

Sequential crop termination and bed fumigation and cultivar resistance as tools for Verticillium wilt management in strawberries

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 - AMVAC Chemical
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 - Cal Poly graduate and undergraduate students





Verticillium Wilt-Symptoms and Signs

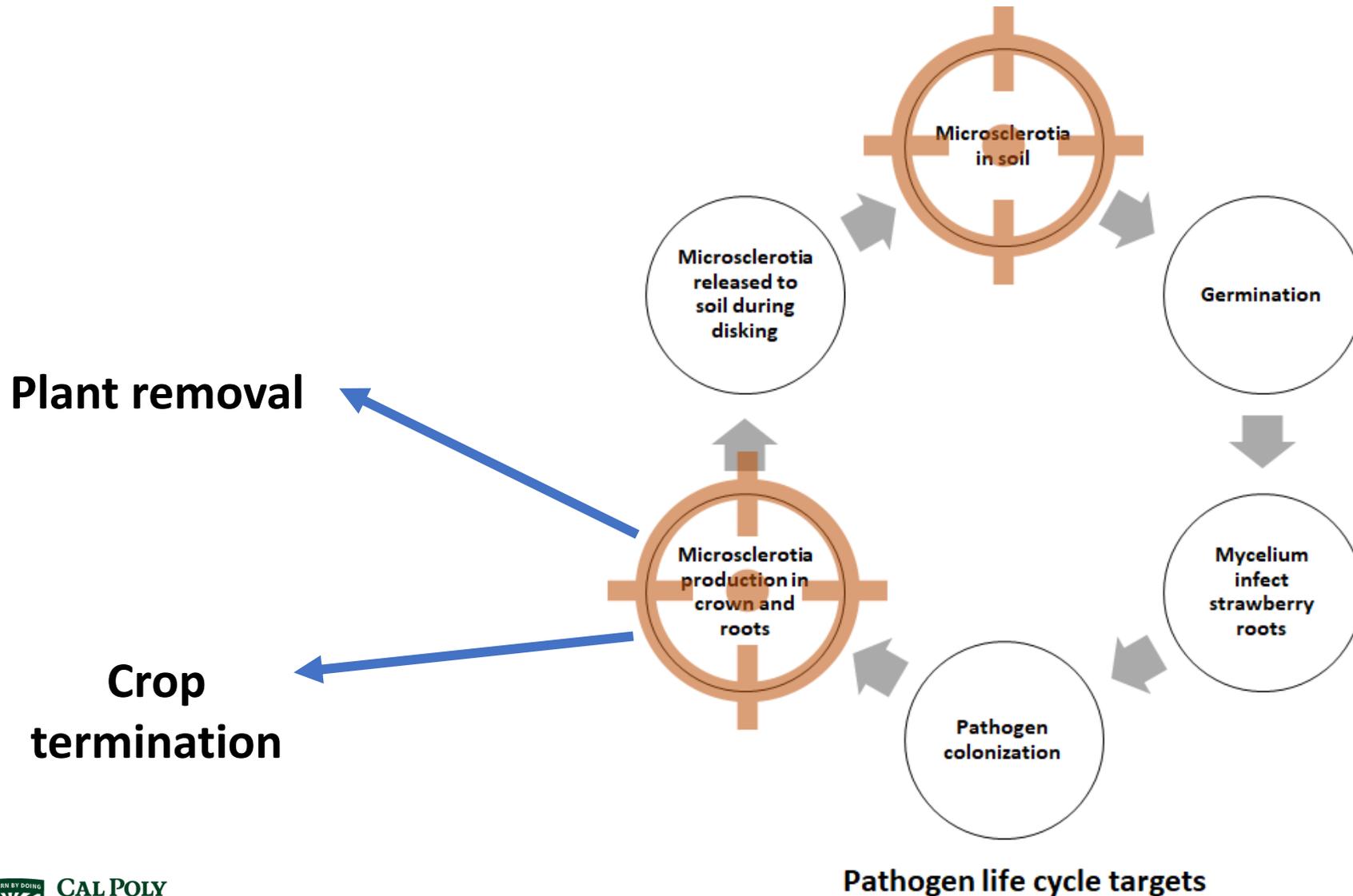


Symptoms

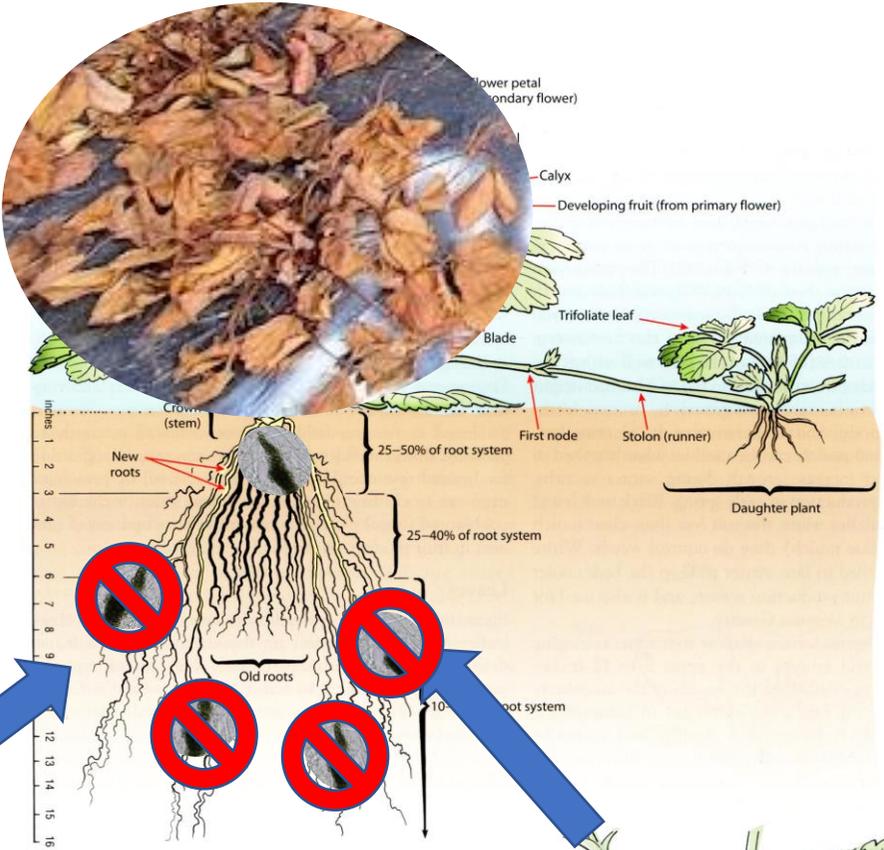


Signs-Microsclerotia

Disease Management



Crop Termination



V. dahliae
microsclerotia

Fumigant

Fumigant

Fumigant

Fumigant

Figure 3. Structure of the developing strawberry plant.



Crop Termination Efficacy for Soil-borne Pathogens of Strawberry

Pathogen	Fumigant and rate	Results	Publication
<i>Verticillium dahliae</i>	138 lb/acre AITC	<ul style="list-style-type: none"> Reduced <i>V. dahliae</i>-below threshold 	Chellemi et al. (2016)
<i>Fusarium oxysporum</i> f sp. <i>fragariae</i>	Flat fumigation with chloropicrin (350 lb/acre) vs crop termination with metam potassium (47 gal/acre)	<ul style="list-style-type: none"> No significant difference at 10" depth No effect on yield in susceptible cultivars-severe symptoms 	Henry et al. (2019)
<i>Fusarium oxysporum</i> f sp. <i>fragariae</i>	Metam sodium 213 lbs/acre-2015 Metam potassium 174 lbs/acre-2018 vs no treatment control	<ul style="list-style-type: none"> Pathogen recovery from infested crowns 50-90% after metam fumigation Not different from untreated soil 	Daugovish et al. (2019)
<i>Macrophomina phaseolina</i>	Metam potassium 58 lb/acre	<ul style="list-style-type: none"> 100% control-bed center 	Khatri et al. (2020)



Objectives

- To develop new, enhanced, soil-borne disease management practices in California strawberries
 - To determine the effectiveness of sequential crop termination and bed fumigation on decreasing *Verticillium dahliae* survival
 - Evaluate efficacy of integration of resistant cultivars to further decrease *Verticillium* wilt of strawberry



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Current B.Sc. student 8**



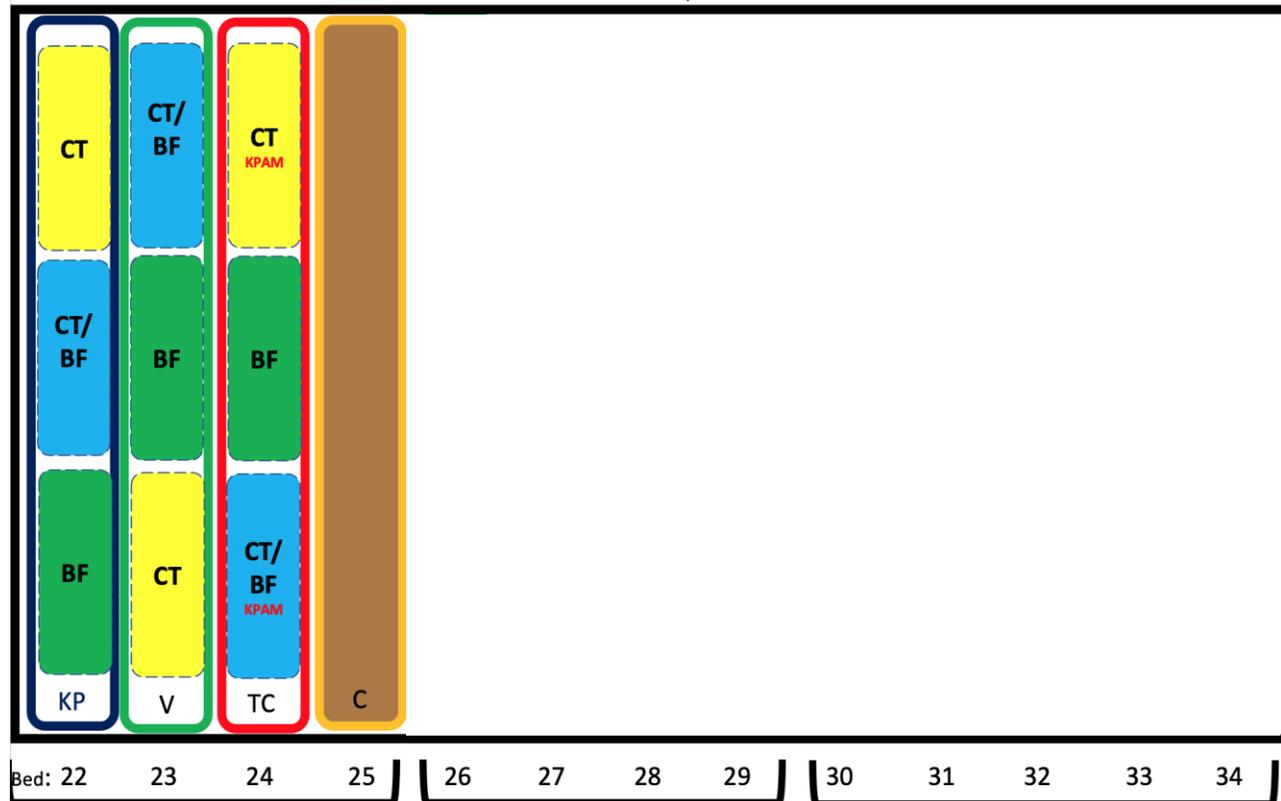
Materials & Methods

- Crop Termination (June 2021 and July 2022)
 - 54% Metam potassium: 47 gal/acre
 - 42% Metam sodium: 62 gal/acre
- Bed fumigation (Oct 2021 and August 2022)
 - 54% Metam potassium: 62 gal/acre
 - 42% Metam sodium: 75 gal/acre
 - 94% Chloropicrin: 240 lb/acre



Materials & Methods—*Experimental Design*

Field 25, Block 6



Tail/South

Crop Term

Bed Fum

CT+BF

TC: Tri-Clor

KP: K-Pam
HL

V: VA-PAM

C: Control

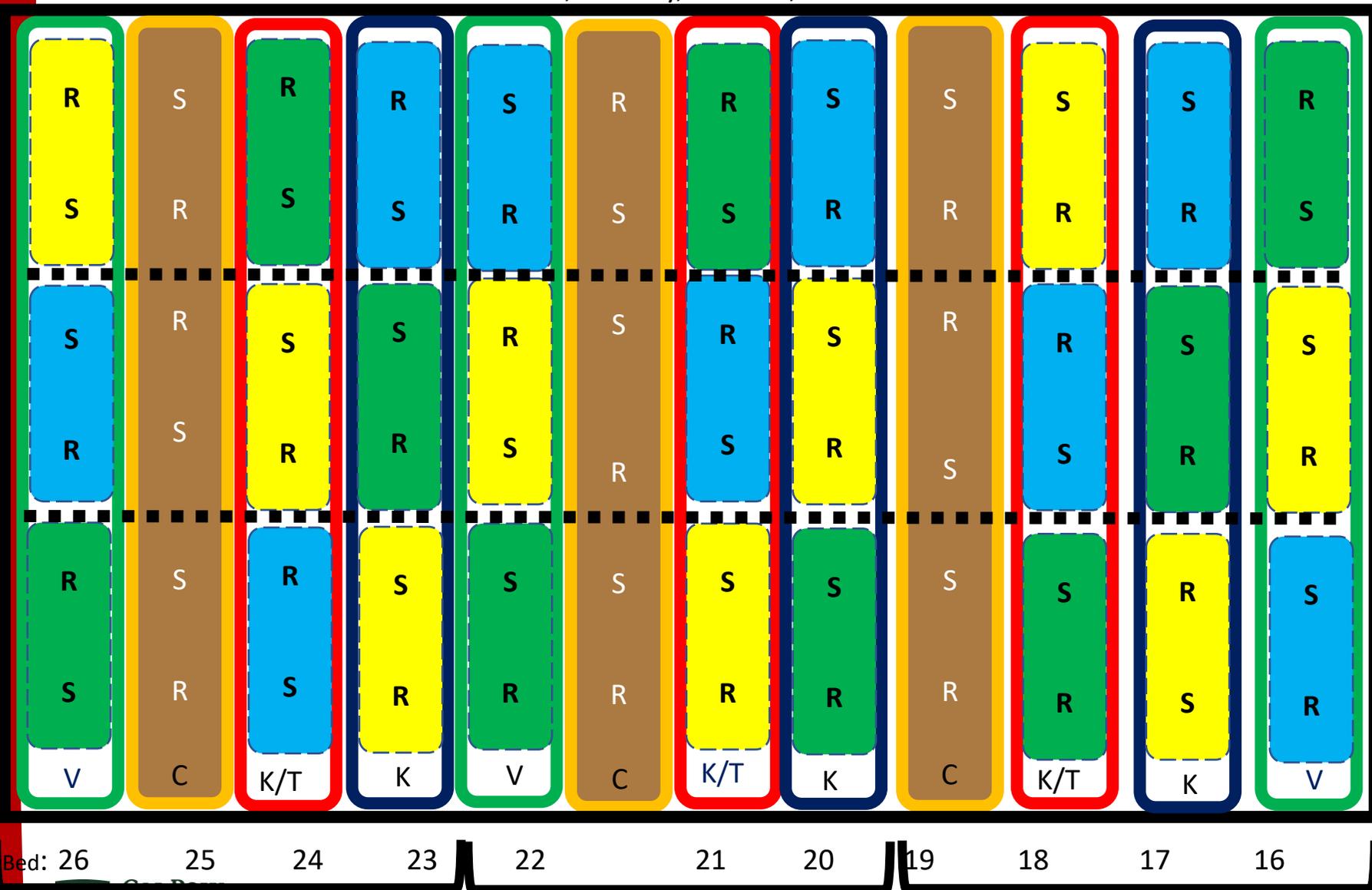
Head/North

- Seascape-Susceptible cv.
- Split-Split plot design
 - Whole plot-fumigant
 - Sub plot-method
 - Sub-sub plot-cultivar
- 12 industry-standard beds
 - ~300 ft in length
- 930 plants per bed
 - 4 rows per bed, 3 lines of drip
- 9 treatment beds, 3 control



2022, Cal Poly, Field 25, Block 6

Head/North



Crop_Term
Bed_Fum
CT+BF

T: Tri-Clor EC
KP: K-Pam HL
V: VAPAM HL
C: Control

S: Seascape
R: UCD Valiant

Year 1-Plant Mortality due to Crop Termination

Crop terminated with

- 5% mortality and
- 45% symptom expression



7 Days after Fumigation (DAF)	14 DAF

* denotes significance. Kruskal-Wallace, Wilcoxon signed-rank ($X^2 = 8.31$, $df = 1$, $P = 0.0039$).



Year 2-Plant Mortality due to Crop Termination

Crop terminated with

- 2.4% mortality and
- 20% symptom expression



7 Days after Fumigation (DAF)	14 DAF

• denotes significance. Kruskal-Wallis, Wilcoxon signed-rank ($X^2 = 17.0$, $df = 1$, $P < 0.001$).

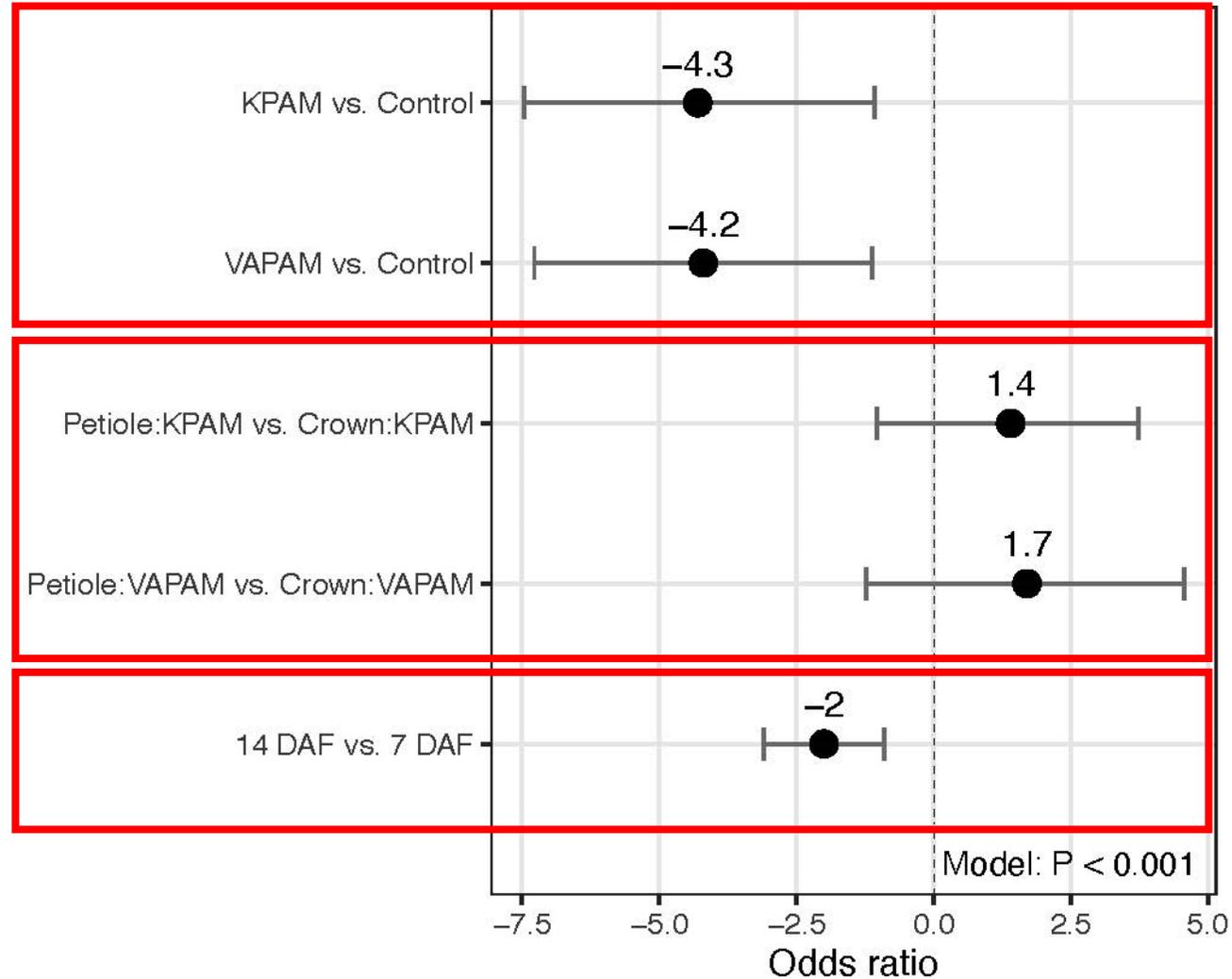
Kruskal-Wallis chi-squared = 17.049, df = 1, p-value = 3.643e-05

** denotes significance. Kruskal-Wallis, Wilcoxon signed-rank ($X^2 = 16.4$, $df = 1$, $P < 0.001$).

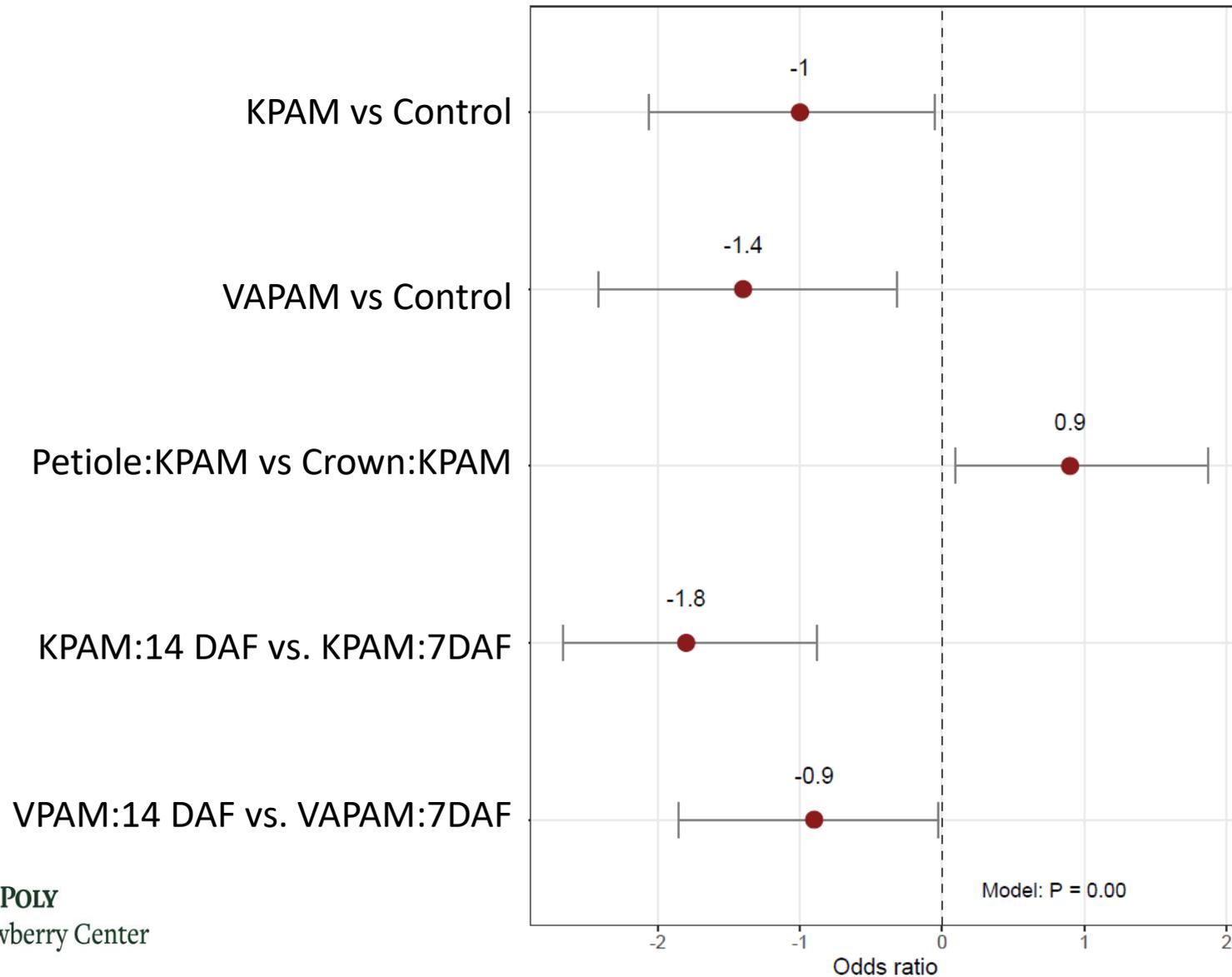
Kruskal-Wallis chi-squared = 16.362, df = 1, p-value = 5.231e-05



Year 1-Pathogen Survival X4 ↓



Year 2-Pathogen Survival

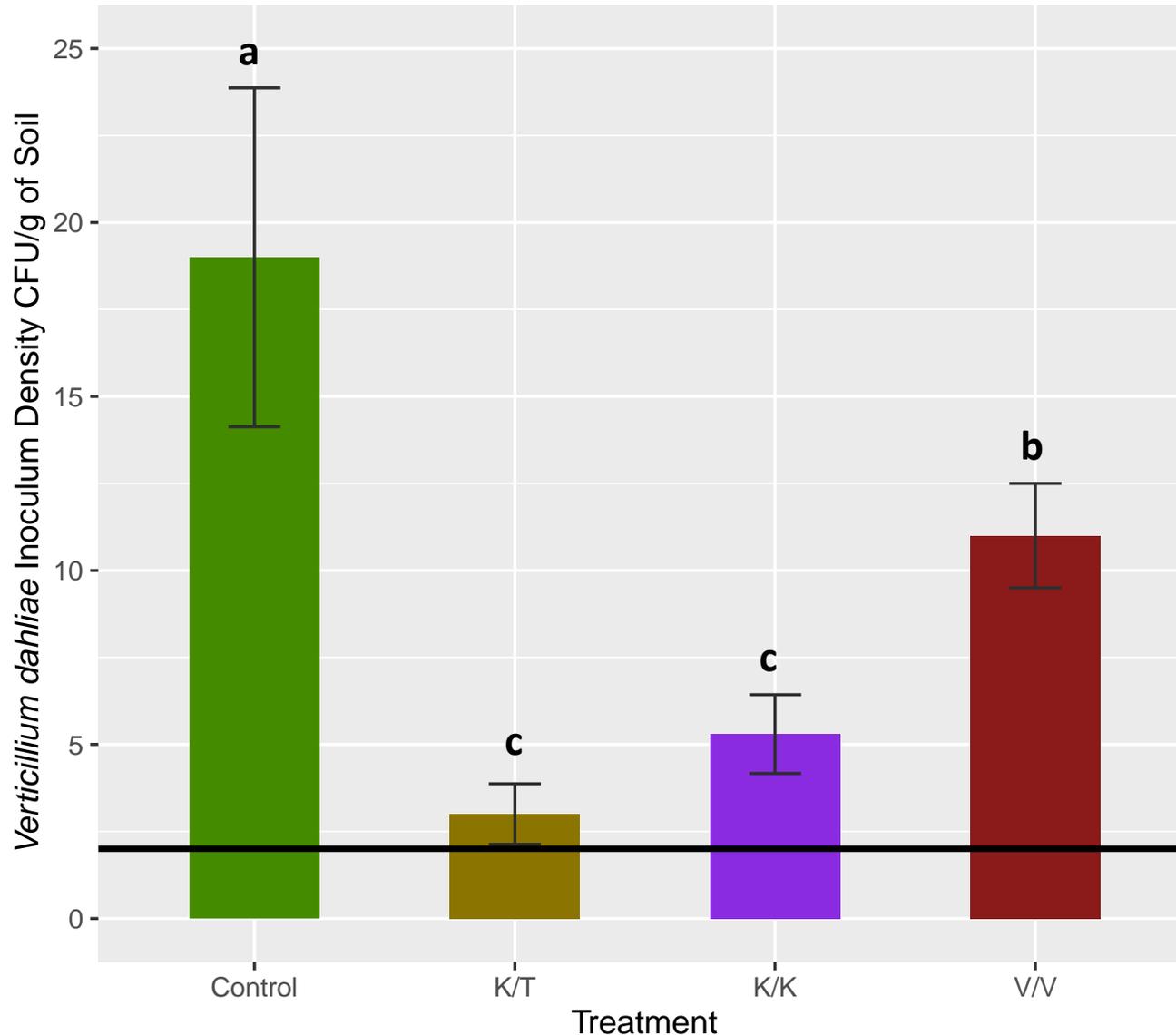


Year 1-Inoculum Density Significantly ↓ in Soil

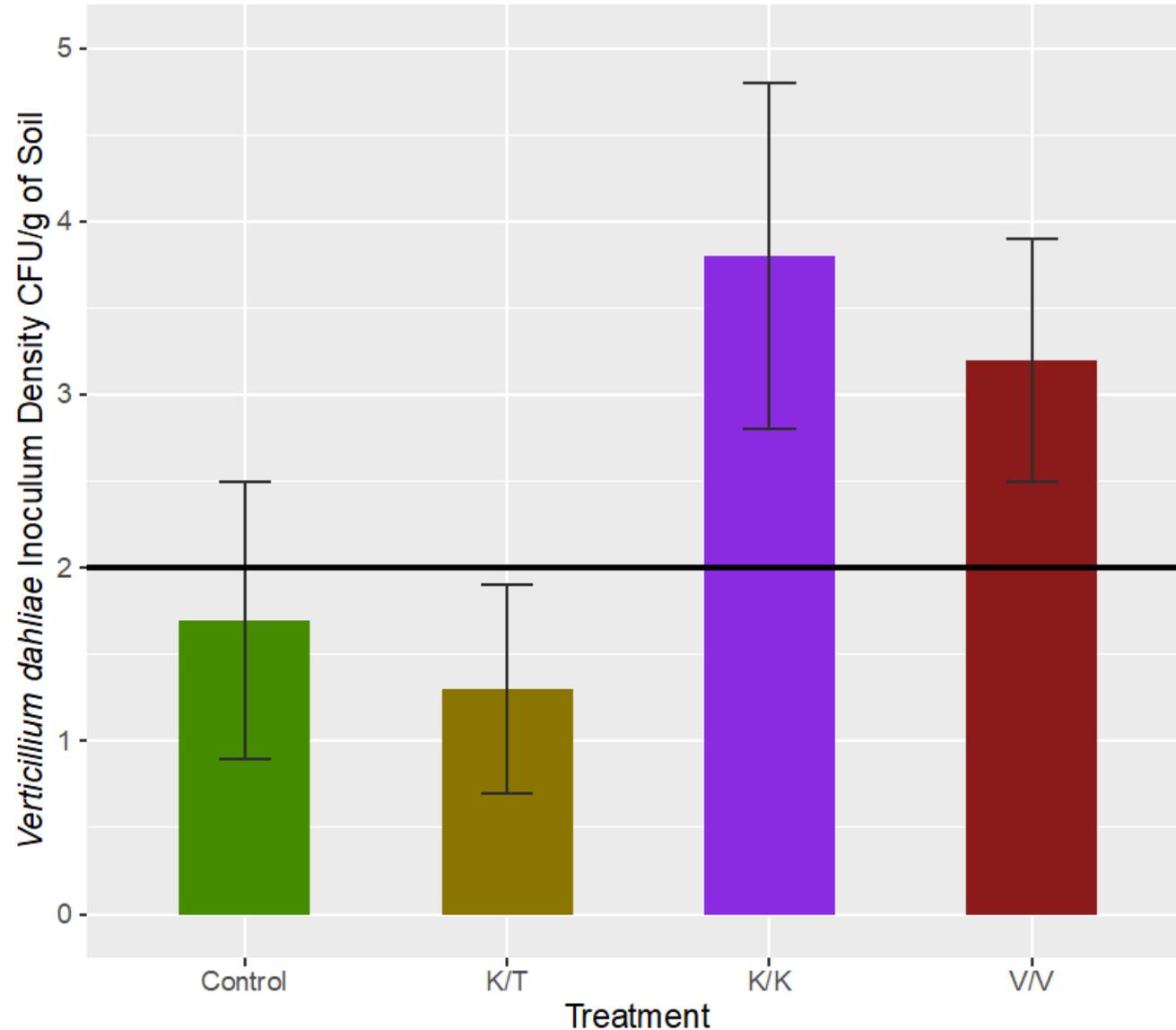
K = Metam Potassium
(K-PAM HL)

V = Metam Sodium
(VAPAM HL)

T = Chloropicrin
(TriClor EC)



Year 2-Inoculum Density



K = Metam Potassium
(K-PAM HL)

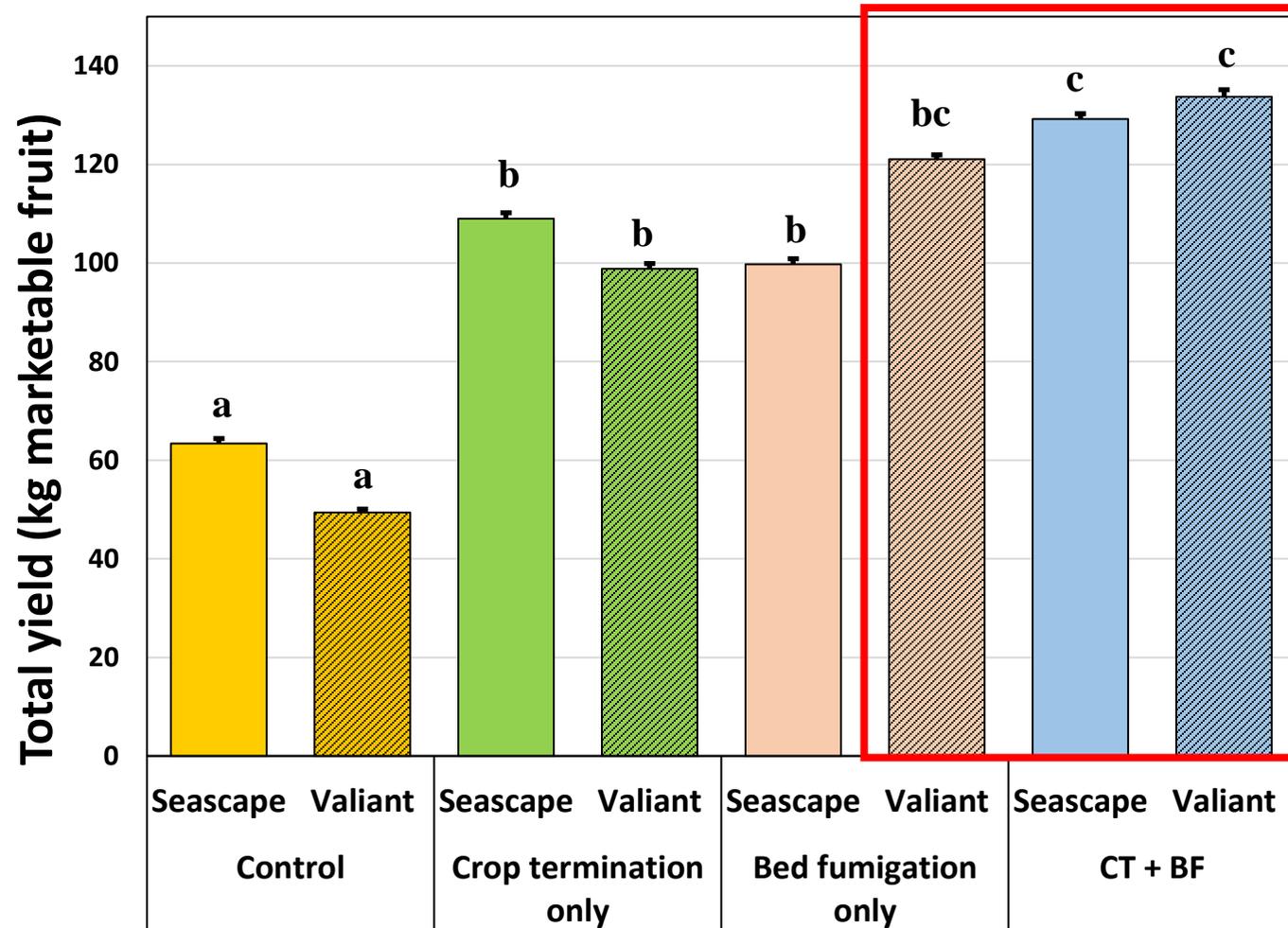
V = Metam Sodium
(VAPAM-HL)

T = Chloropicrin
(TriClor EC)

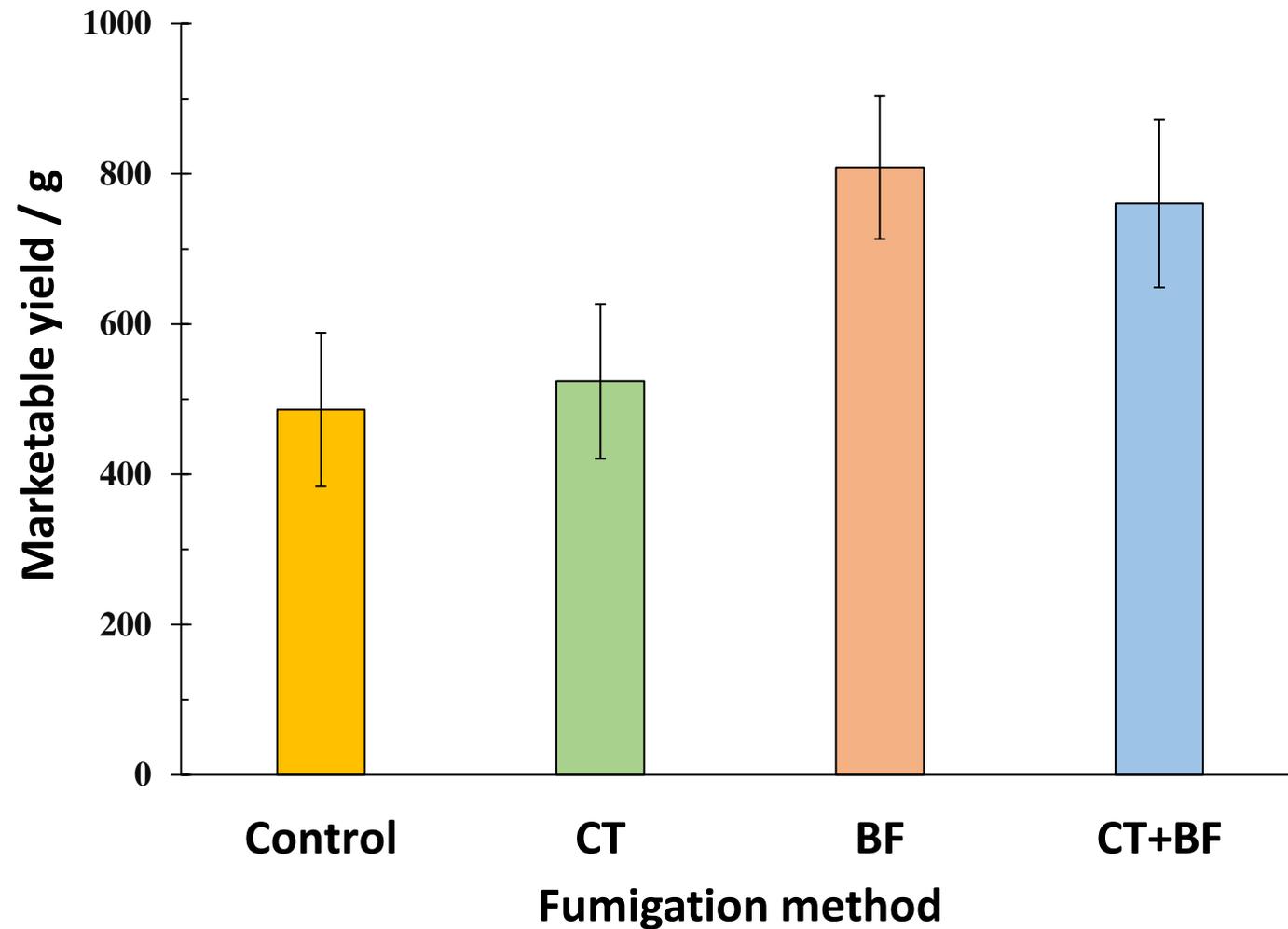


Year 1-Total Marketable Yield Significantly ↑

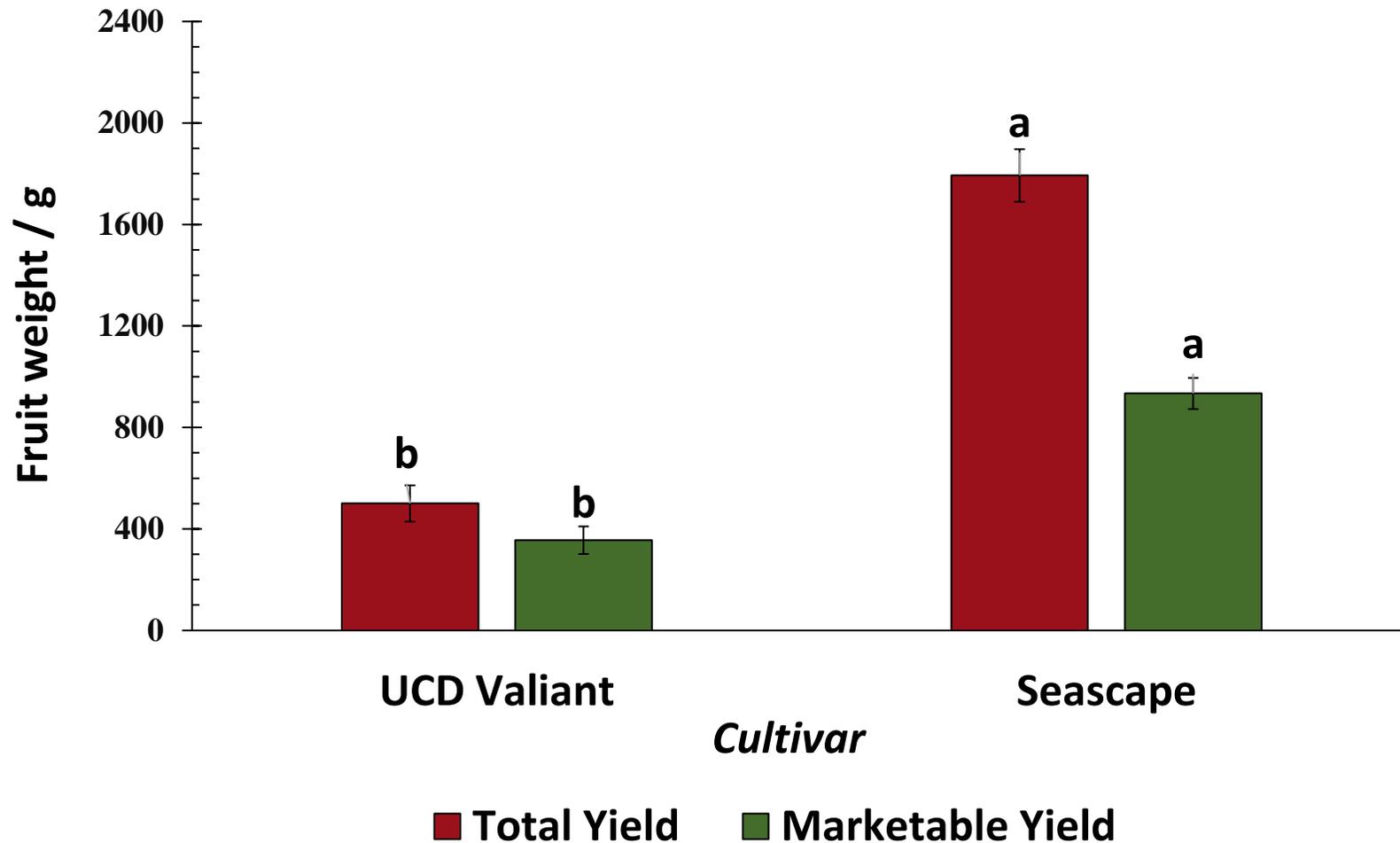
Seascape-Susceptible UCD Valiant-Resistant



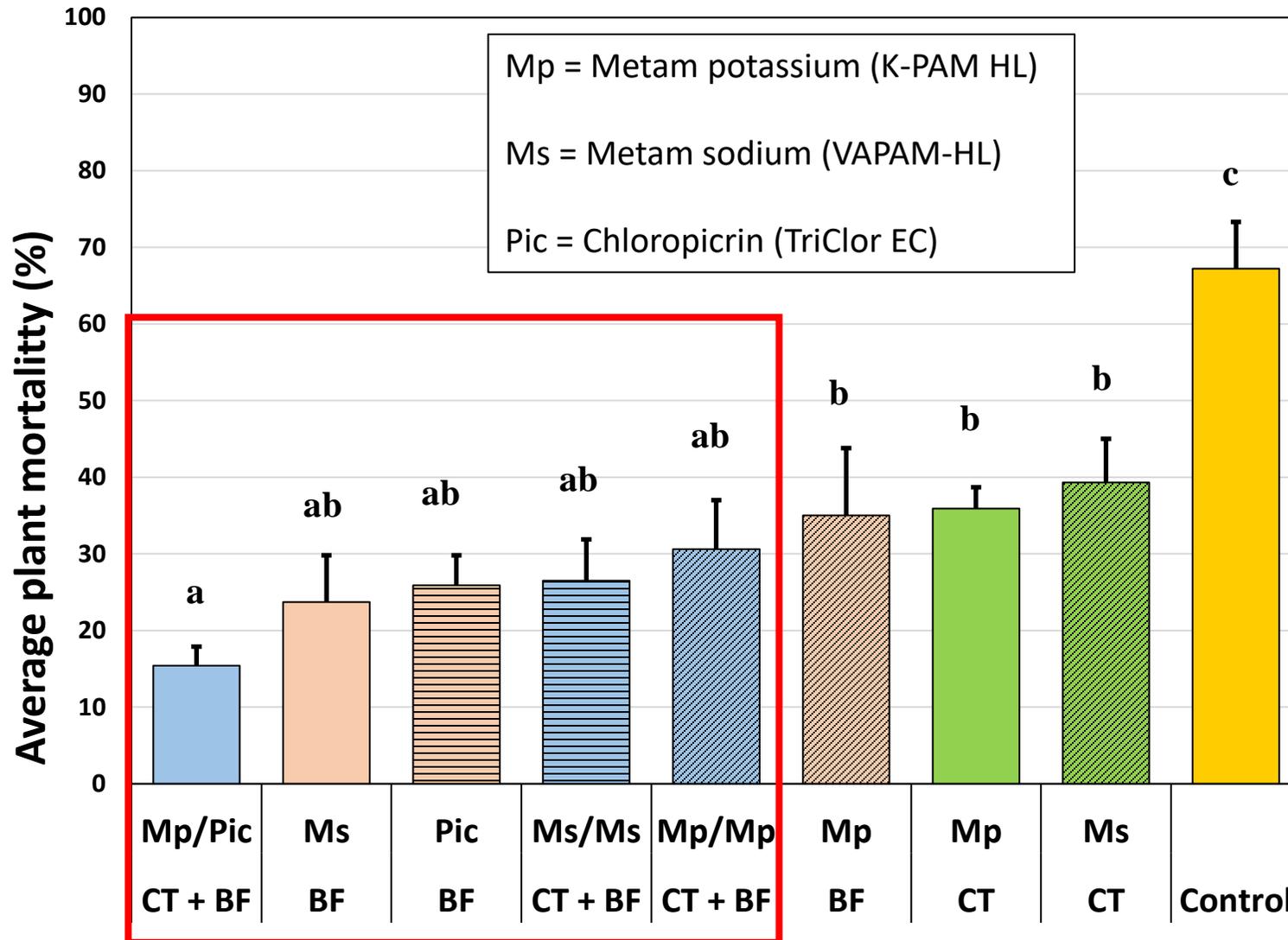
Year 2-Total Marketable Yield



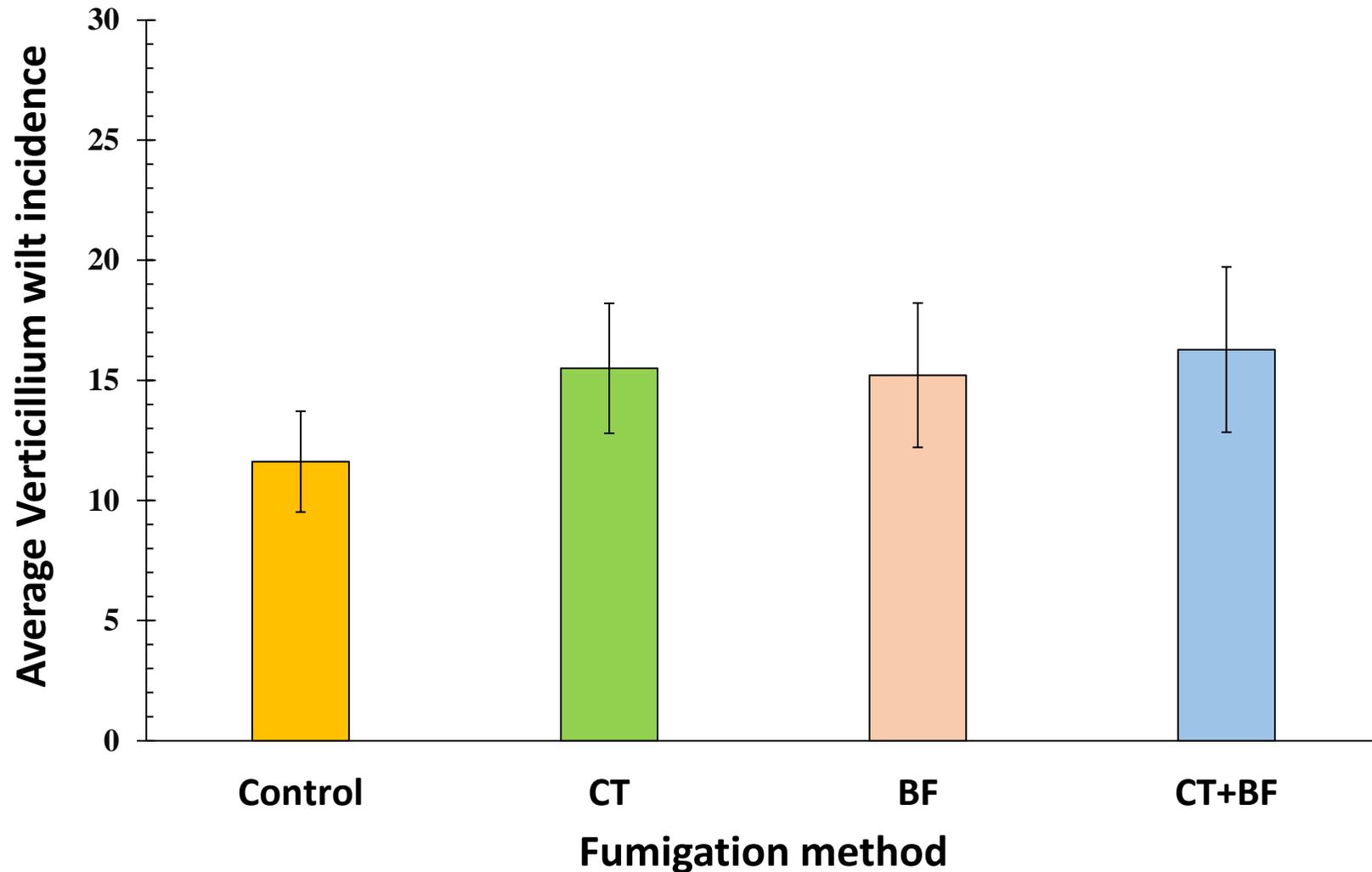
Year 2-Total Marketable Yield



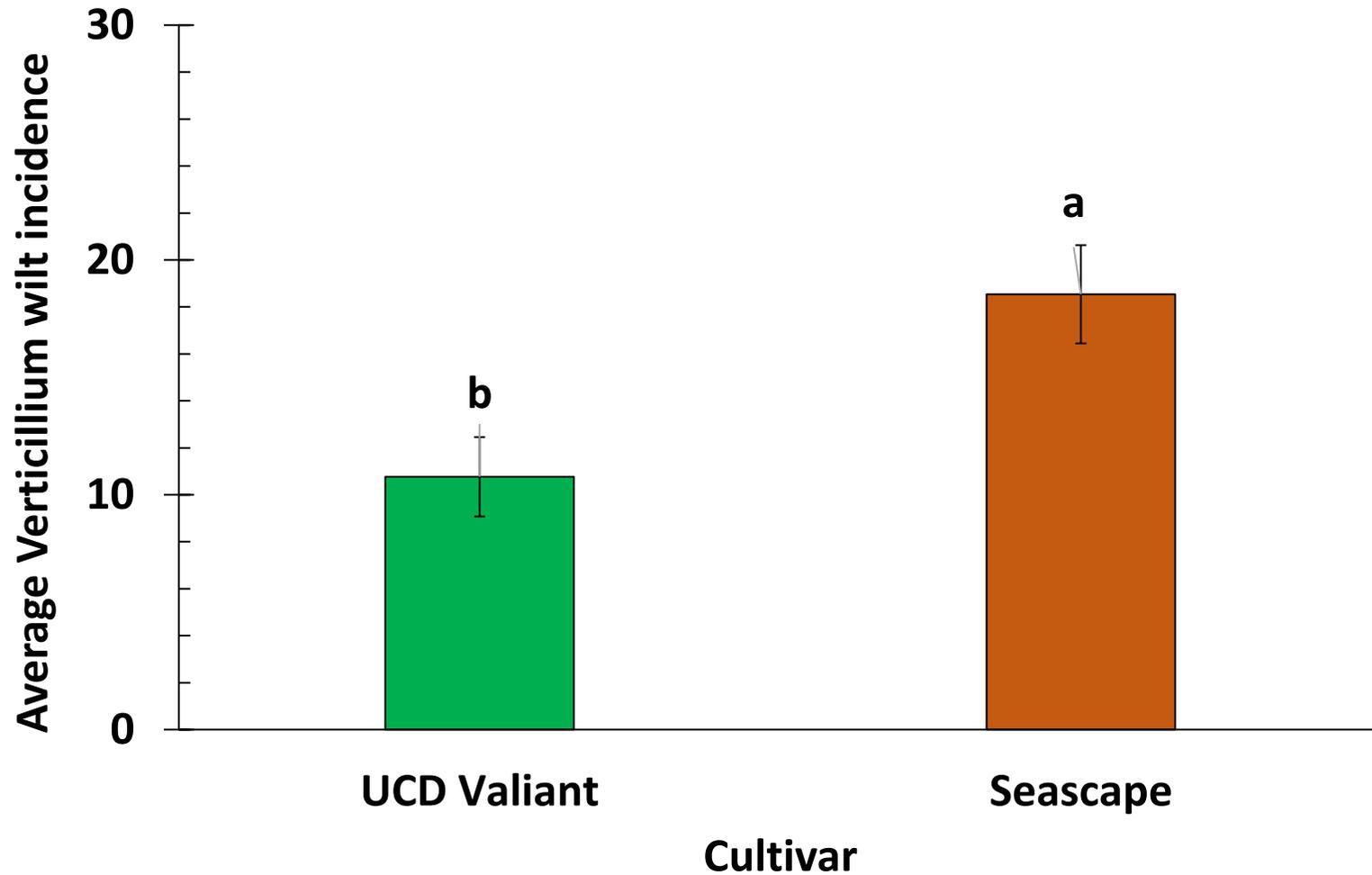
Year 1 - Average Plant Mortality Significantly ↓



Year 2-Average Plant Mortality



Year 2-Average Plant Mortality



Lessons Learned

Crop termination

- Make sure the drip tape is still functional
- Leaks can make the fumigant treatment ineffective
- Can be ineffective when most of the plants are dead



Conclusions

- **Crop Injury**
 - Plant mortality significantly increased at 14 DAF
- **Pathogen Survival in Crop**
 - Log odds of *Verticillium dahliae* survival in crop tissue roughly **X4** lower in those terminated treatments compared to control
- **Soil Inoculum Density**
 - Sequential application on Mp/Pic (KPAM-HL/Chloropicrin) significantly reduced the pathogen inoculum
- **Yield**
 - Sequential application of crop termination and bed fumigation and bed fumigation by itself provided the highest yield
- **Plant mortality**
 - The least plant mortality was in Mp/Pic (KPAM-HL/Chloropicrin) -not significantly different from bed fumigation with Pic, Ms, Ms/Ms, or Mp/Mp



Thank you!



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