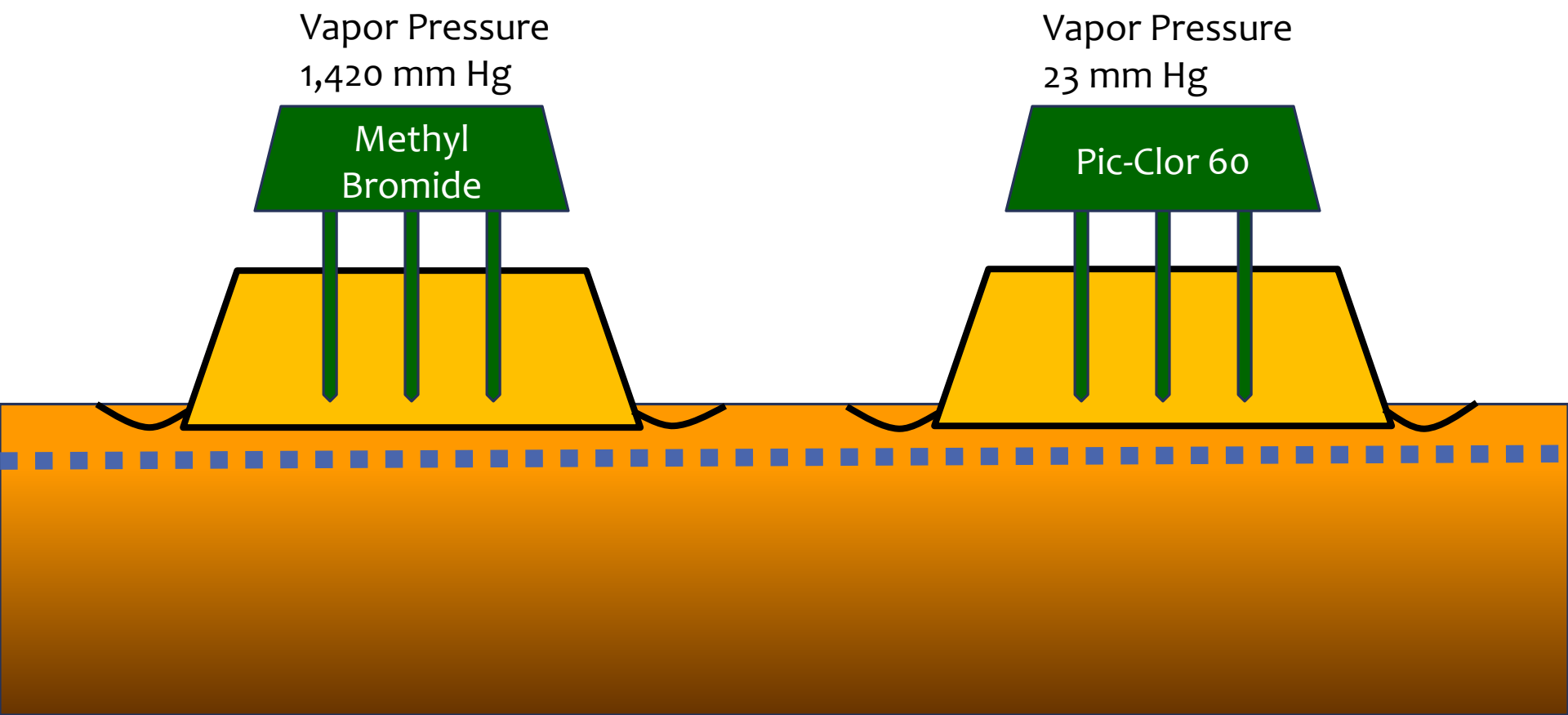
Identify weaknesses in current fumigation systems.

* Gan et al. 2000. J. Environ. Qual. 29:1391-1397.



* Distribution in an untarped column packed w/ sandy loam.
  * Pic degrades faster than MBr via microbial degradation
  * Pic degradation increases with soil temp.
  * Dispersal of MBr in soil is > 10^3 greater than Pic (Jury et al. 1997).

Identify weaknesses in current fumigation systems.



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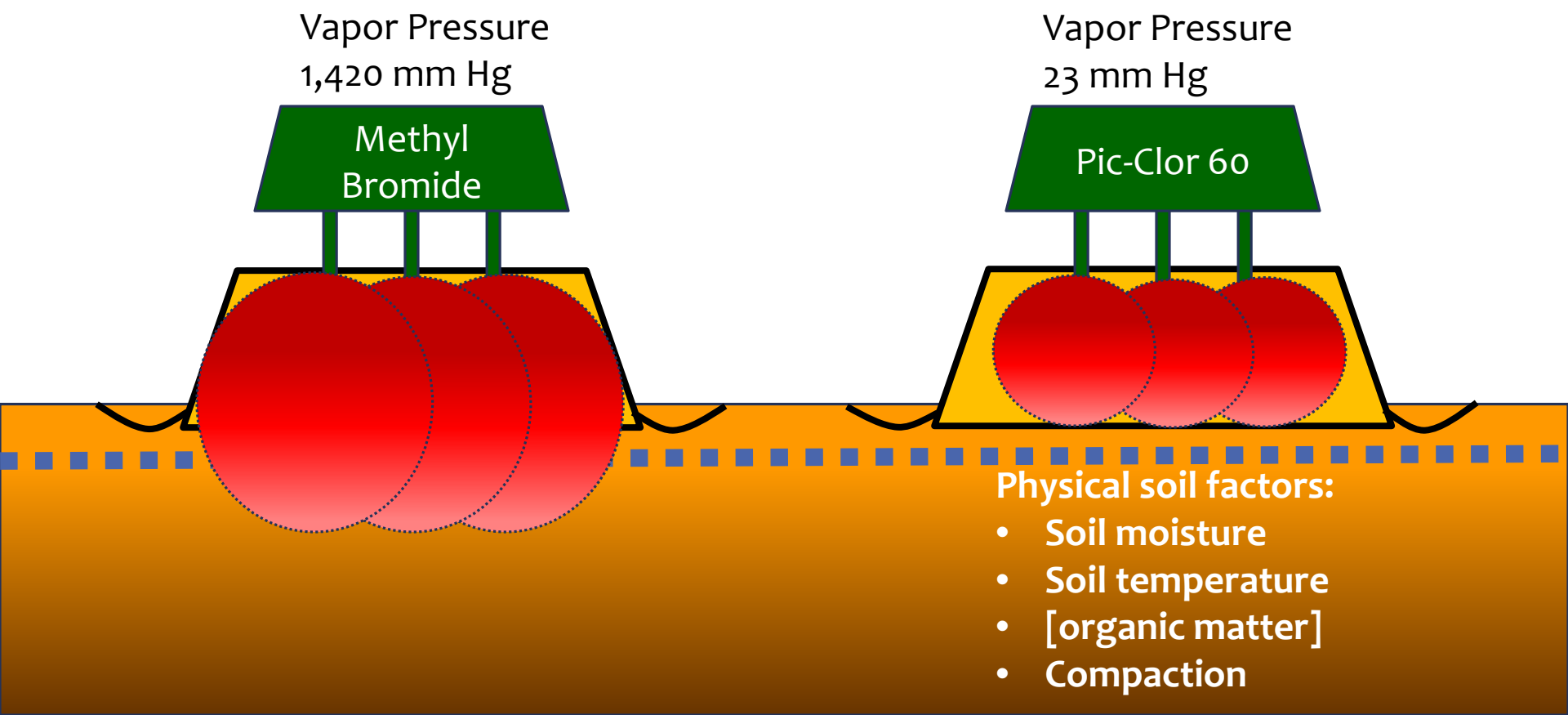


Physical soil factors:

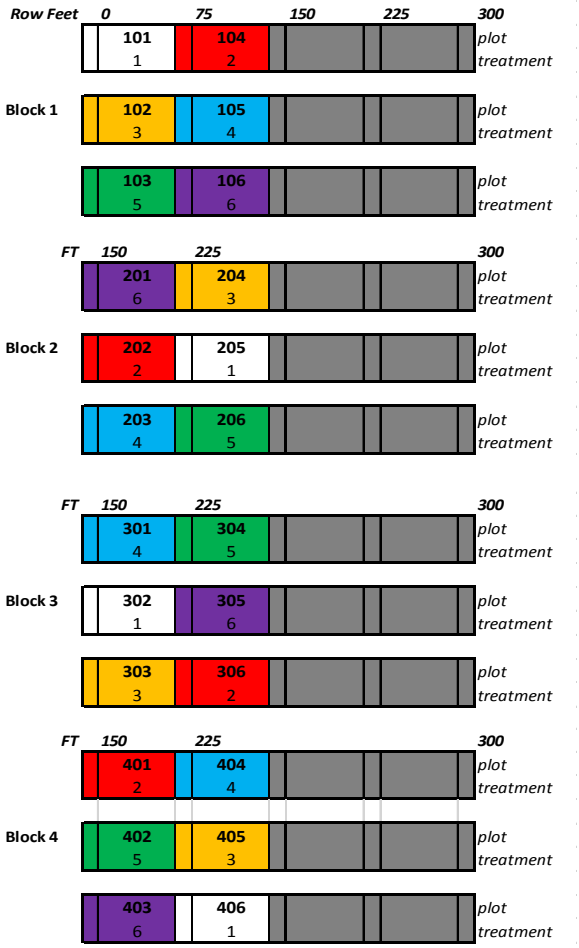
- **Soil moisture**
- **Soil temperature**
- **[organic matter]**
- **Compaction**

MBr Rescue Trials

Trials were established at GCREC as a last attempt to:

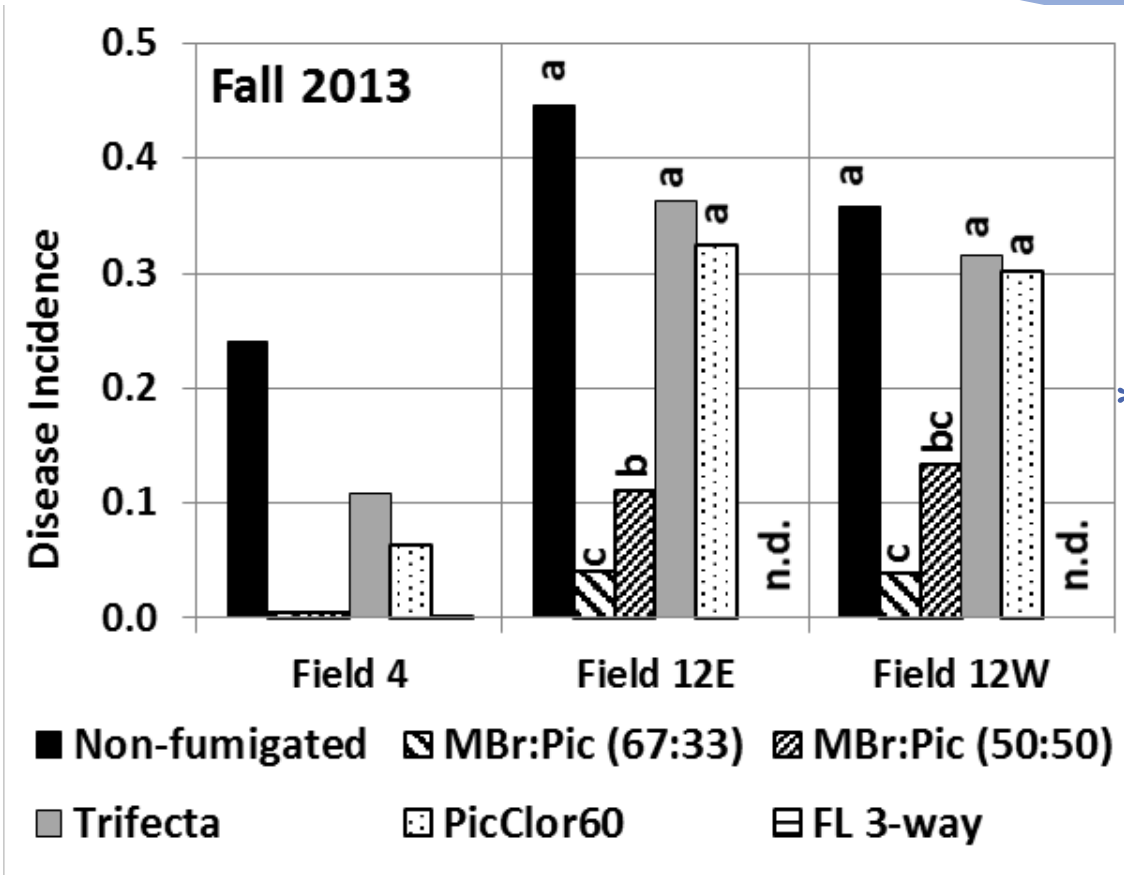
- Compare chemical alternatives to MBr
- Evaluate MBr as a crop rescue treatment for situations where the alternatives failed

GCREC Fumigant Trials



- Planned, multi-site studies at GCREC
  - 4 separate field sites
    - With varying pest & disease pressure
    - 1 inoculated site
  - 4 reps per treatment
  - 75 ft single bed plots
  - Fall & Spring trials…
  - PicClor60 (300 lbs); Trifecta (400 lbs); MBr:Pic (67:33 & 50:50, 350 lbs); FL 3way (Telone II, 122 lbs; Pic, 150 lbs; Kpam, 60 gal)

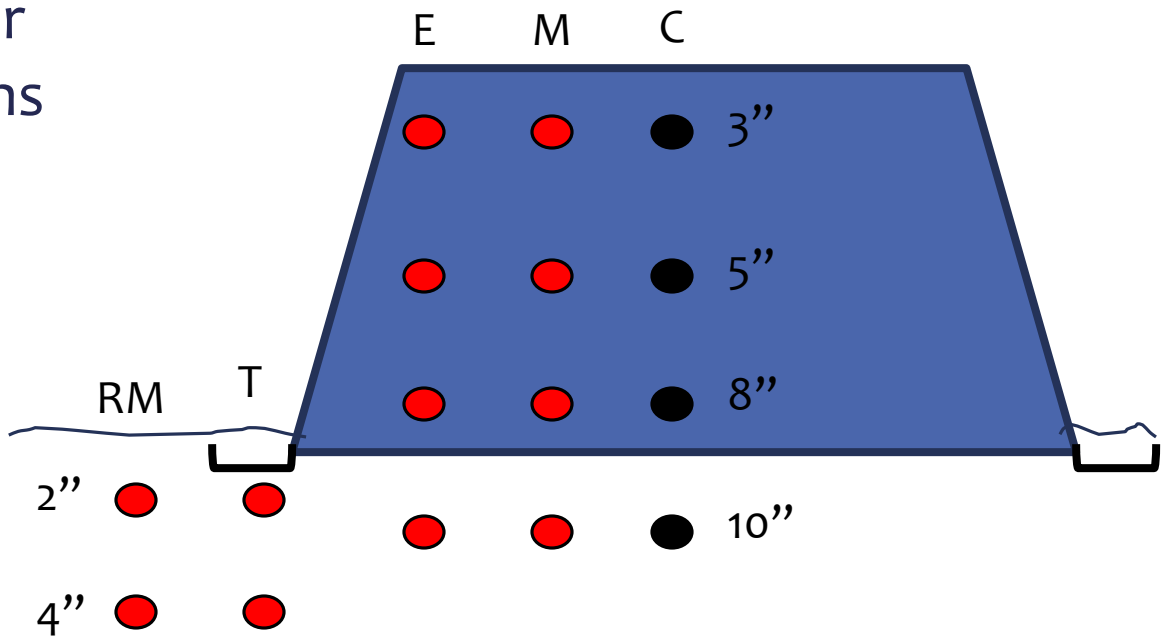
Soilborne Disease



* MBr 67:33 provided consistent control of Fusarium wilt and crown rot under field conditions. Other chloropicrin containing formulations failed…

Identify weaknesses in current fumigation systems.

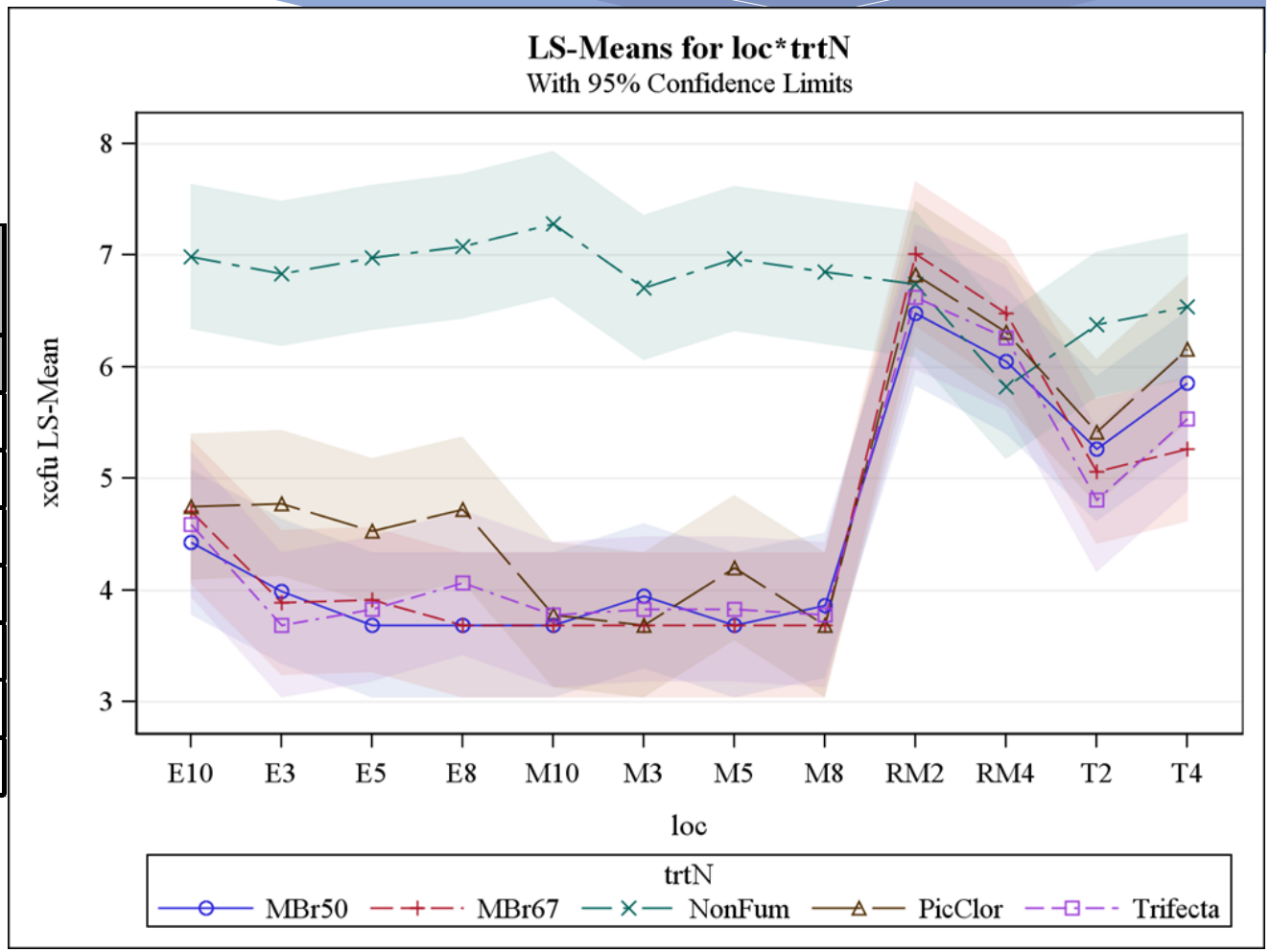
* Understand effective fumigation zone for soilborne pathogens
  * *Fusarium* spp.



Identify weaknesses in current fumigation systems.

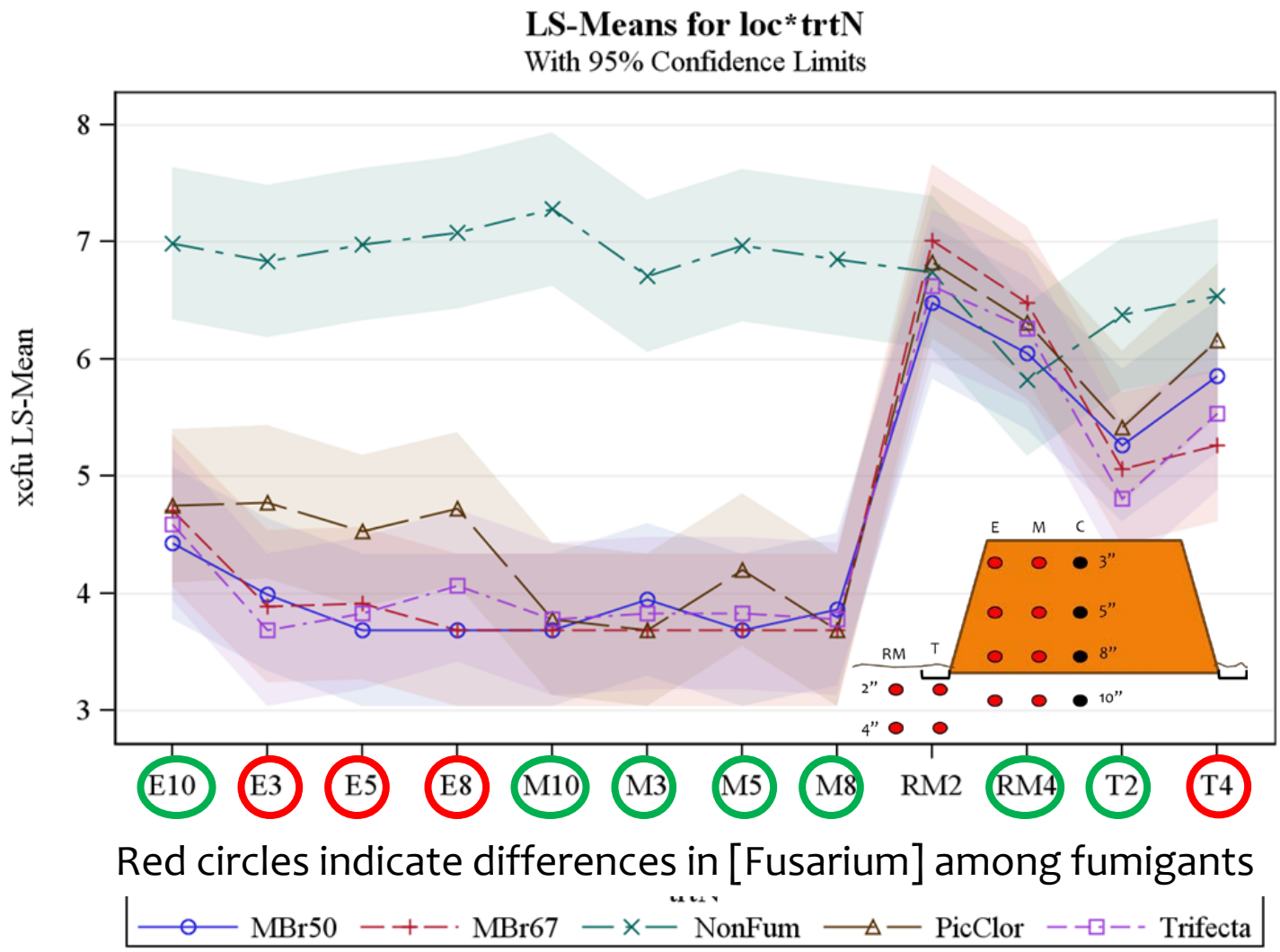
Recovery of total *Fusarium oxysporum* from soil samples

Type III Tests of Fixed Effects	
Effect	**Pr > F**
Field	0.9363
TRT	<.0001
Field*TRT	0.2896
Loc	<.0001
Field*Loc	0.7216
Loc*TRT	<.0001
Field*Loc*TRT	0.4649



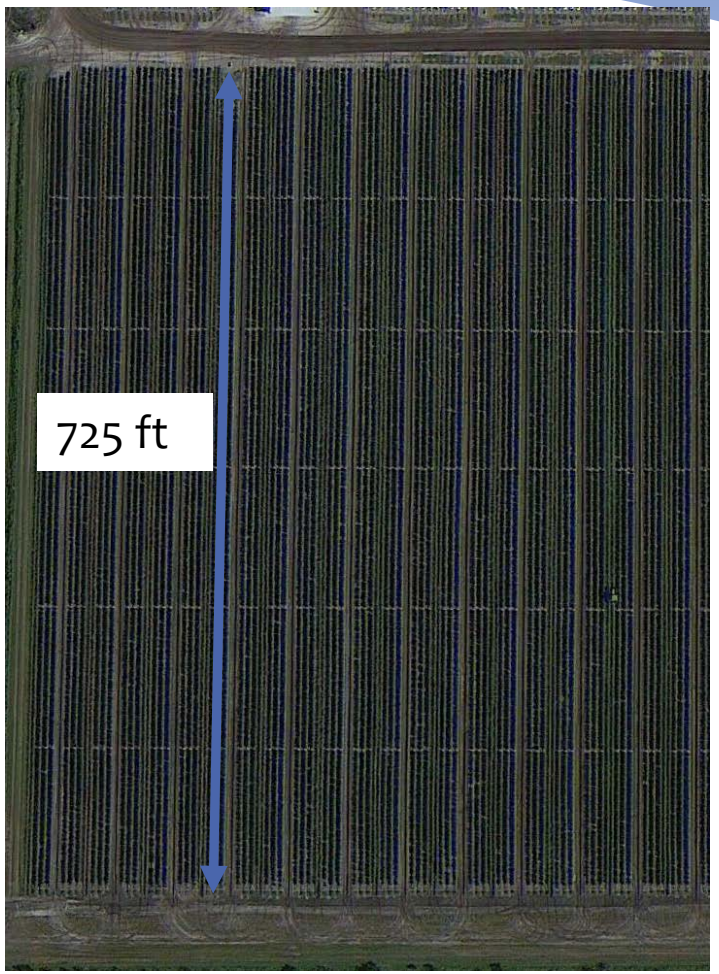
Identify weaknesses in current fumigation systems.

Effect Slices for Loc*TRT Sliced By Loc	
loc	**Pr > F**
M3	<.0001
M5	<.0001
M8	<.0001
M10	<.0001
E3	<.0001
E5	<.0001
E8	<.0001
E10	<.0001
RM2	0.8274
RM4	0.6577
T2	0.0105
T4	0.0537



Red circles indicate differences in [Fusarium] among fumigants

Florida Fumigant Studies



- Assess MBr at grower sites with specific disease/pest problems.
- Specific grower sites: MBr:Pic 67:33 & 50:50
  - 350 lbs/A.
  - Comparison to grower standard (PicClor60, 300 lbs/trtA)
  - Stripped applications
  - Varying plot dimensions; 3 raised beds (500 – 700ft row lengths)
  - 4 – 6 reps per treatment

Yes, MBr works!!!!

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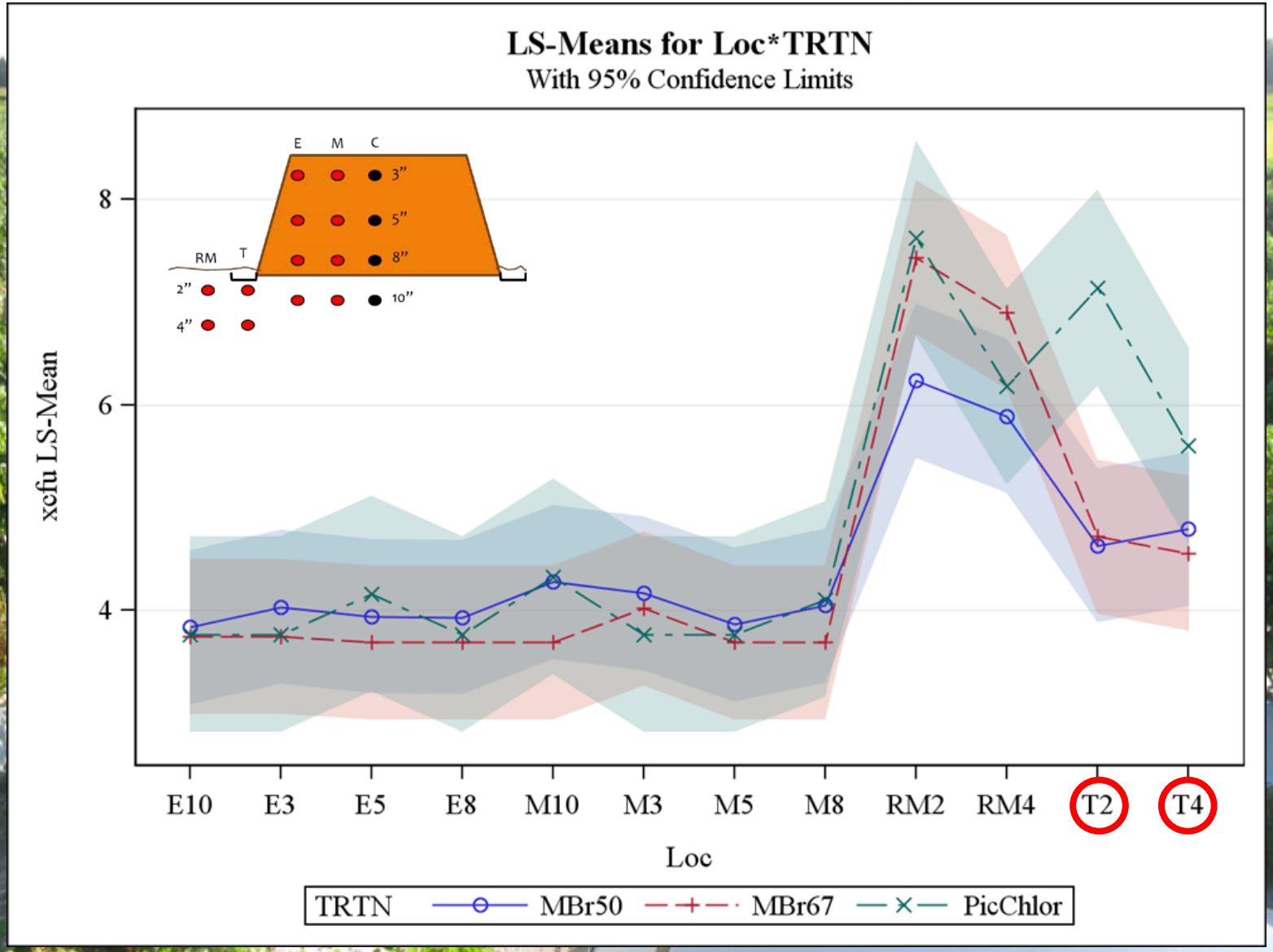
MBr:Pic 67:33
350 lbs/A

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

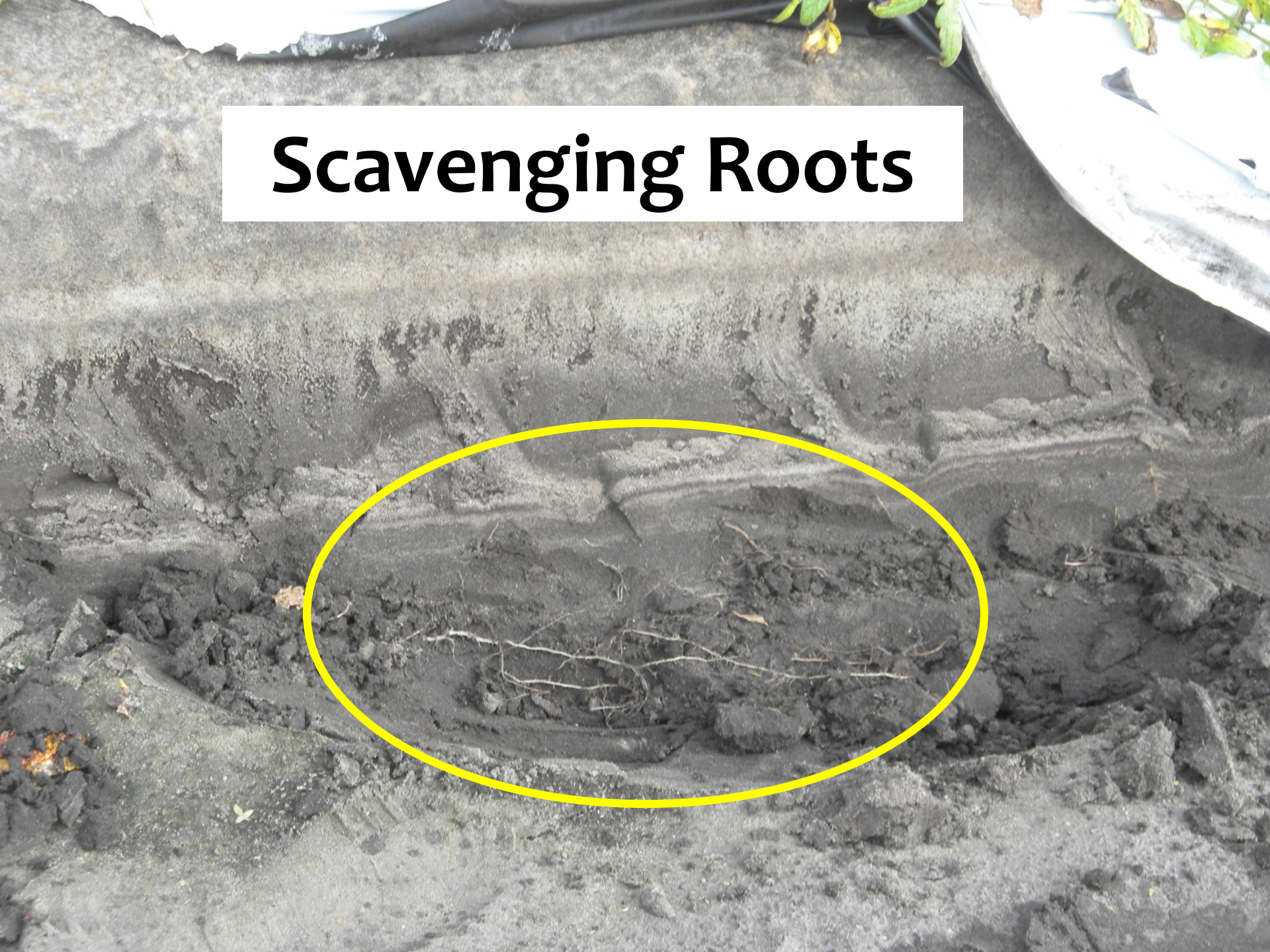
Pic-Clor 60
300 lbs/A

MBr:Pic 50:50
350 lbs/A

Yes, MBr works!!!!



Scavenging Roots



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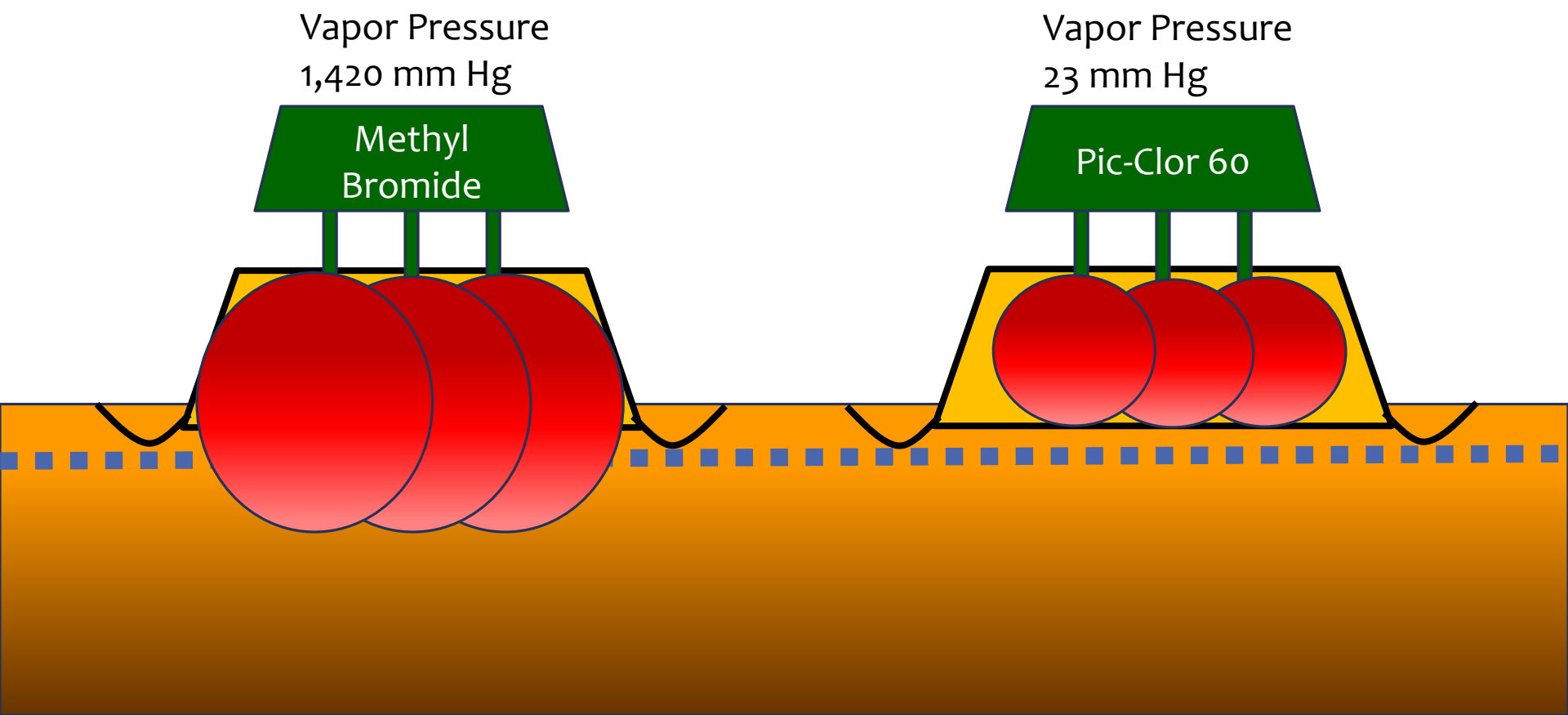

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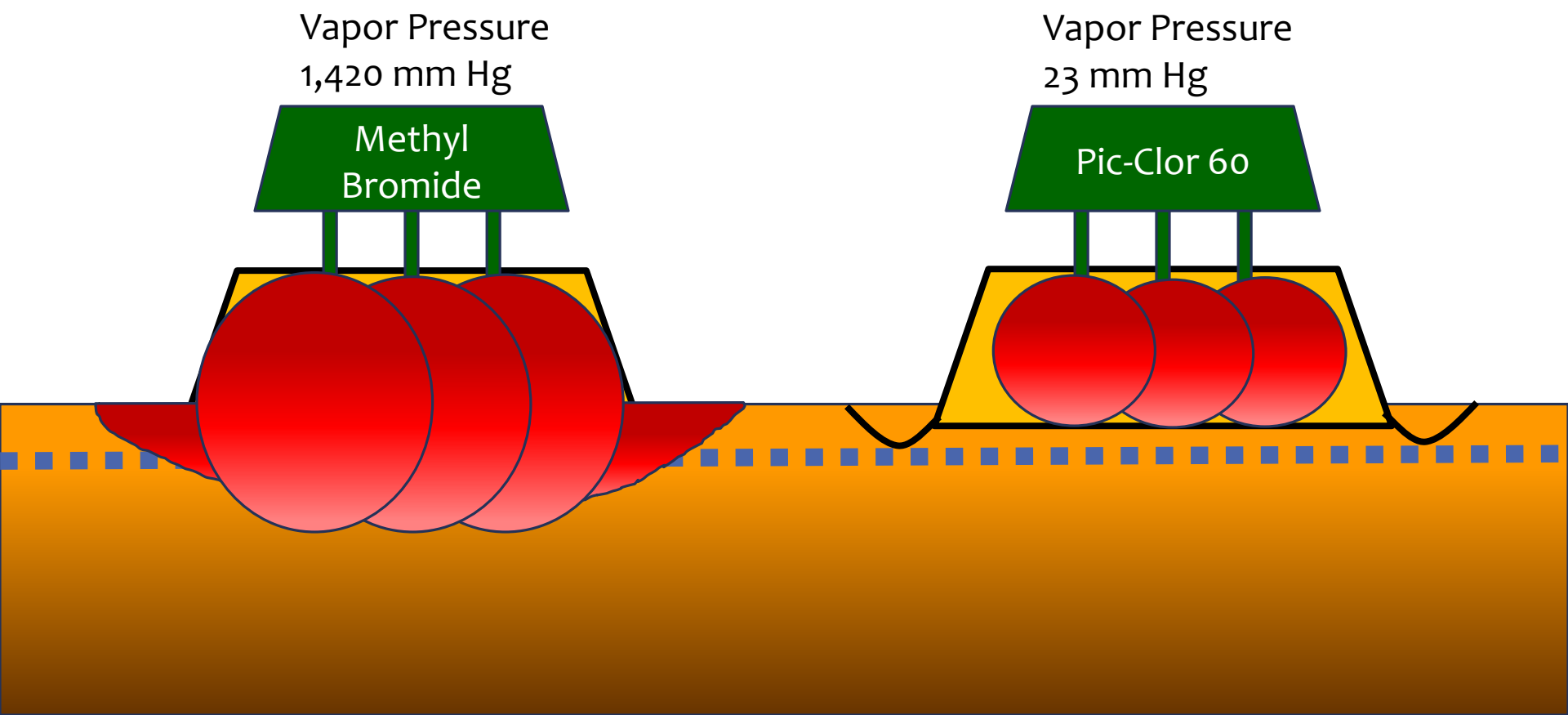

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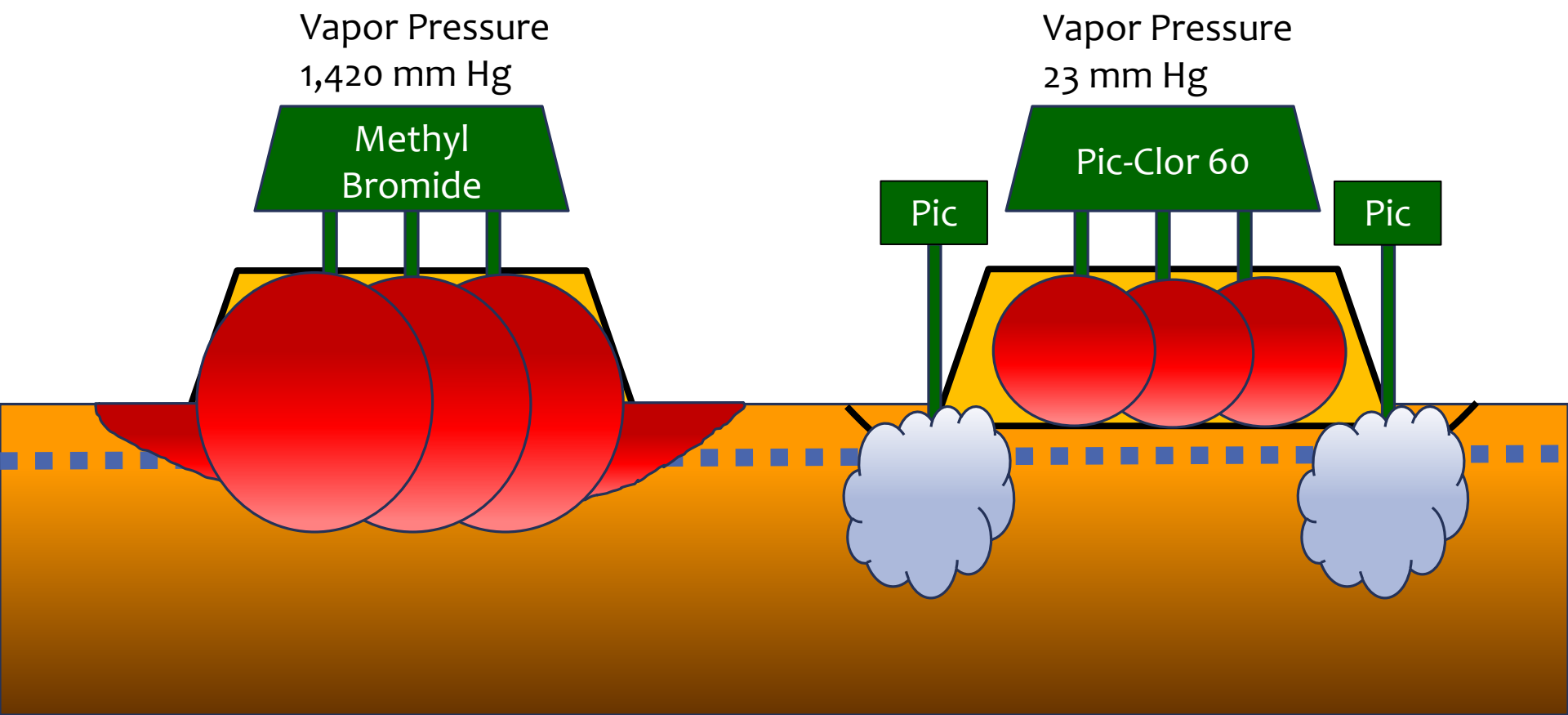
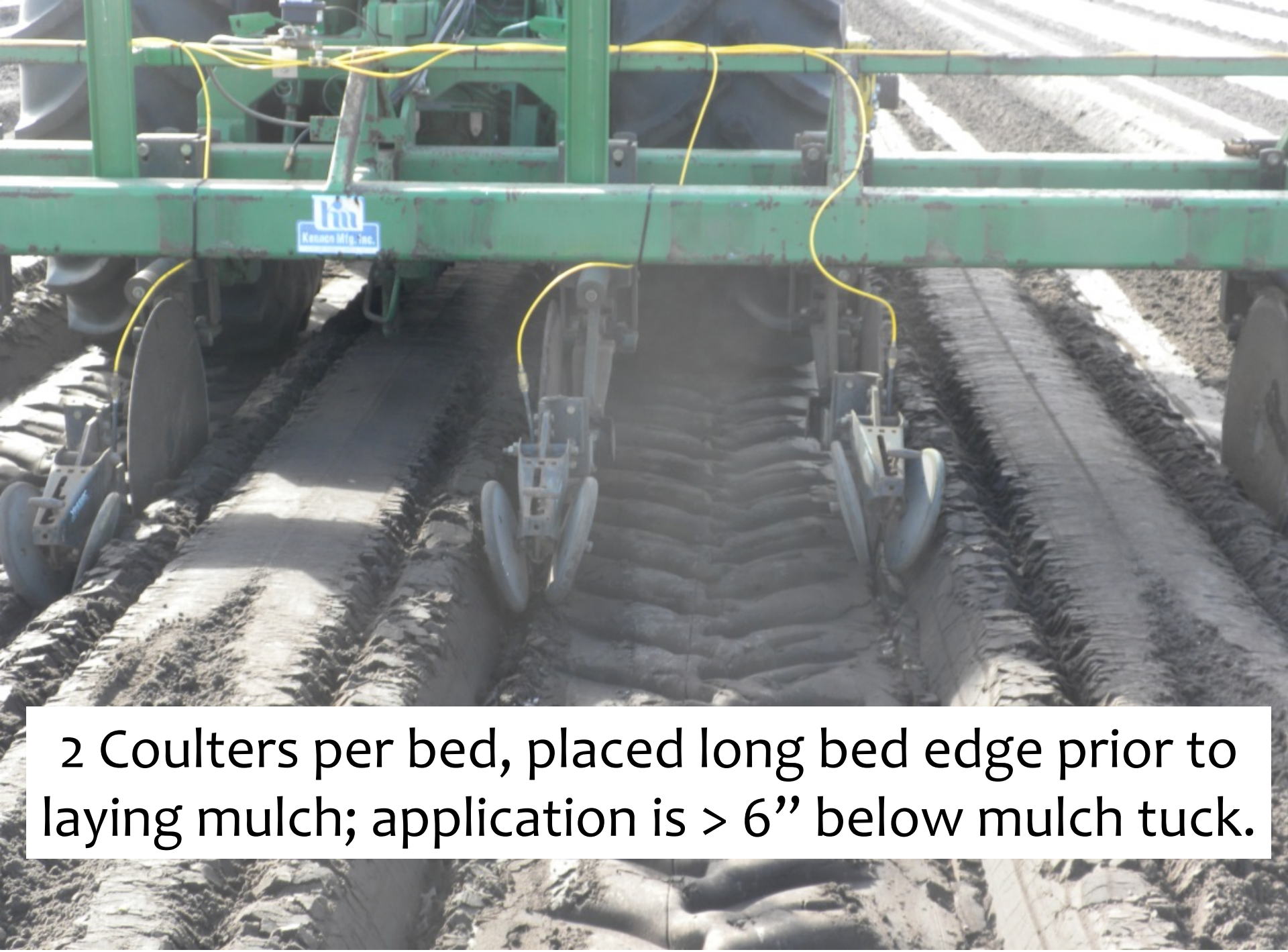
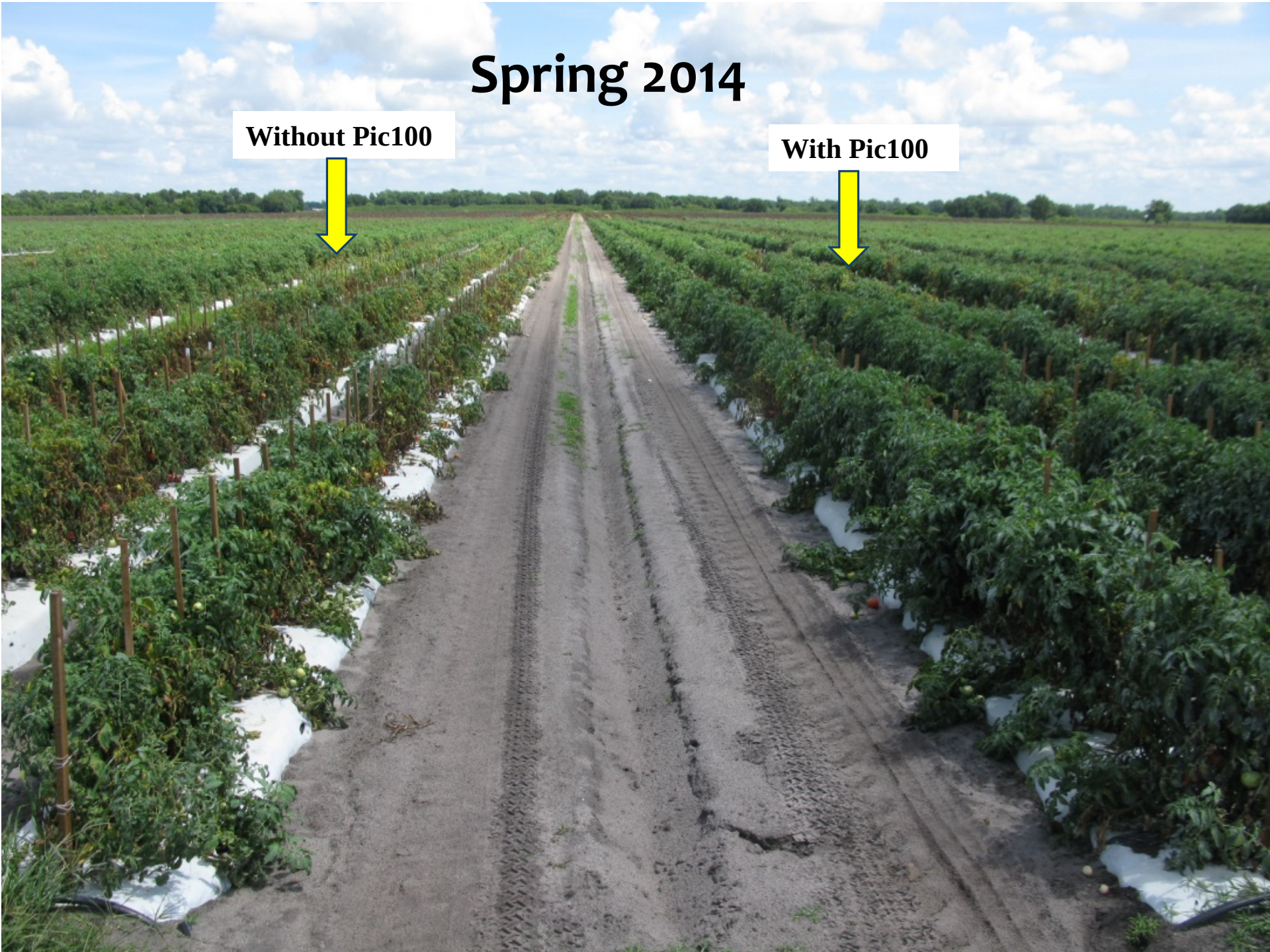


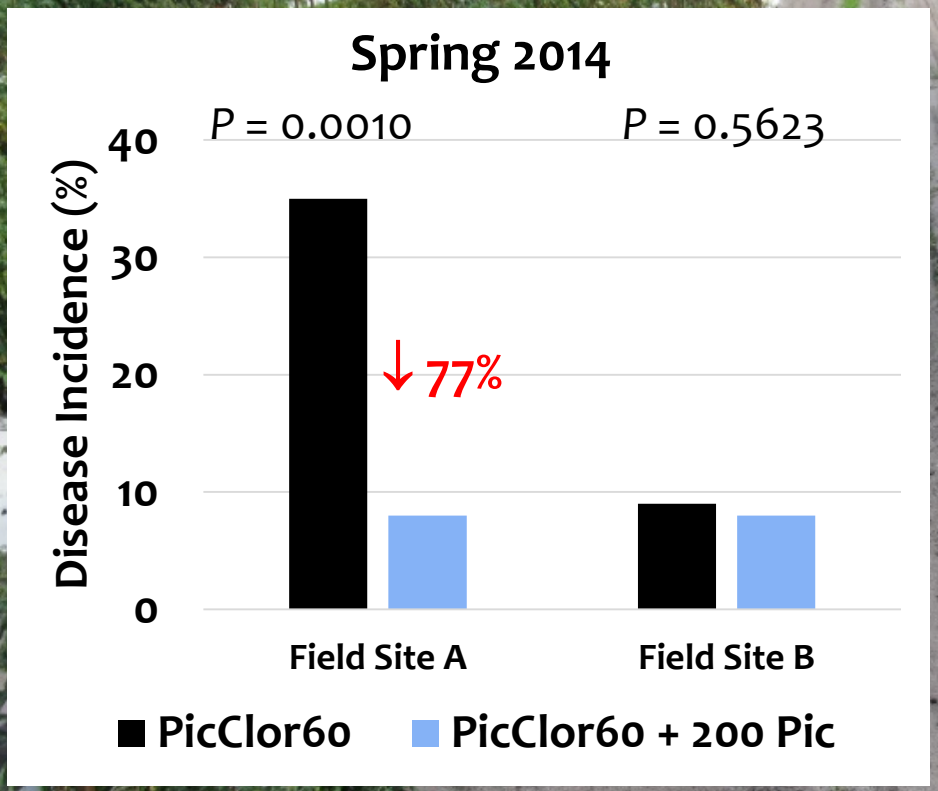
Supplemental applications of chloropicrin along bed edges for under-fumigated areas.

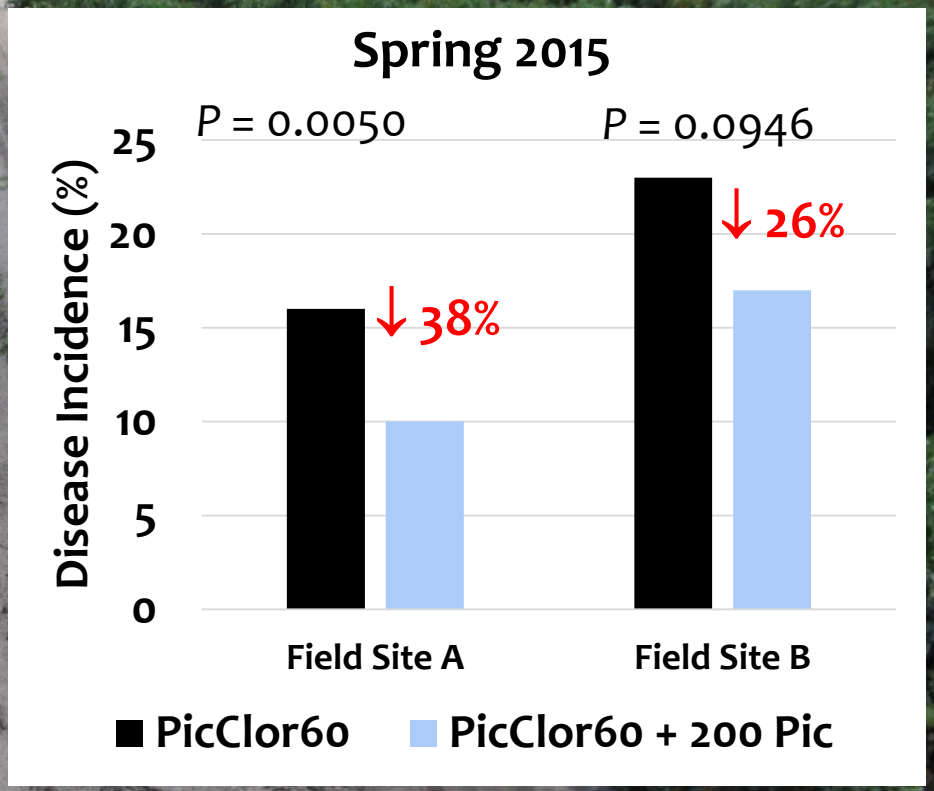
* Located at field with a known history of high levels of FOL
* Treatments:
  * 1) Pic-Clor 60 @ 300 lbs/Treated Acre
  * 2) Pic-Clor 60 @ 300 lbs/Treated Acre + Pic 100 @ 200 lbs/Treated Acre (Yetter rig)
* Plot size: 3 beds x 700 ft long; 6 Replications



2 Coulters per bed, placed long bed edge prior to laying mulch; application is > 6” below mulch tuck.

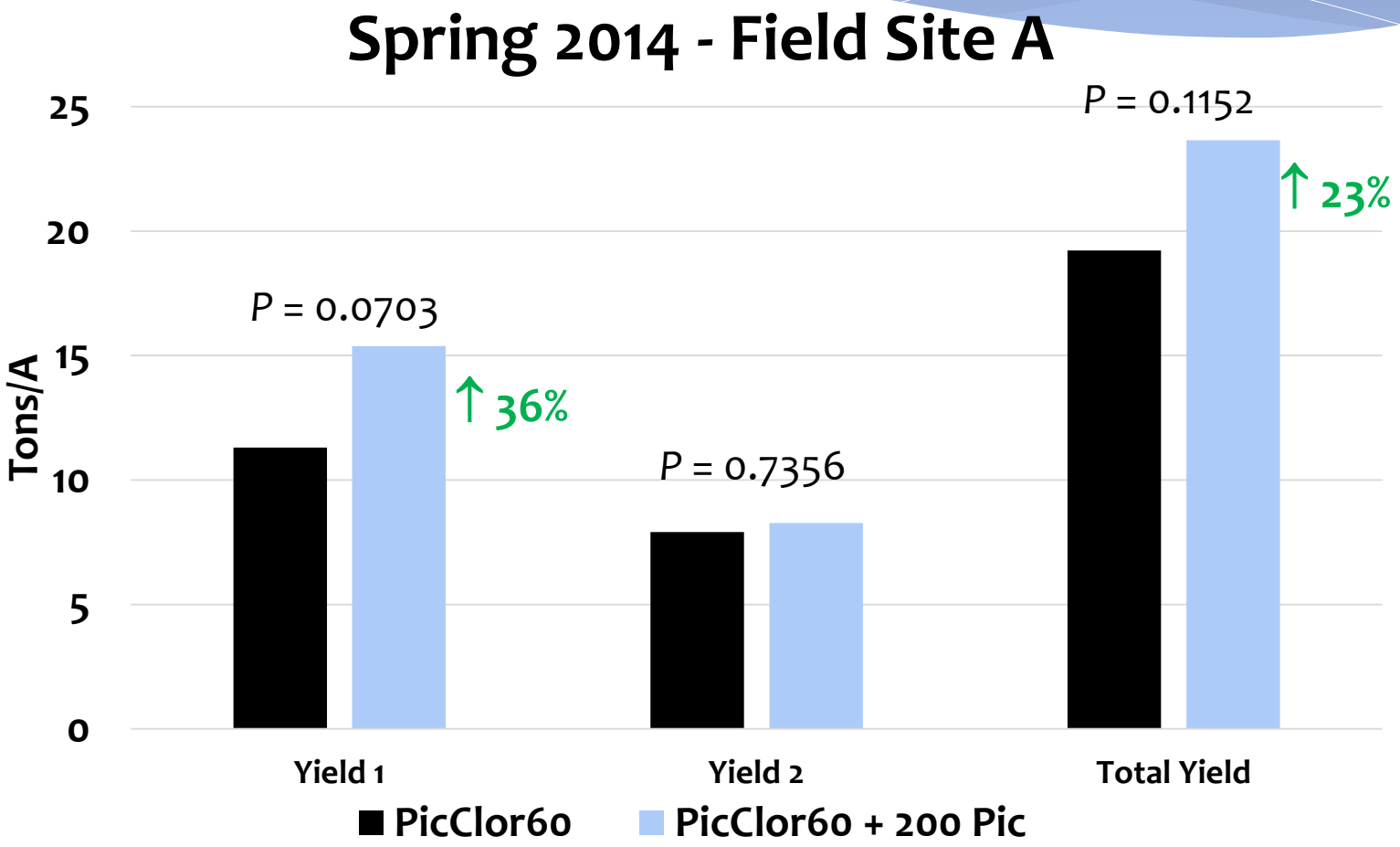

Spring 2014
Without Pic100
With Pic100


Spring 2014
P = 0.0010
P = 0.5623
Disease Incidence (%)
40
30
20
10
0
↓ 77%
Field Site A
Field Site B
PicClor60
PicClor60 + 200 Pic


Spring 2015
P = 0.0050
P = 0.0946
Disease Incidence (%)
25
20
15
10
5
0
↓ 38%
↓ 26%
Field Site A
Field Site B
PicClor60
PicClor60 + 200 Pic

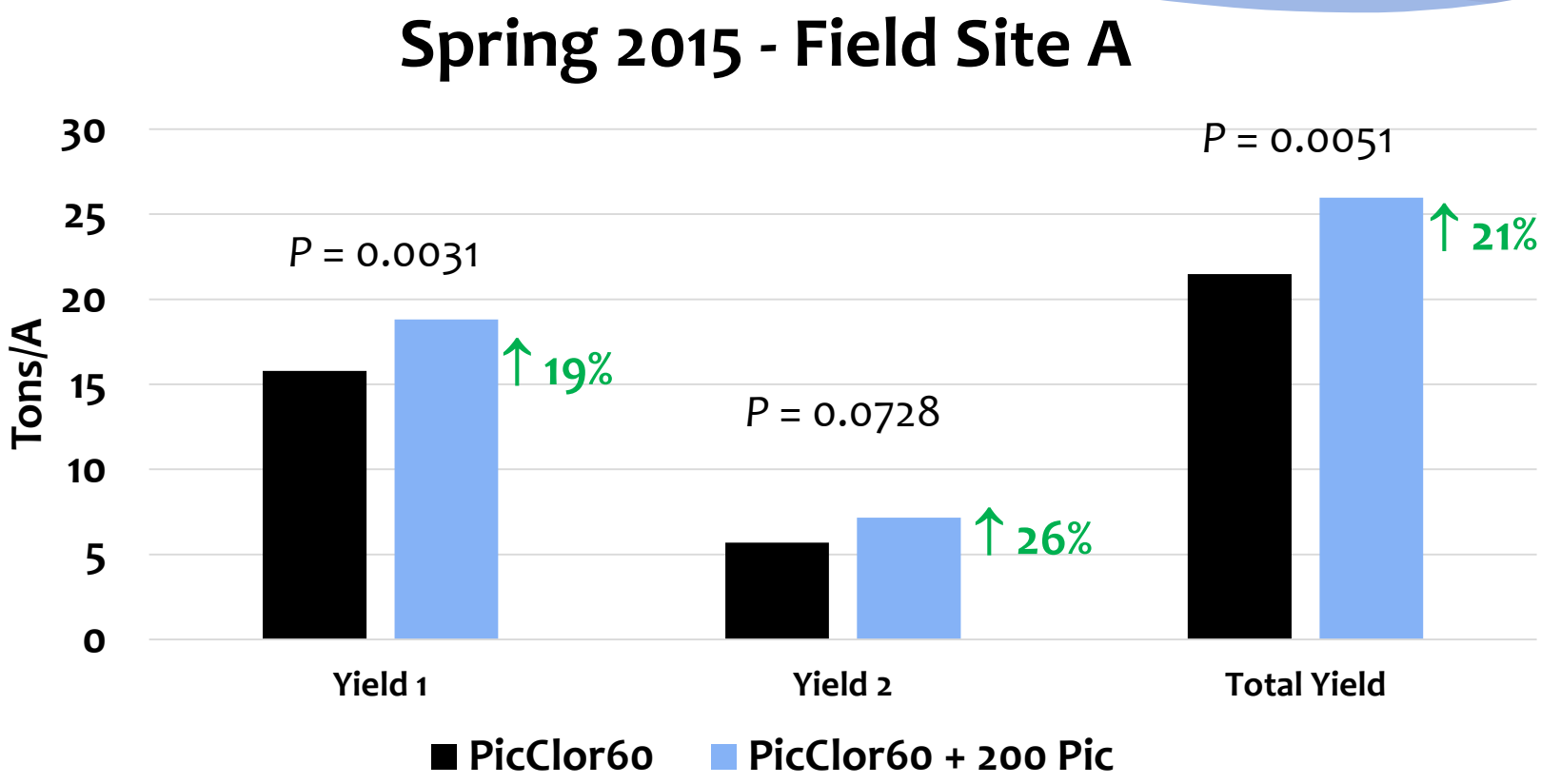
Tomato Yield

(field pack out)



Tomato Yield

(field pack out)



Tomato Yield

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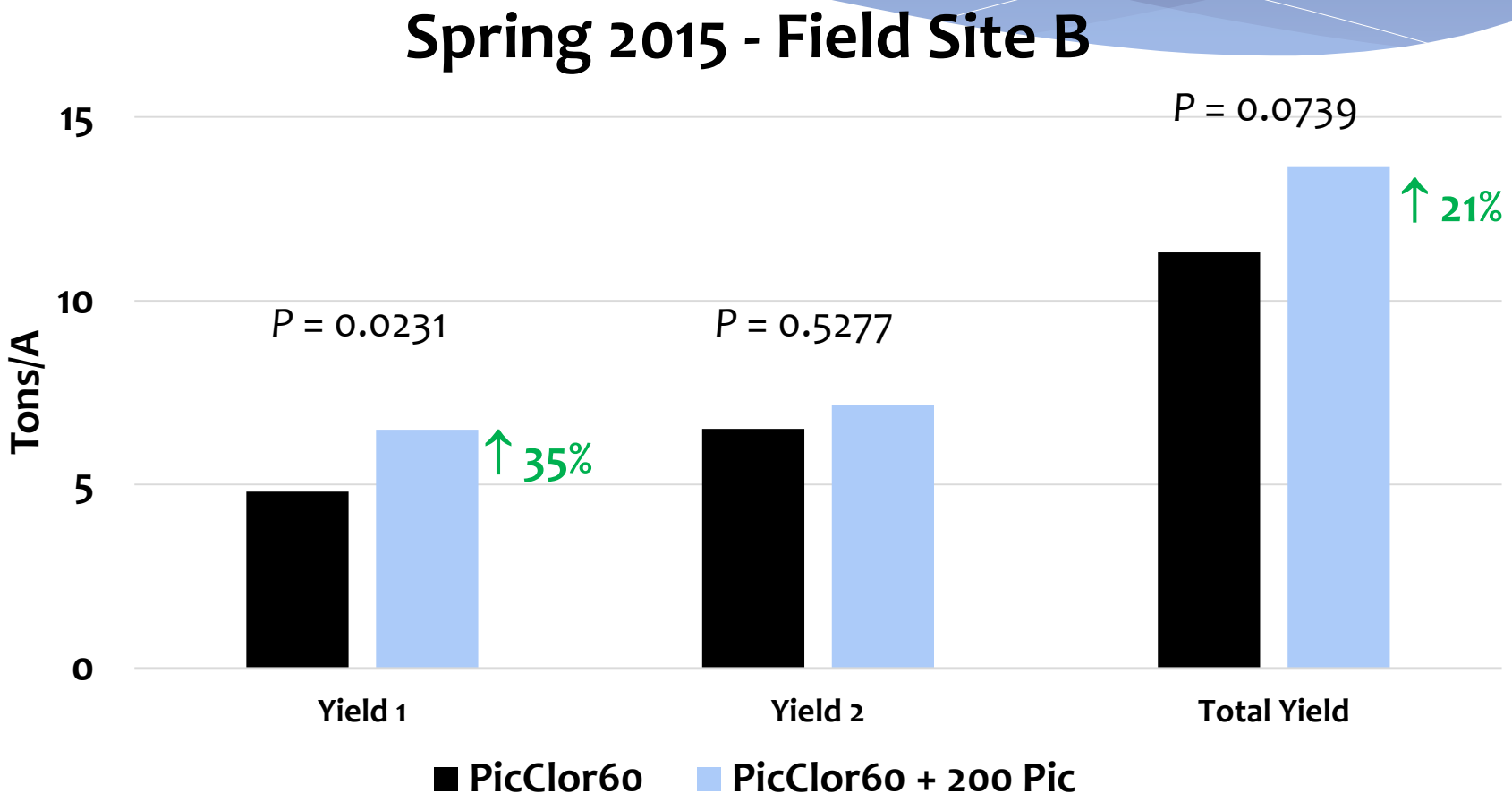
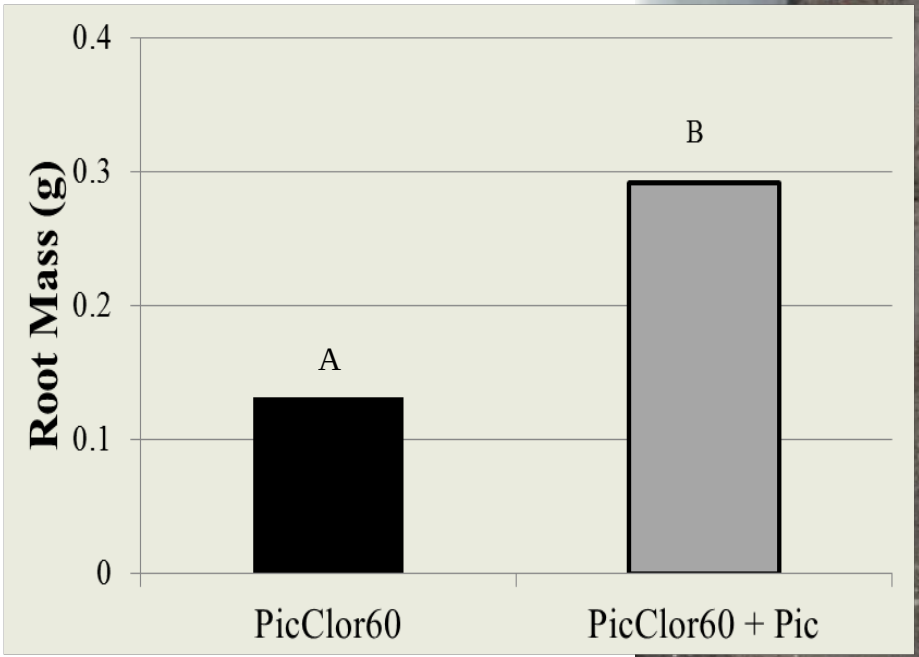


Effect of Supplemental Pic on Root Mass



Supplemental Pic application improved root growth throughout bed and bed edge.

Effect of Supplemental Pic on Root Mass

Supplemental Pic application extended roots to > 1 foot beyond edge of bed.

However, only dead roots could be found along bed edge of grower standard.

PicClor60 + Supplemental Pic

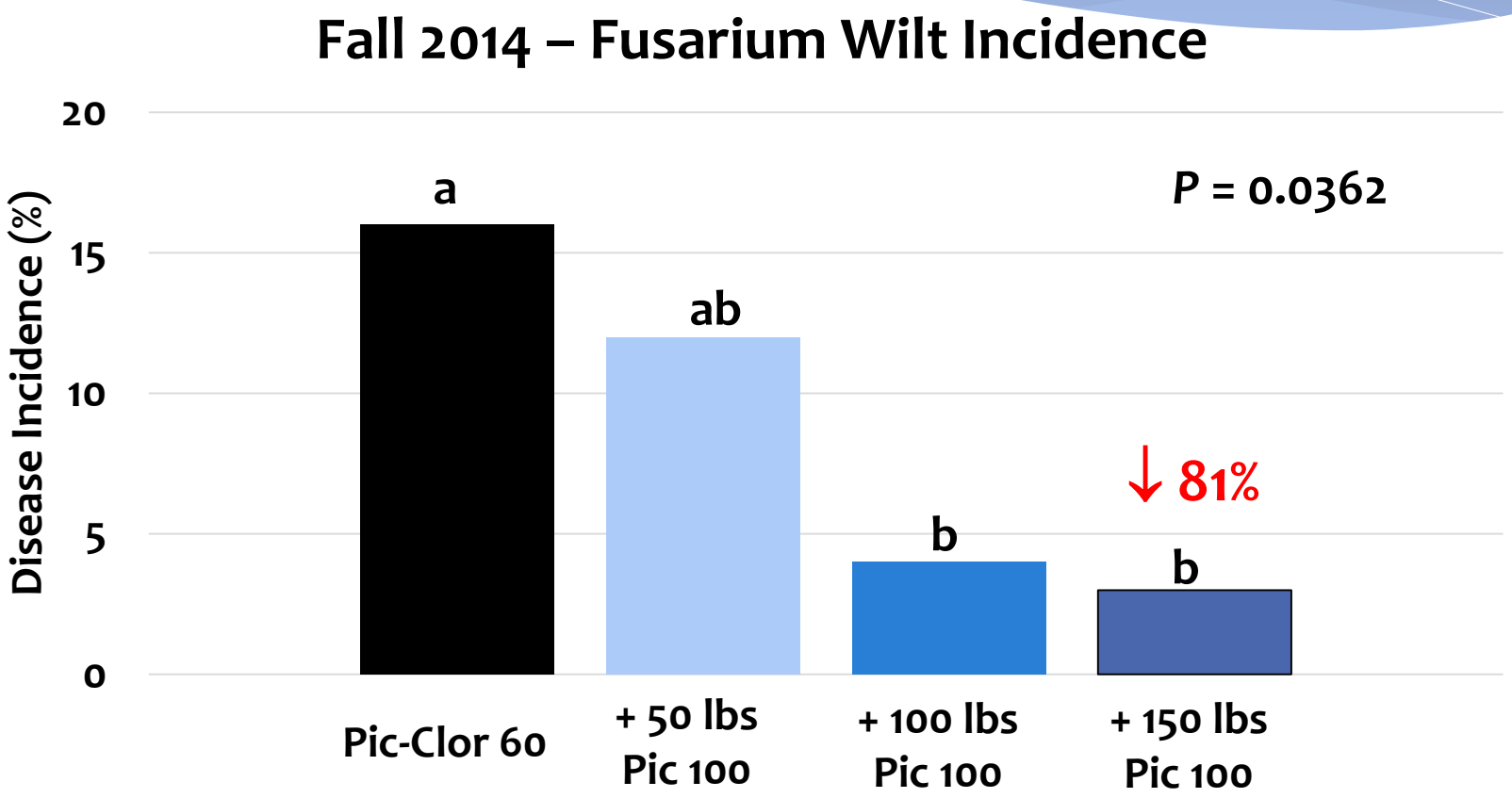
PicClor60

On-Farm Rate Studies

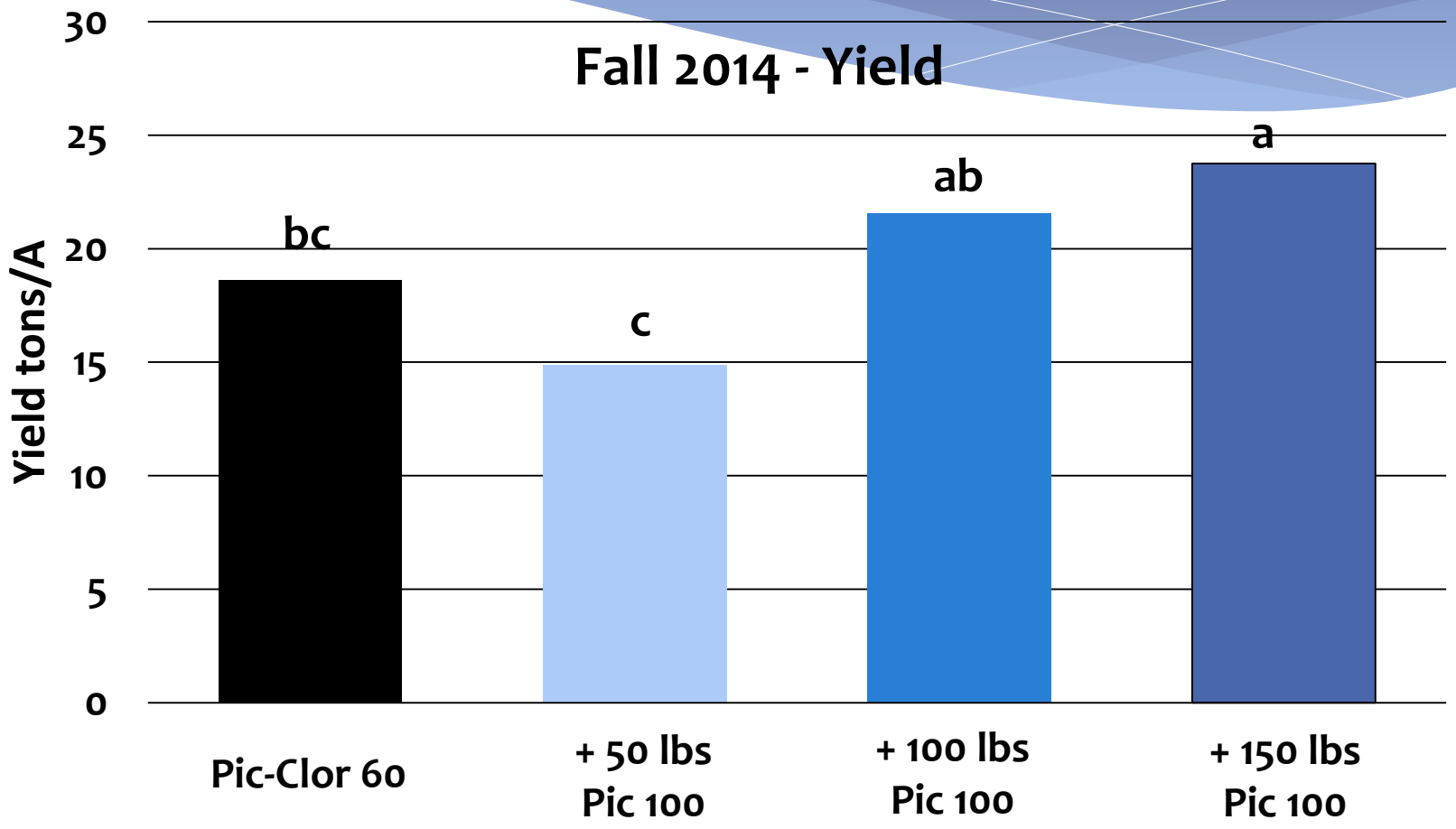
Supplemental Chloropicrin Rate Study

* Fall 2014:
  * Standard Pic-Clor 60 @ 300 lbs/A
  * + Pic 100 @ 50, 100 & 150 lbs/A
  * Plot size: 3 beds x 1500 ft long; 6 Replications
* Spring 2015:
  * Standard Pic-Clor 60 @ 300 lbs/A
  * + Pic 100 @ 75, 100, 150 & 200 lbs/A
  * Plot size: 3 beds x 1500 ft long; 6 Replications

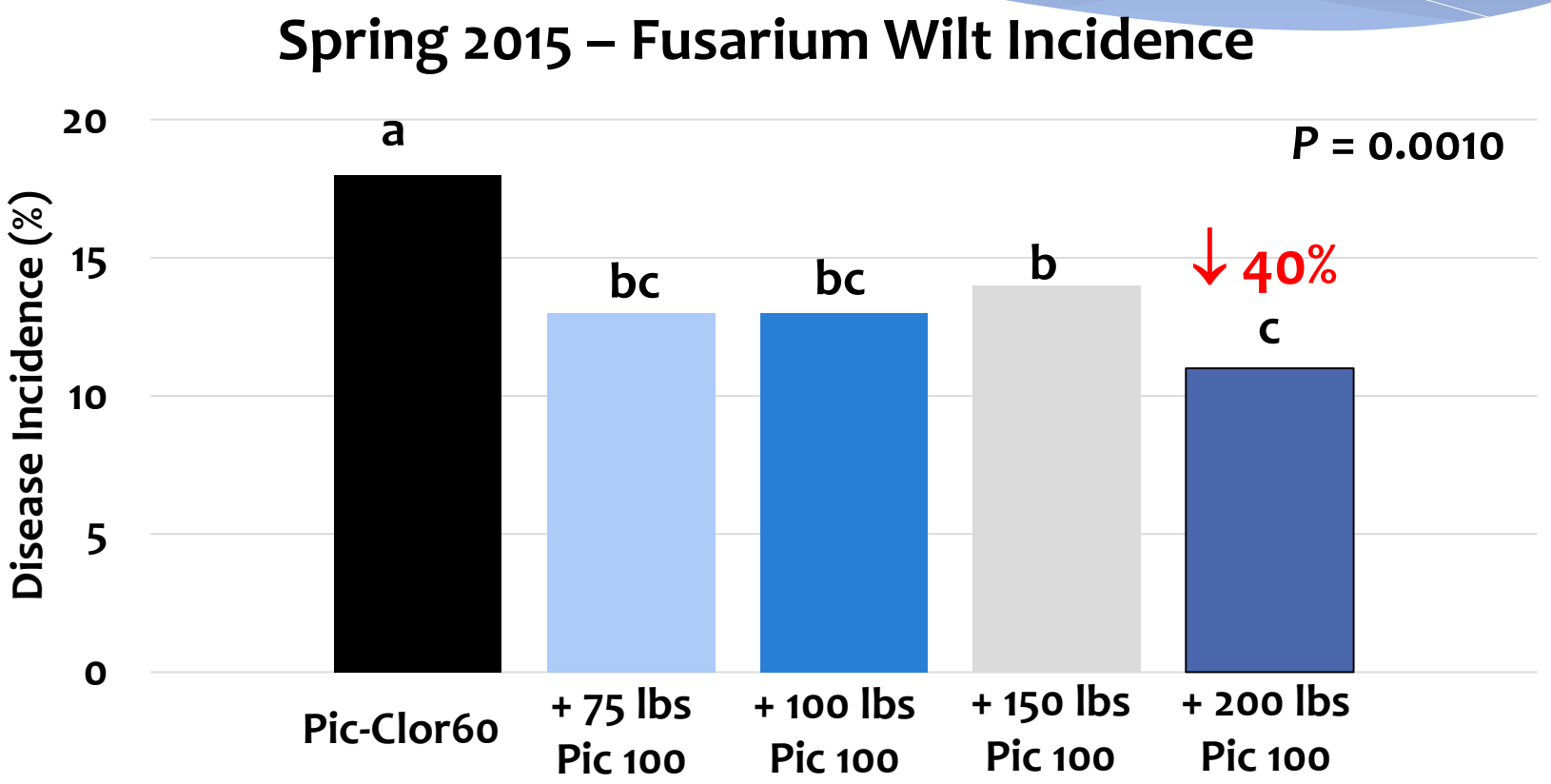
On-Farm Rate Study - Fall 2014



On-Farm Rate Study - Fall 2014

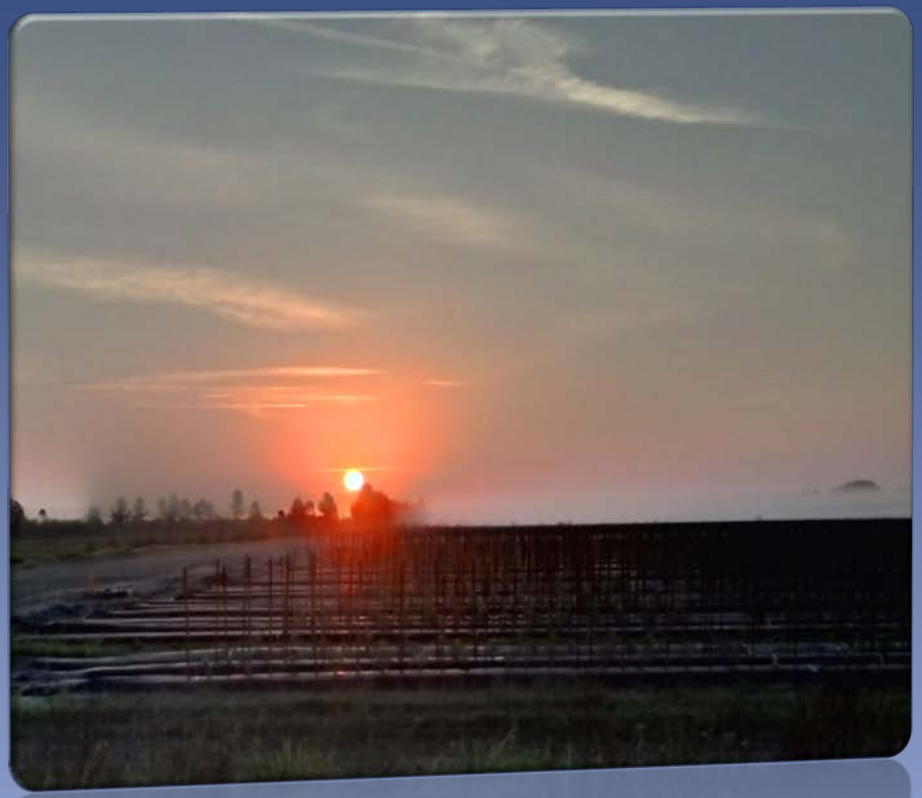


On-Farm Rate Study - Spring 2015



Notes and Future Research

* Supplemental Pic 100 adds:
  * $183/A (150 lb/Trt Acre)
  * $246/A (200 lb/Trt Acre)
* Repeat grower trials assessing chloropicrin rates and offset of chloropicrin in bed are in progress
* Large-scale demonstration trials – Economics…
* Also assessing whether other fumigants could be used to further reduce cost…metam sodium/potassium or AIT?



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THANK YOU