



**5TH INTERNATIONAL
STRAWBERRY CONGRESS**

Thursday

Parallel Session 3: Innovative Technology & Vertical Farming

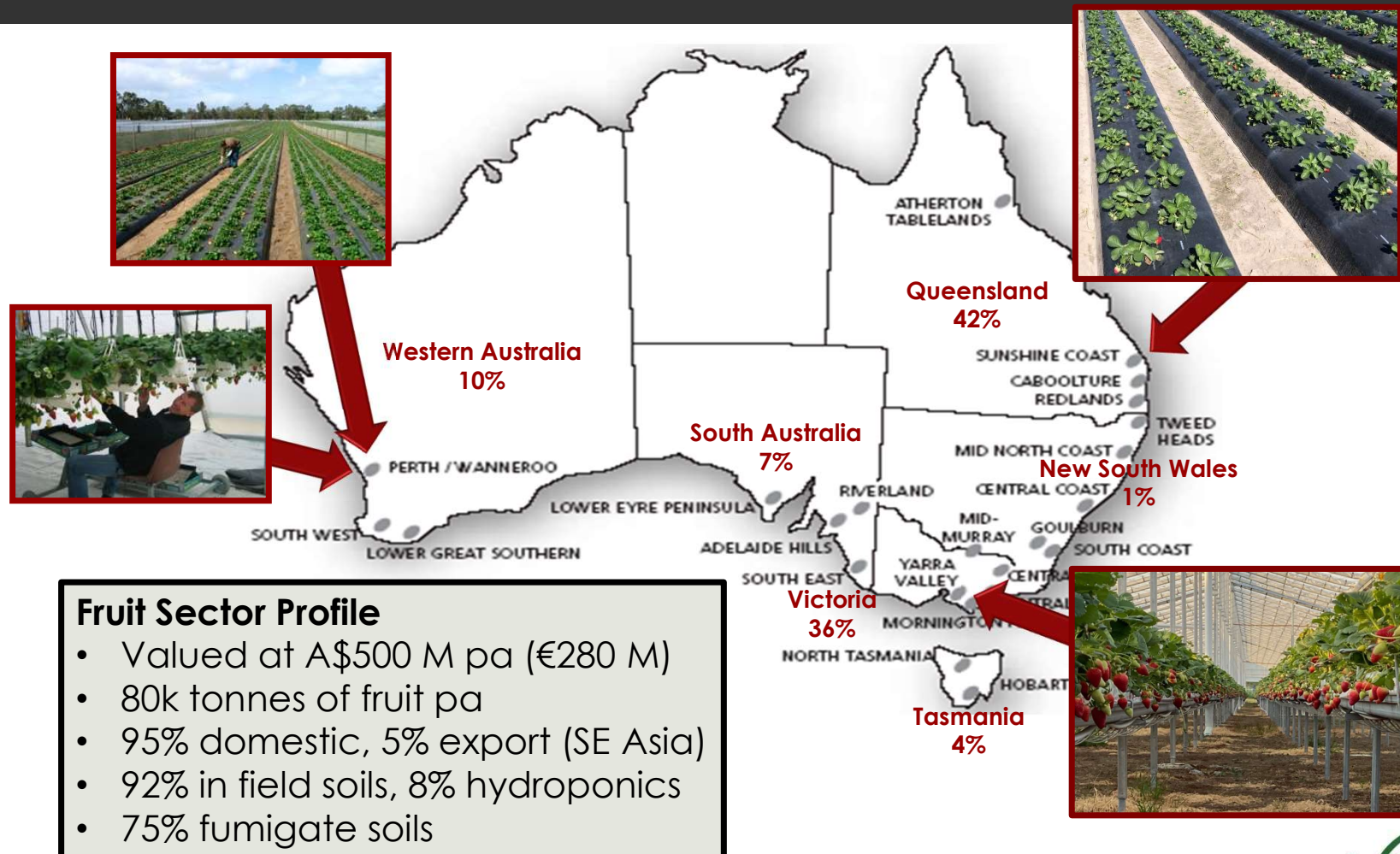
Microwave Technology: A Sustainable Approach to Soil Disinfestation in Strawberries

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Strawberry Production in Australia

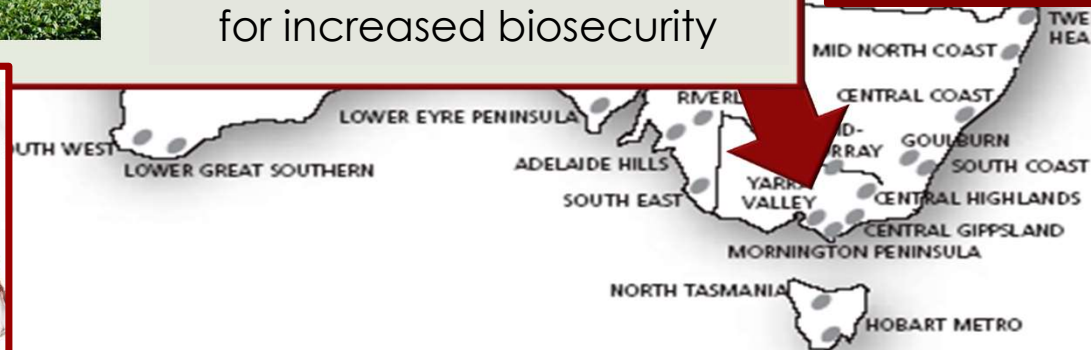


Strawberry Production in Australia

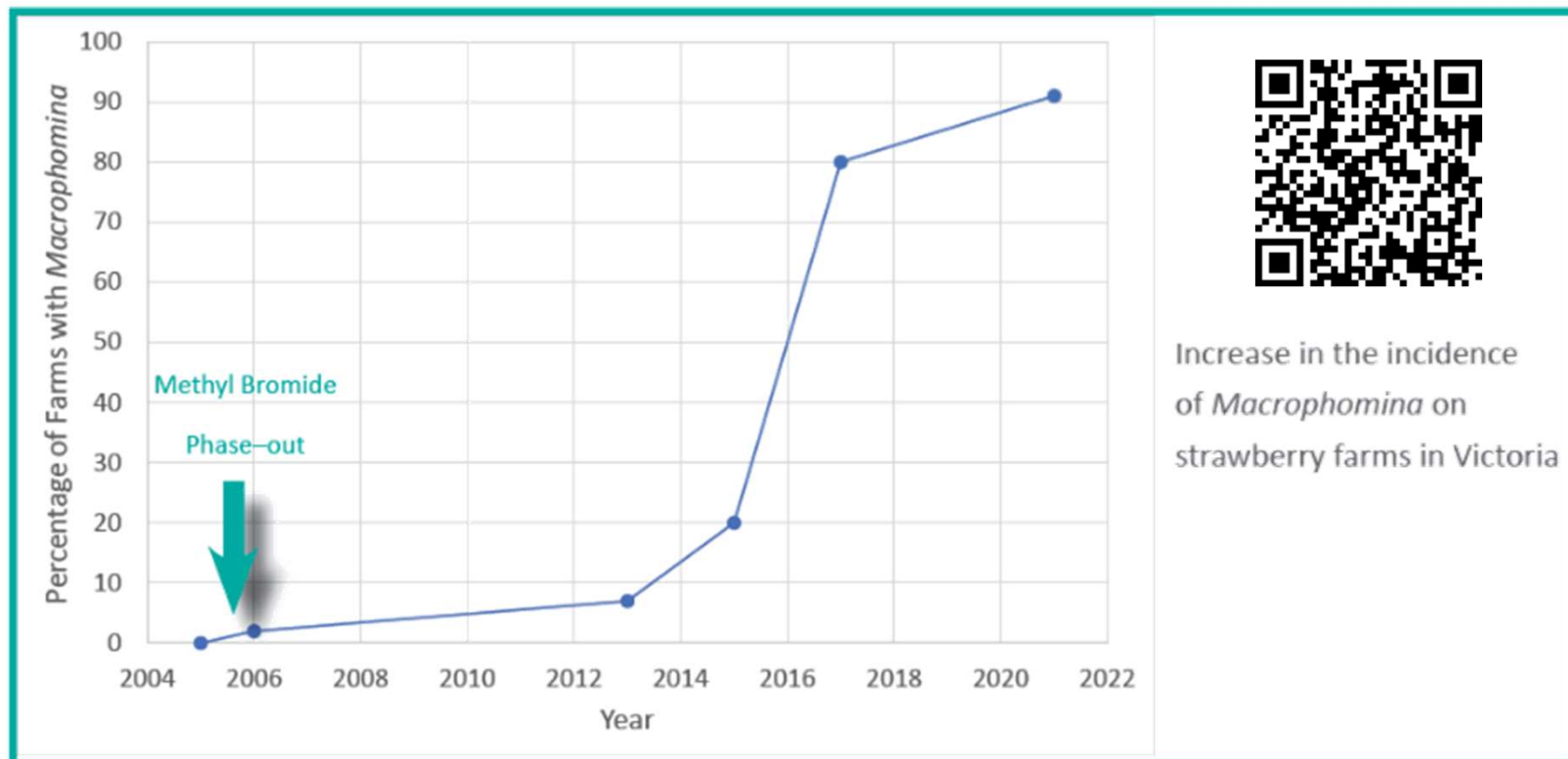


Nursery Sector Profile

- 75% of national production at Toolangi, Victoria
- 90% bare-rooted runners grown in soils fumigated with methyl iodide
- 10% plug plants grown in hydroponic systems
- Production is within a government-declared 'Plant Protection District' for increased biosecurity



Increased importance of Soil-Borne Diseases Associated with the Loss of Methyl Bromide



Charcoal Rot in Western Australia



Charcoal Rot in Western Australia

- ❑ Charcoal Rot is a crown rot disease of strawberry crops caused by the fungus *Macrophomina phaseolina*
- ❑ The disease kills strawberry plants
- ❑ There are no fungicide controls for Charcoal Rot
- ❑ Current soil fumigants are less effective than methyl bromide was at controlling charcoal rot

Charcoal Rot in Victoria in 2020/21





Charcoal Rot in Victoria in 2020/21

- ❑ Killed 18% of plants
- ❑ Reduced revenue from fruit by A\$20 M (€11 M)
- ❑ 90% of strawberry fruit farms affected
- ❑ No *Macrophomina* detected in strawberry nurseries

Inoculum of *M. phaseolina* in soil on strawberry farms

Photo: A. Gomez



Infected strawberry crown in soil



Microsclerotia in strawberry crown

Soil Disinfestation using Heat

- The combined effect of heat and exposure time on soil organisms has been studied since the late 1800s.
- Steam and solarisation are the traditional methods of heating soil for disinfestation.
- For example, Fennimore and his colleagues have demonstrated that heat disinfestation with steam can be as effective against soil-borne pathogens as chemical fumigants.



What are Microwaves?

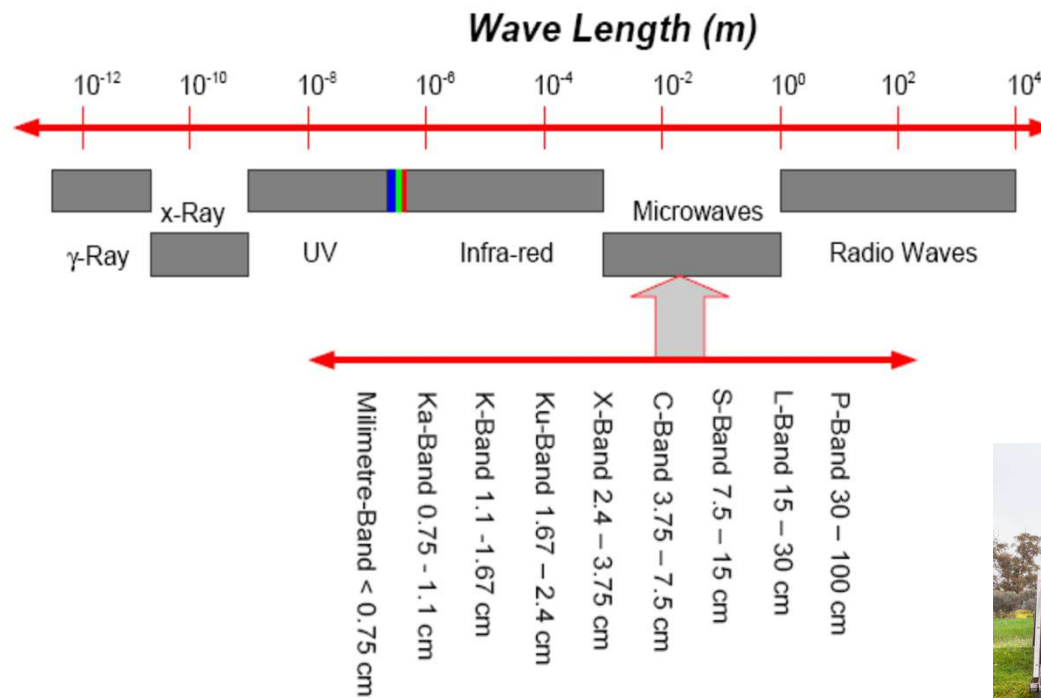


Figure 1: Electromagnetic Spectrum

Experiments with Microwave in Strawberry

1. Potential of microwave for crop termination in the fruit sector to manage *Macrophomina*
2. Effectiveness of microwave for soil disinfestation against pathogens and weeds for strawberry runner production



Crop Termination

- Crop termination is the practice of killing old strawberry plants and cultivating them back into soil, before preparing beds and planting a new crop.
- In Australia, growers commonly use herbicides for crop termination, but this does not kill *M. phaseolina* inside the crowns.



Opportunity: Crop Termination with Microwave?



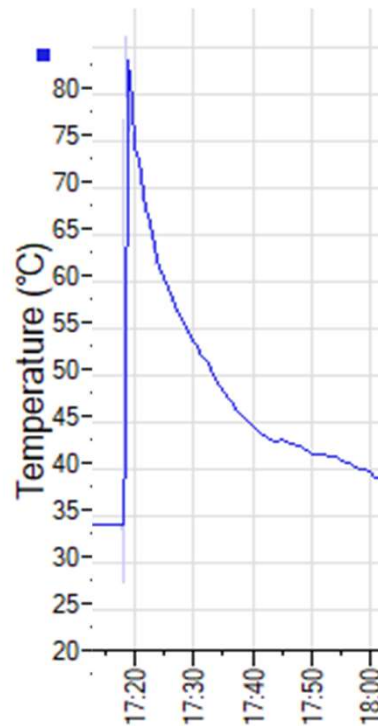
Opportunity: Crop Termination with Microwave?

- ❑ Aim: To use microwave to terminate the old strawberry crop (cv. Albion) and kill *Macrophomina* in their crowns before turning them back into soil.
- ❑ Microwave treatment: 10 sec per plant (5 kW unit)
- ❑ Control (comparison) Treatments:
Herbicides (glufosinate-ammonium + triclopyr),
Untreated
- ❑ Experimental size: Eight plots per treatment of 100 plants, 3200 plants in total (RCBD)
- ❑ Location: Silvan, Victoria, Australia



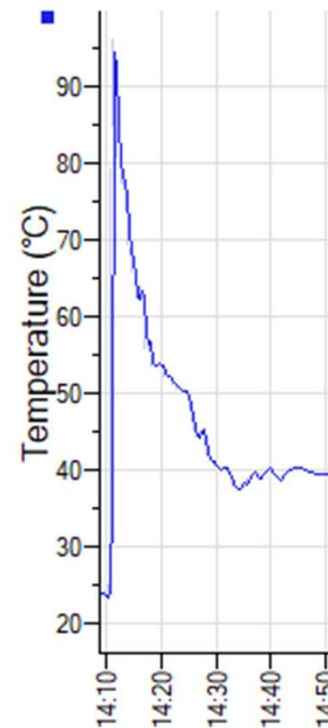
Temperature in Crowns after MW

Microwave (10 sec)



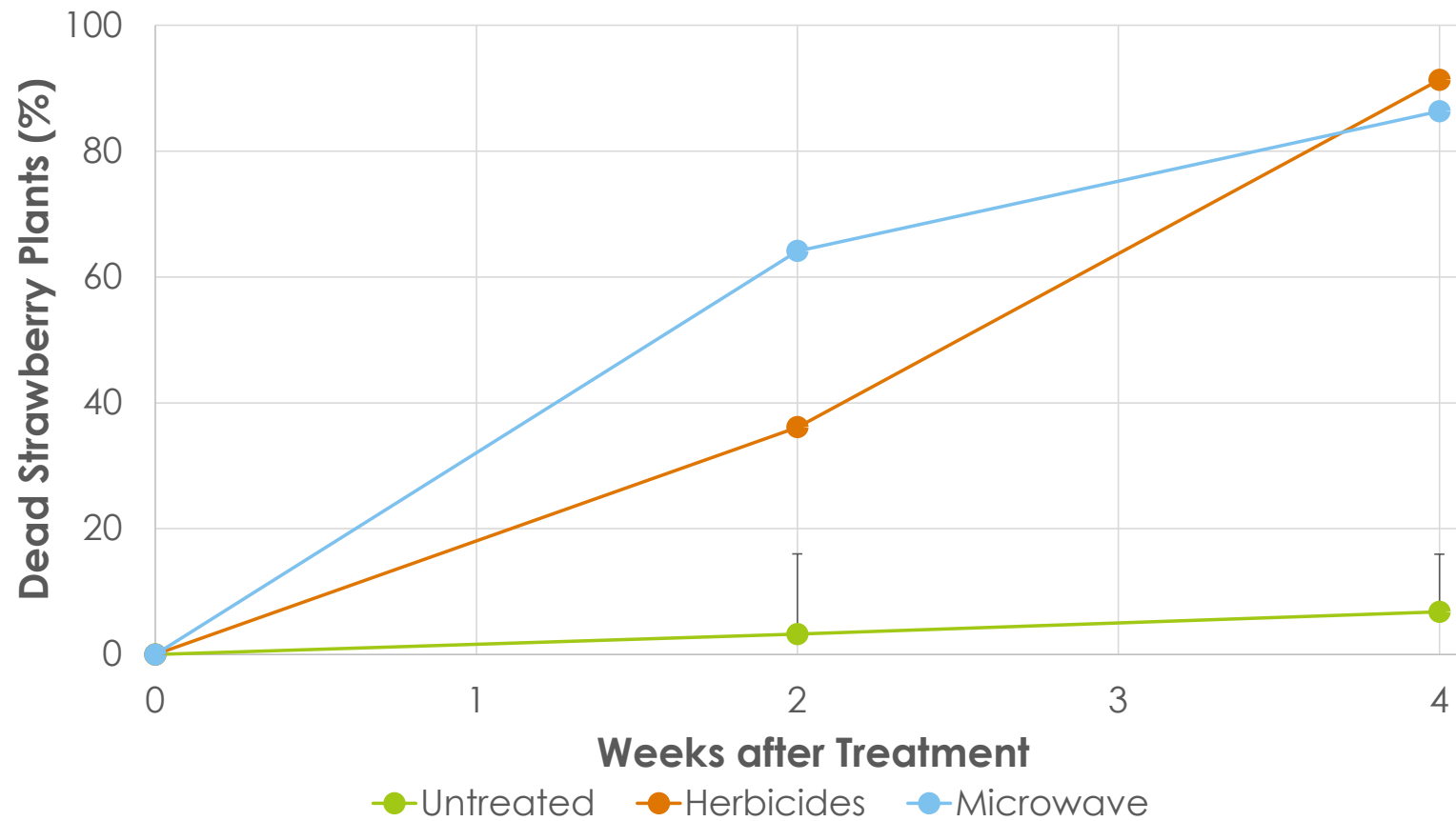
Max. Temp = 81°C

Microwave (15 sec)



Max. Temp = 96°C

Strawberry Crop Termination



Crop Termination with Microwave (4 wks)



Untreated

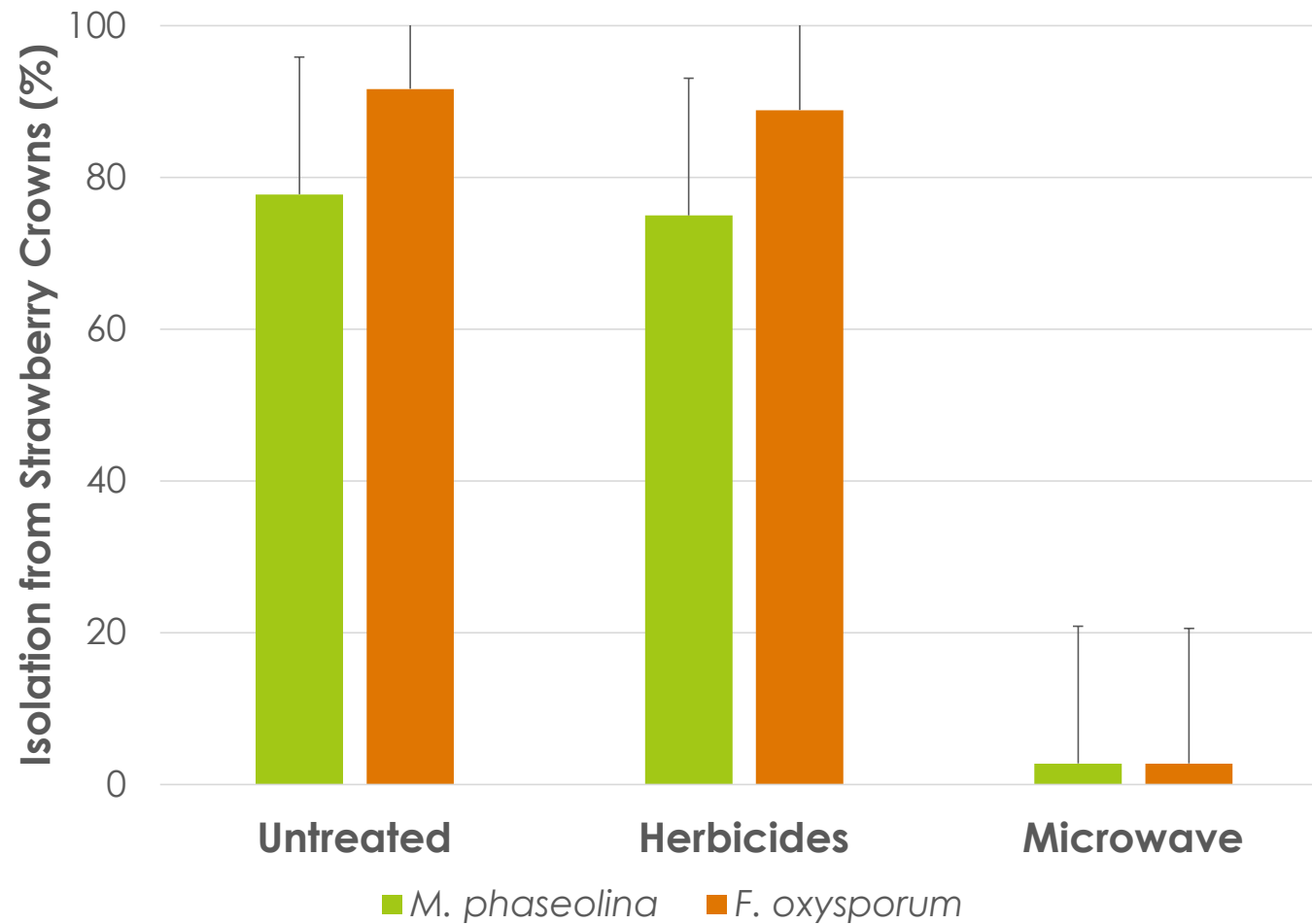


Herbicides

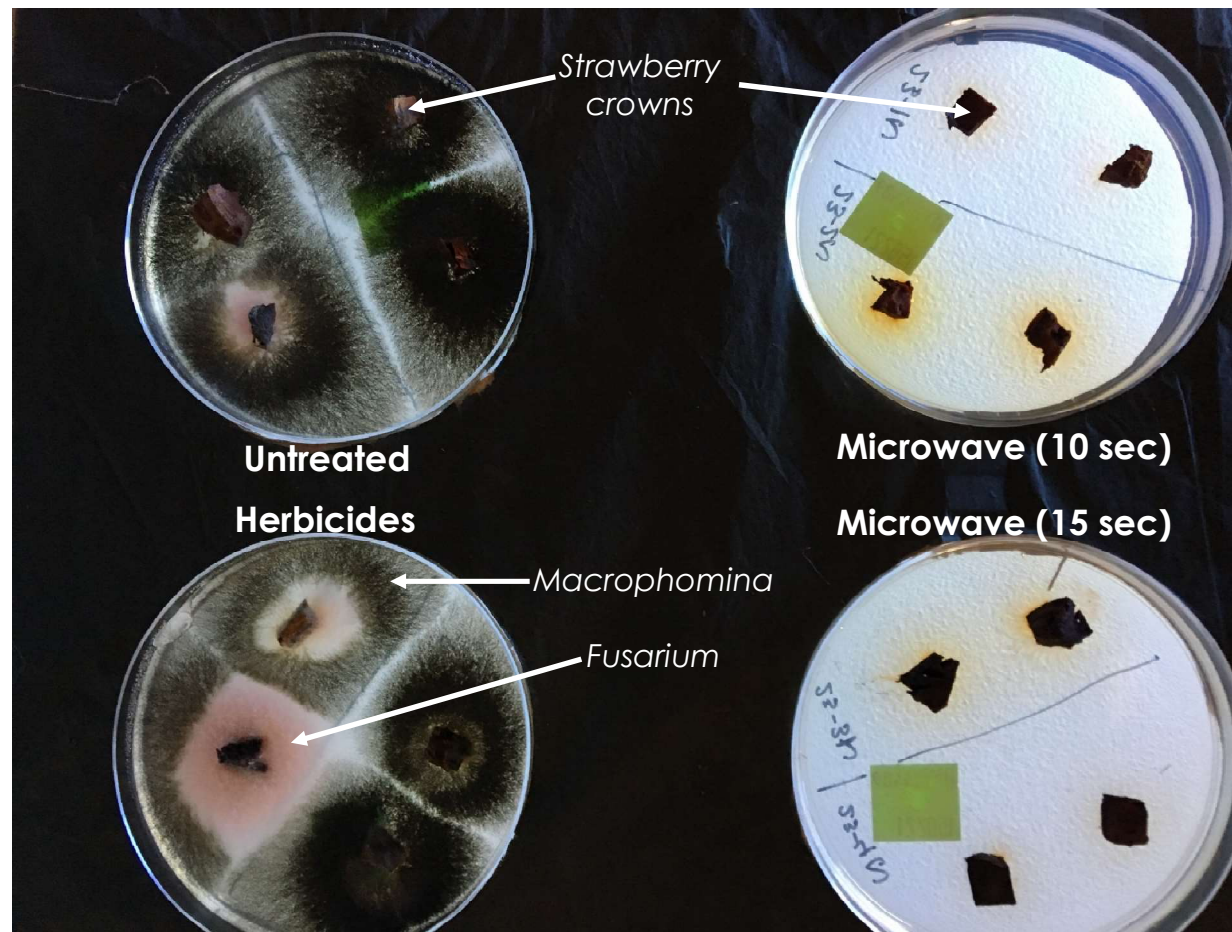


**Microwave
(10 sec)**

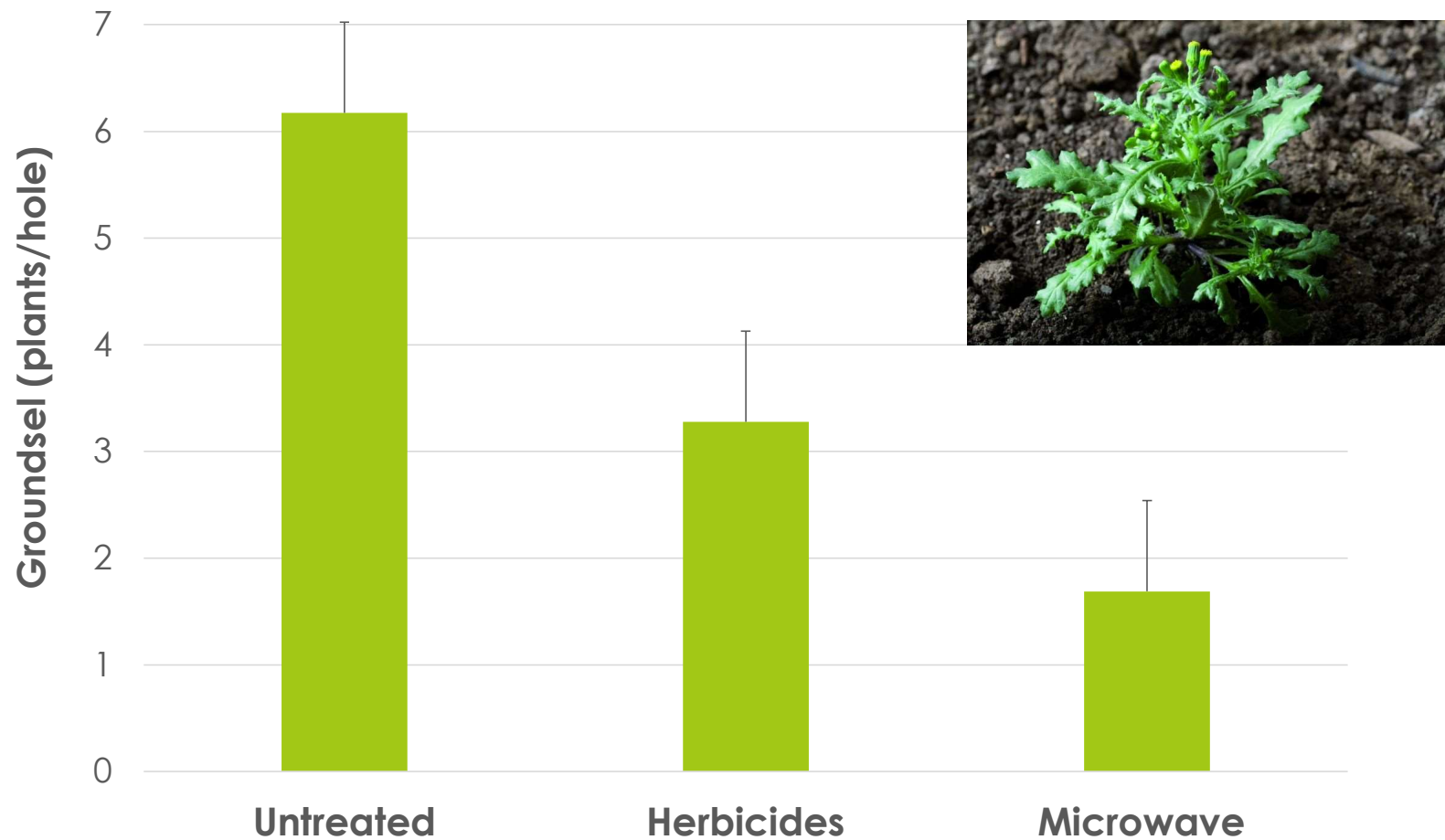
Pathogens in Infected Crowns after Crop Termination



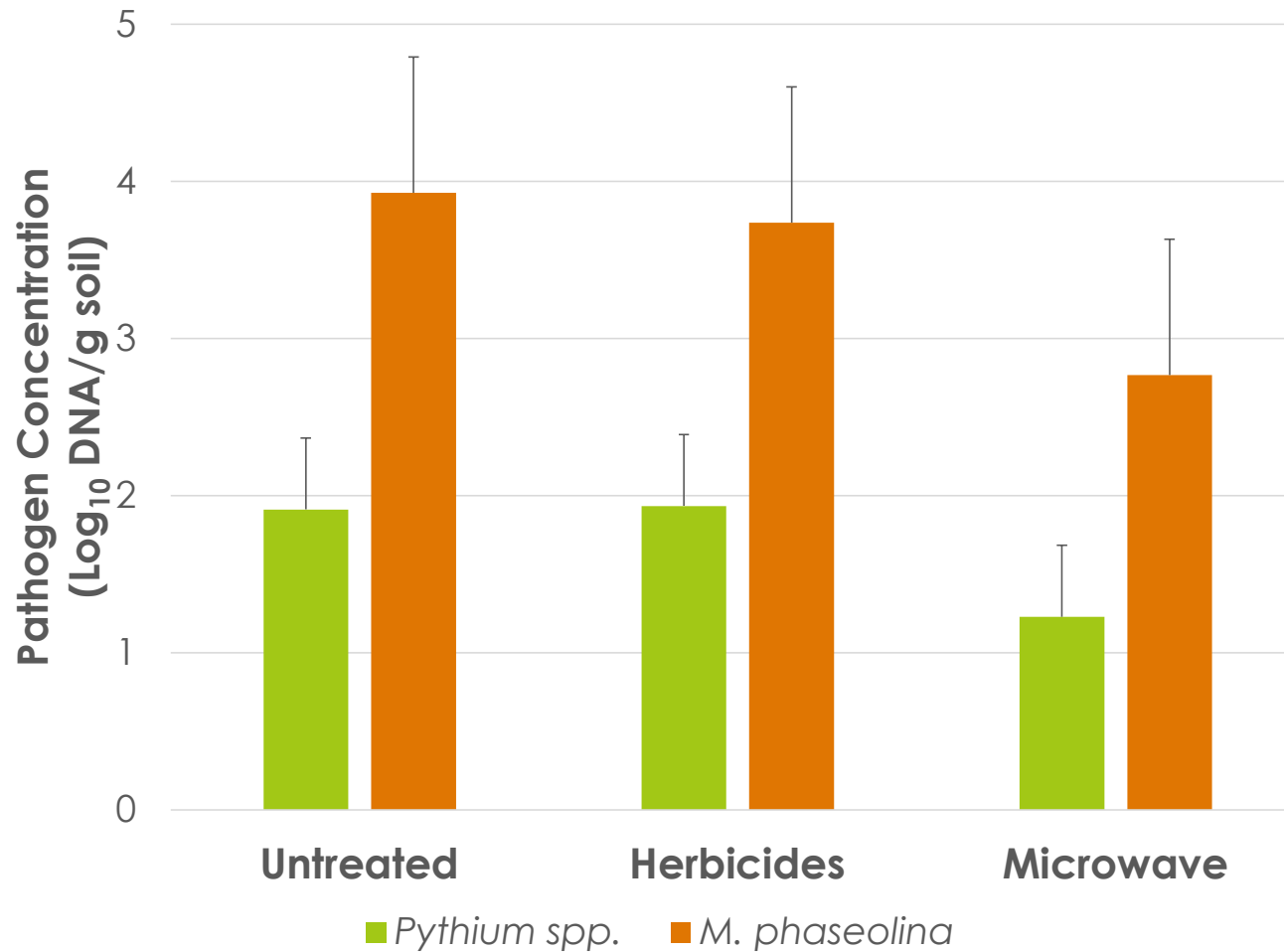
Effect of Microwave on *Macrophomina* and *Fusarium* in Strawberry



Weed Control (2 wks)

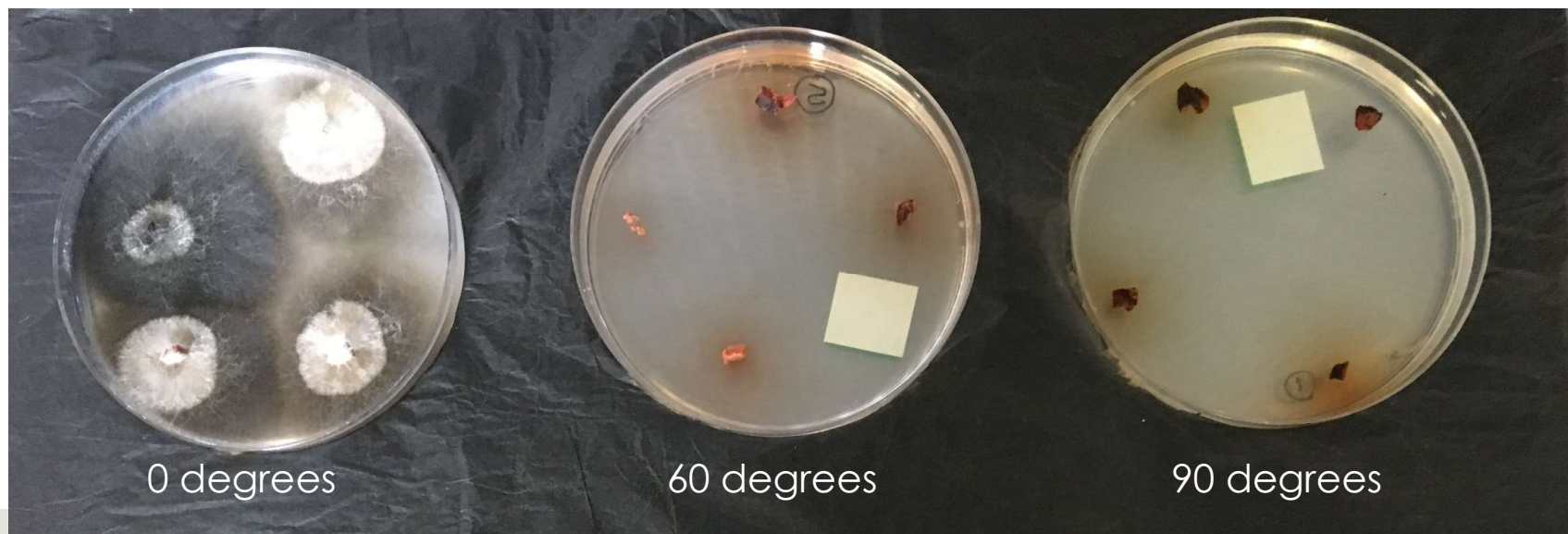


Pathogen Control in Soil (0 – 5 cm)



Improving Efficiency of Crop Termination with Microwave

- Engineering improvements: Higher power microwave units, autonomous operation
- Biological improvements: to better understand the temperature thresholds that kill *Macrophomina* in old crowns, especially when treatments are followed by soil fumigation



Opportunity: Soil Disinfestation with Microwave?

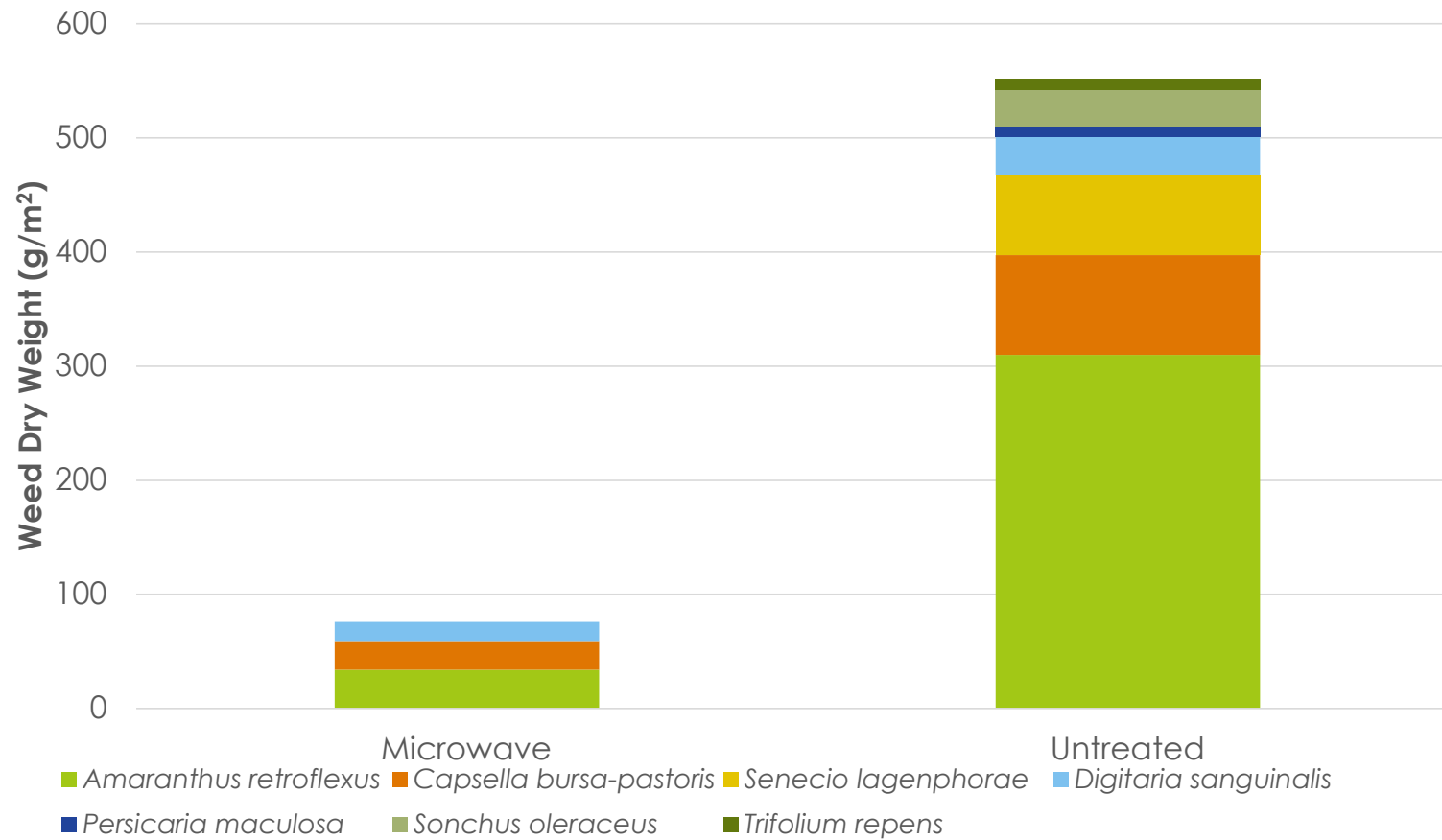


Opportunity: Soil Disinfestation with Microwave?

- ❑ Aim: To use microwave to disinfest soil for strawberry runner production (cv. Monterey).
- ❑ Microwave treatment: Four 2 kW MW generators used to heat soil at 5 cm to 80°C
- ❑ Control (comparison) Treatment: Untreated
- ❑ Experimental size: Five replicates of each treatment (2m x 2m microplots) (RCBD)
- ❑ Location: Toolangi, Victoria, Australia



Weed Control (7 months)



Weed Emergence (4 Weeks)

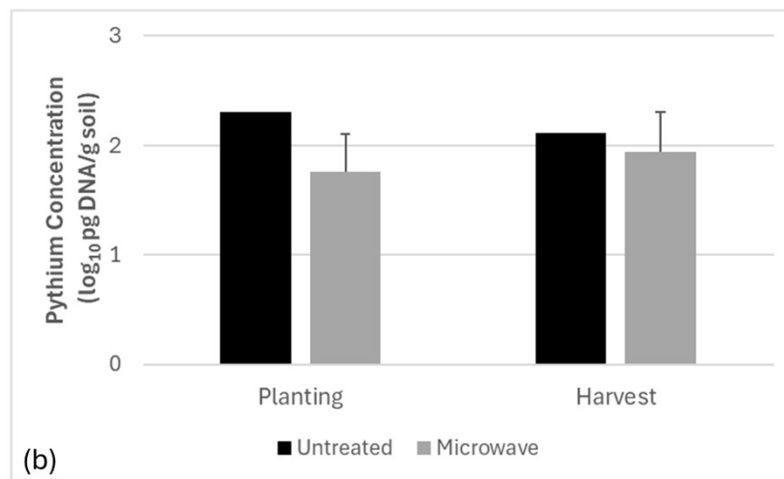
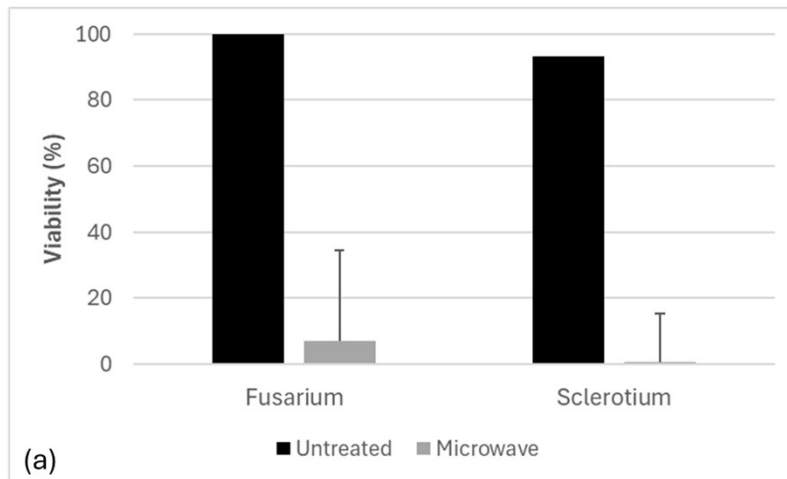


Untreated



Microwave

Soil-borne Pathogen Control



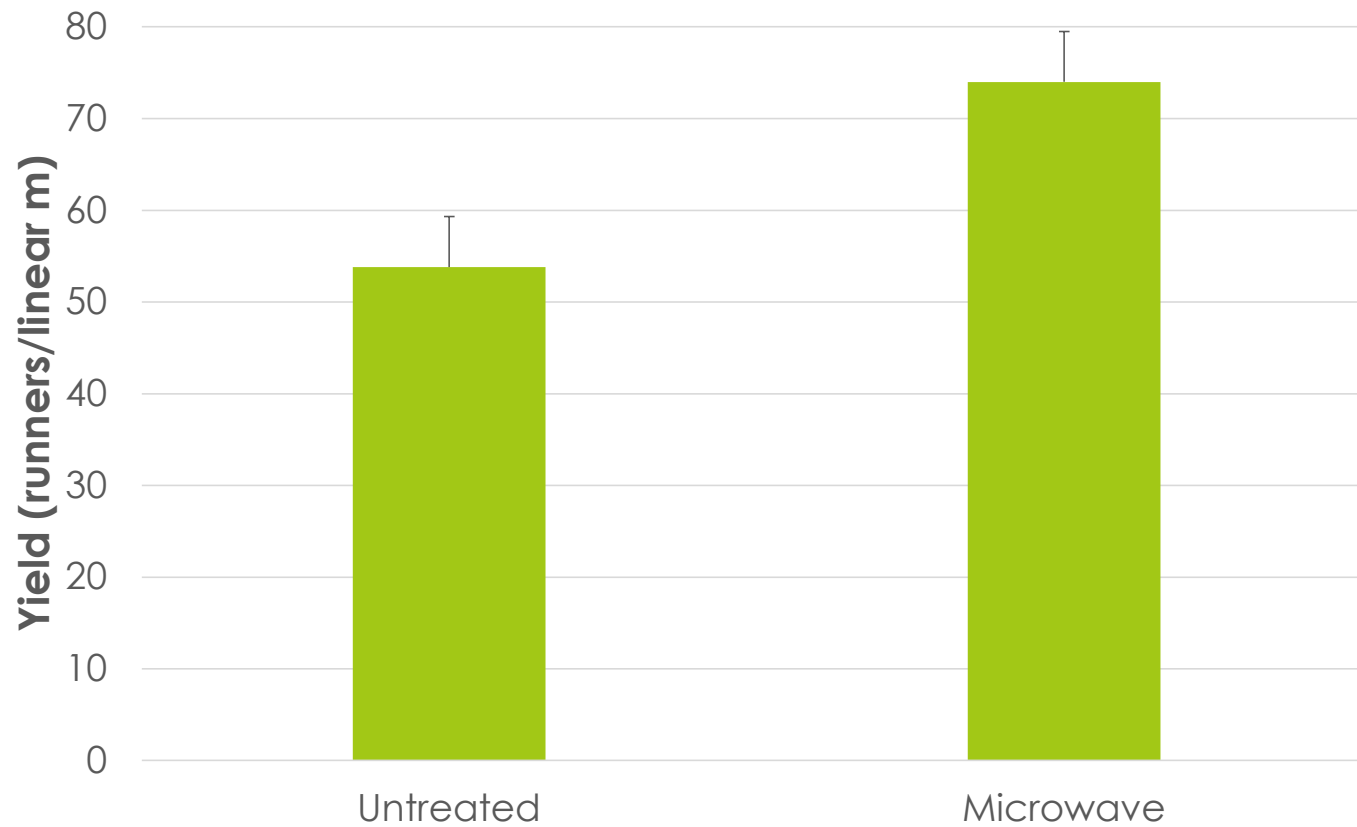
Strawberry Runner Growth (4 months)

Untreated



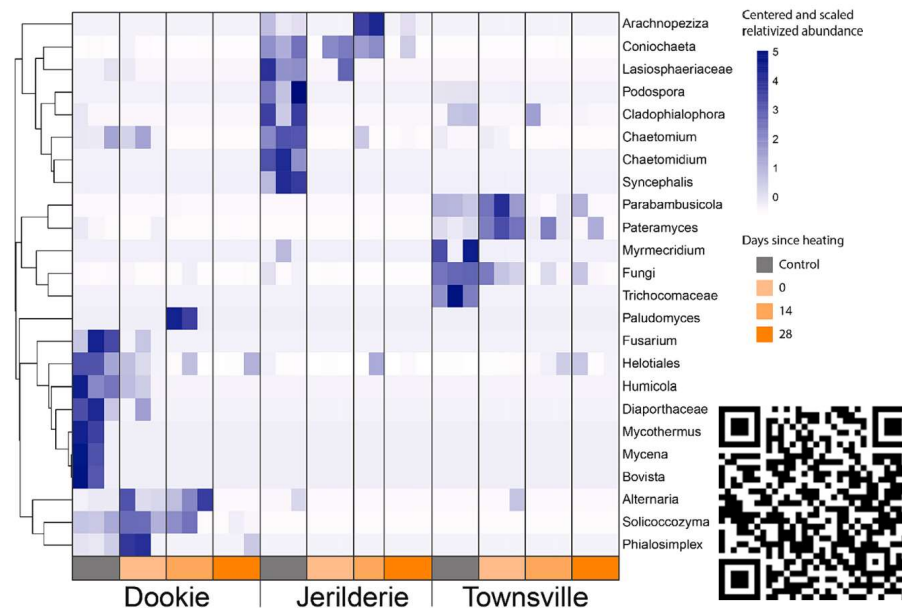
Microwave

Runner Yield (7 months)



Impact of Microwave on Soil Biology

- Used sequencing approaches (16S rRNA gene and ITS amplification) to understand the impact of MW on soil microbial communities.
- MW reduced fungal and bacterial richness in 3 contrasting soils for at least 4 weeks.
- MW changed microbial structure, promoting some taxa associated with increased crop growth.



Conclusions

- Microwave treatment of soil using prototype rigs has the capacity for soil disinfestation and crop termination against key soil-borne pathogens and weeds of strawberry.
- Further R&D is needed on microwave to optimise pathogen control through the soil profile, engineer autonomous delivery systems, and integrate its use with other treatments to manage soil-borne diseases more effectively.

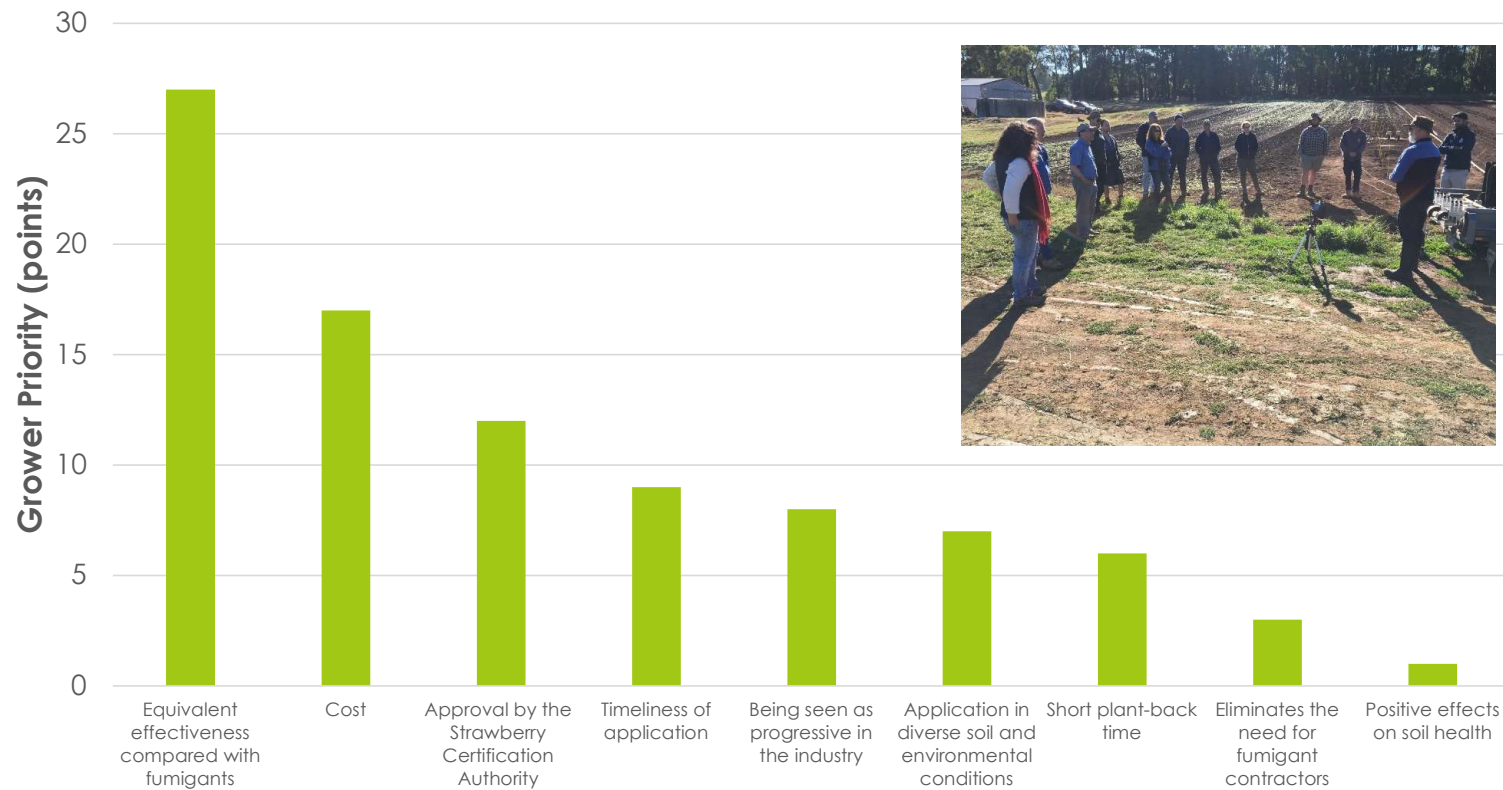


Microwave Webinar



Attitudes of Strawberry Nursery Growers

What would make you feel confident about adopting microwave for treatment of soil for runner production?





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Thursday

Networking Break

- Sponsors & Exhibitors Fair
- Poster Sessions

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