

Physical weed control strategies for vegetables using above and below ground strategies

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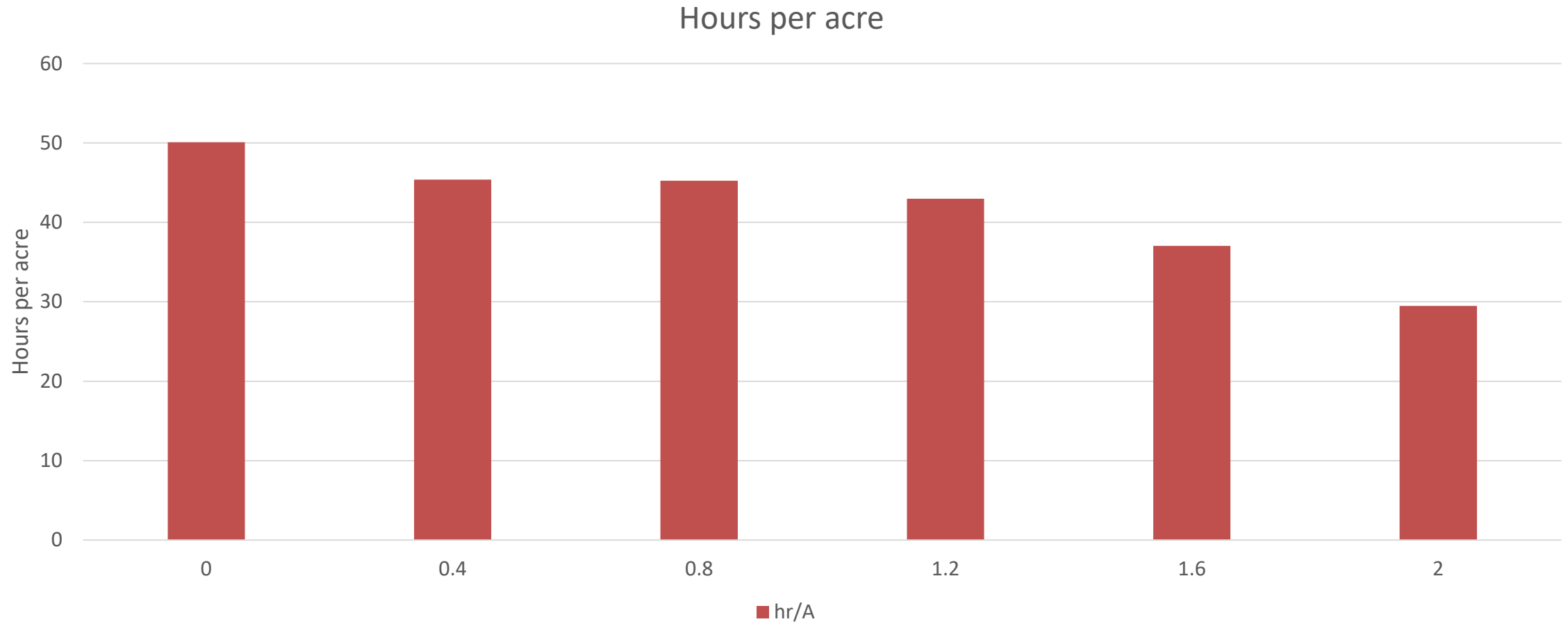


UCCE Monterey Nov. 3, 2022

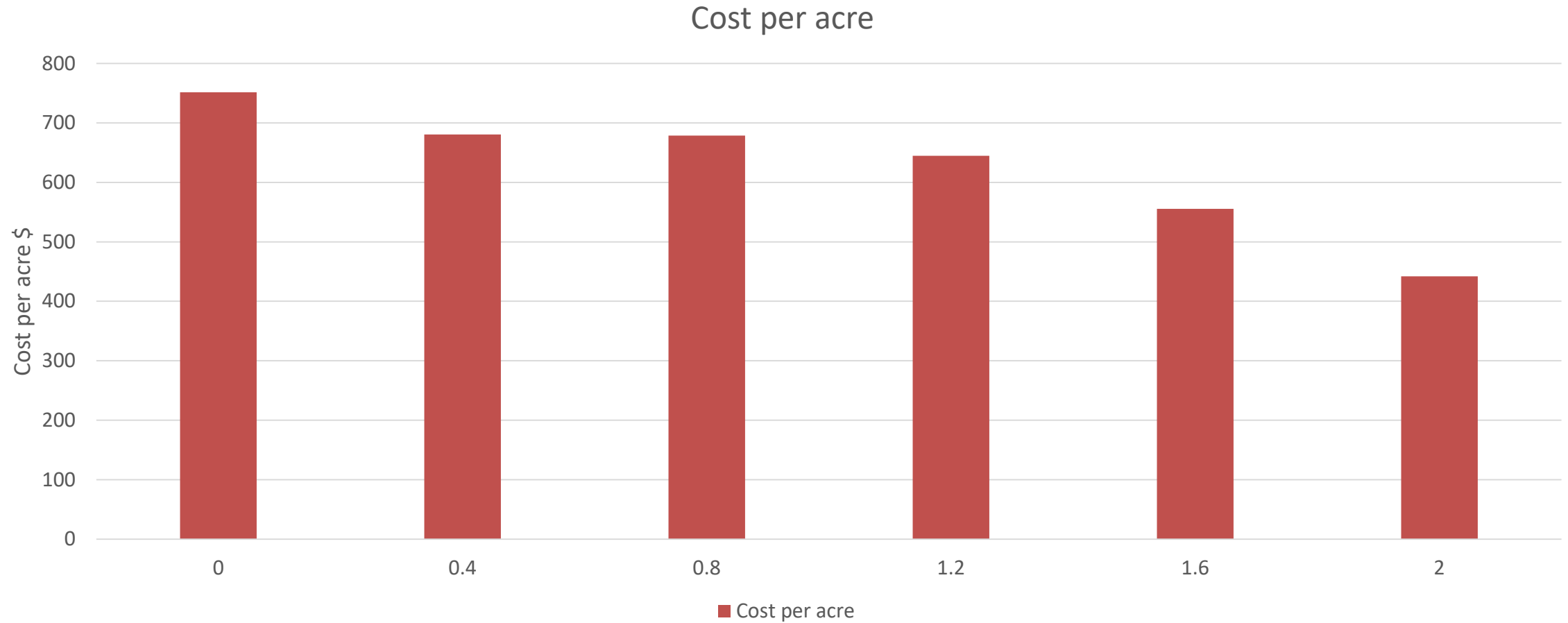
Are some weeds more expensive to control than others?

- ❖ We worked with a Cal Poly student who did a senior project to answer this question**
- ❖ Purslane was planted 0, 0.4, 0.8, 1.2, 1.6 and 2 inches from lettuce plants.**
- ❖ Time to hand weed these treatments was measured**

Time to remove weeds at 6 distances from lettuce plants



Cost (\$/A) to remove weeds at 6 distances from lettuce plants



Are some weeds more expensive to control than others?

- ❖ Yes weeds close to the crop are tedious to remove by hand and take more time to weed.
- ❖ How do we control those weeds close to the crop?

Two forms of physical weed control

- ❖ Laser weeder

- ❖ Band steam

High density crops like spinach are hard to weed

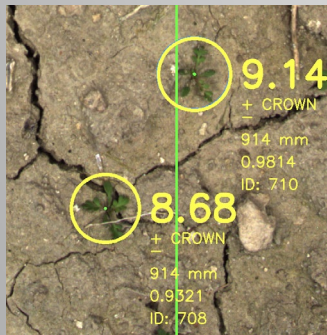


Weed Detection

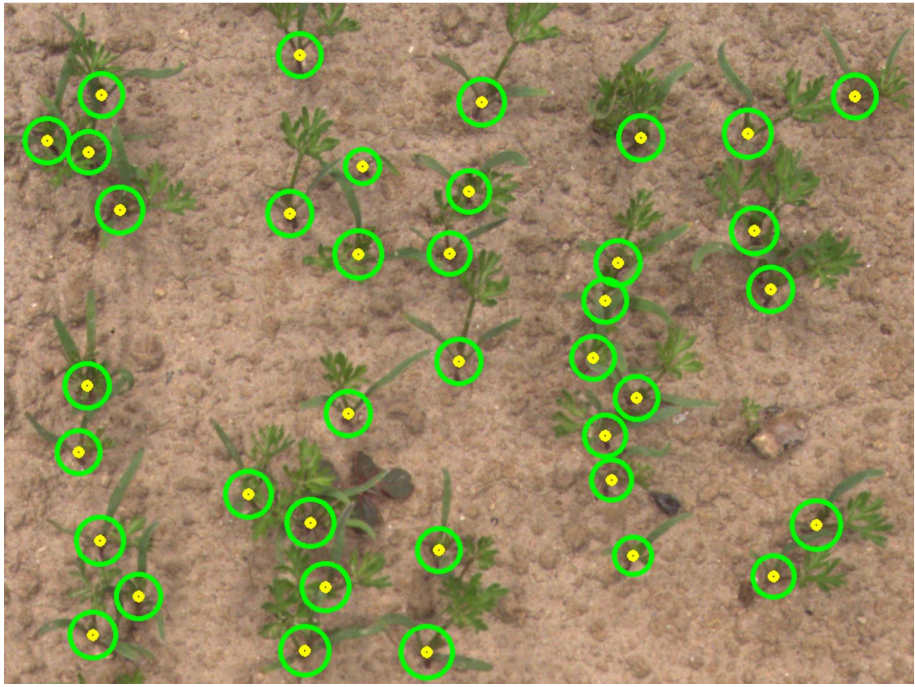
Meristem detection + inputs for kill time formula

- Size
- Weed Type
- Proximity to crop/infrastructure

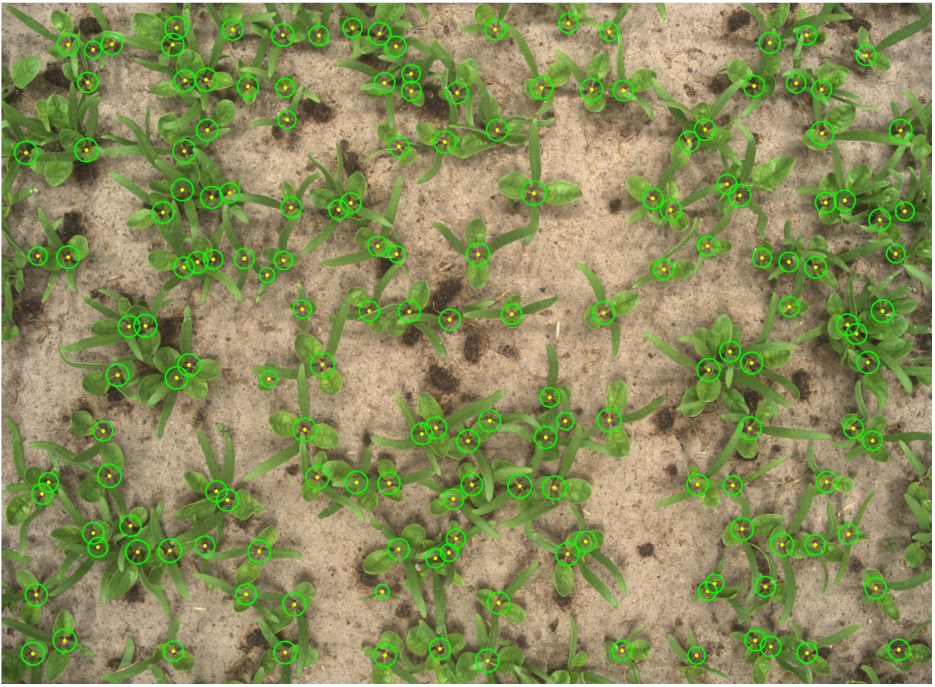
Day 1 weeds detectable



Crop/Yield differentiation



Carrots (actual computer-model output)



Spinach (actual computer-model output)

Weeding - Optimal Application Timing



Lighting

~4x brighter than sun

No shrouding required

= Does not touch the crop!



Lasers

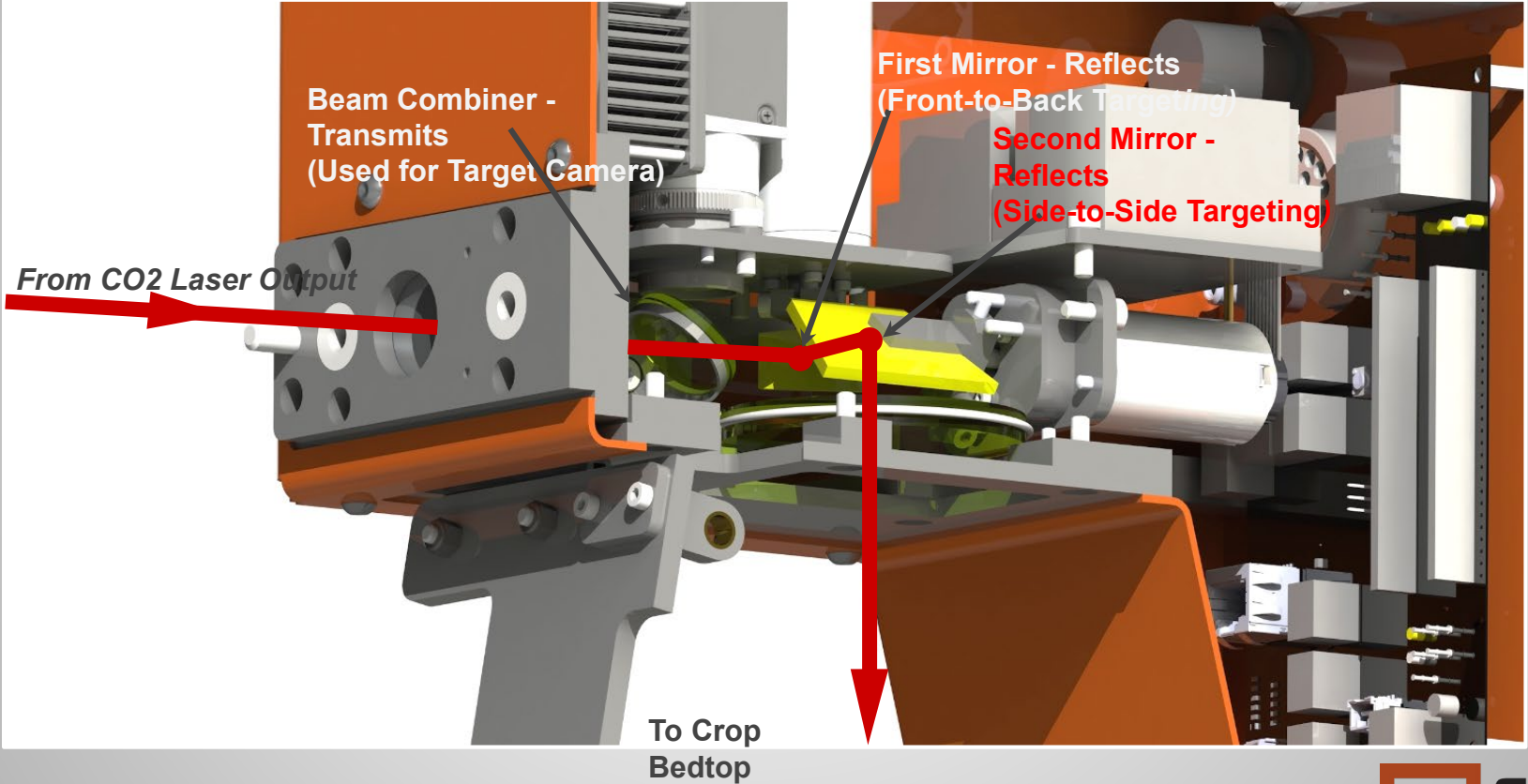
150 Watt CO₂

Multi-Season Tested

Easily Swappable (Consumable)



Scanner: Laser Beam Path



Implement: Slayer (2022)

“3-Row” (6 m wide)

Tractor pulled/liftable

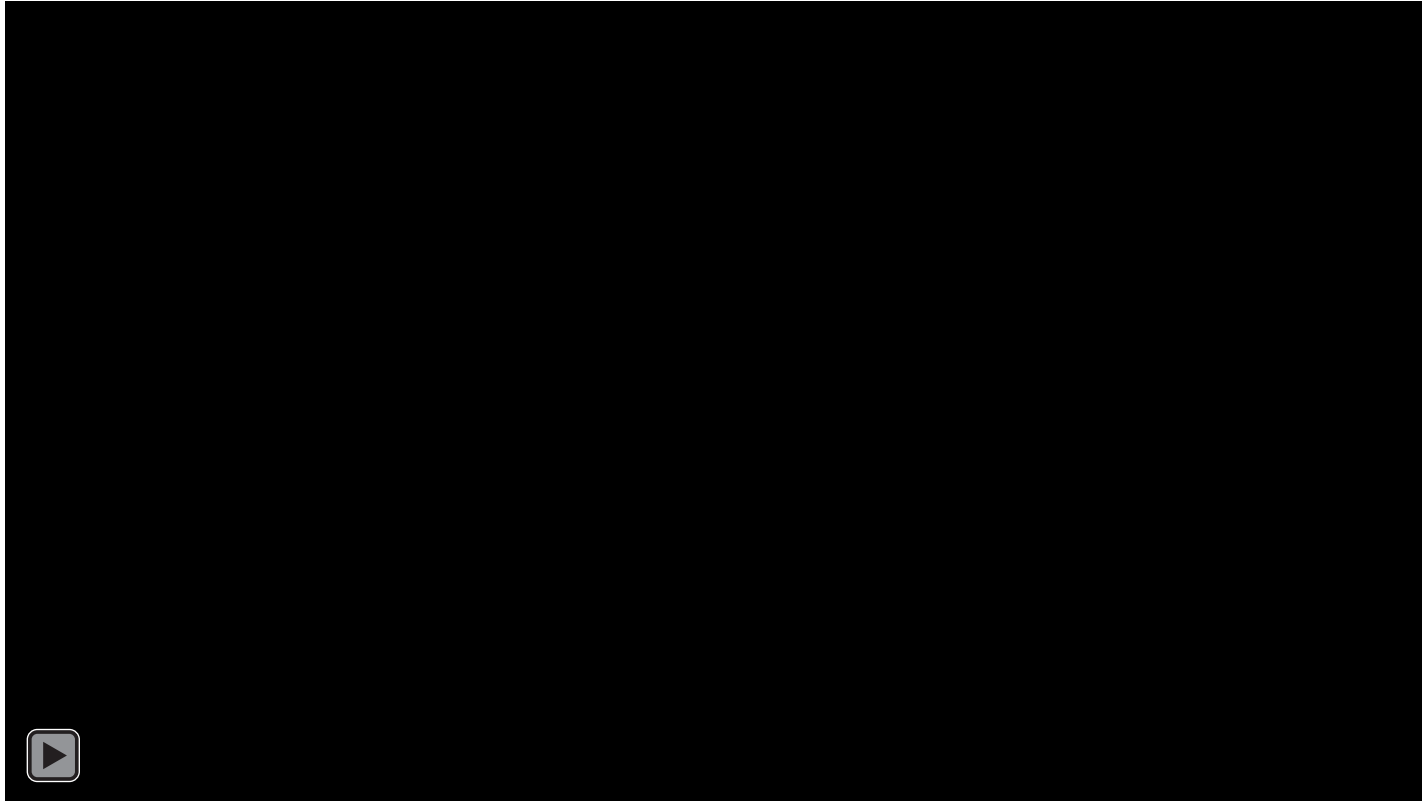
JD 6145R Minimum

0.8-1.4 ha/hour (2-3.4 acres/hr)

30 Lasers (10/bed)



Laser weeder at Soledad, CA



Preliminary results with Carbon Robotics weeder

- ❖ Two trials in high density arugula (*Eruca vesicaria*) at Soledad, CA and San Lucas, CA**
- ❖ Soledad 80% weed control SD 14.6%**
- ❖ San Lucas 83% weed control SD 15.9%**
- ❖ In high density crops it has a very short window to control the weeds due to crop growth and weed visibility to the weed detection system.**

Laser weeder weed control in spinach




| Treatment | Dead bed | Middle bed |
|-----------|-----------|------------|
| | % control | |
| Control | 0 | 0 |
| Laser | 66 | 96 |

Richard Smith data, San Lucas, CA

Laser weeder weed hand weeding times in spinach

| Treatment | Dead bed | Middle bed |
|-----------|----------------|------------|
| | Hours per acre | |
| Control | 69 | 26 |
| Laser | 25 | 12 |

Richard Smith data, San Lucas, CA

| | | |
|---|--|---|
|  |  |  |
| Figure 1 | Figure 2 | Figure 3 |
| Planting configuration of arugula | Weed removal around arugula | Weed removed within millimeters of keeper plant |

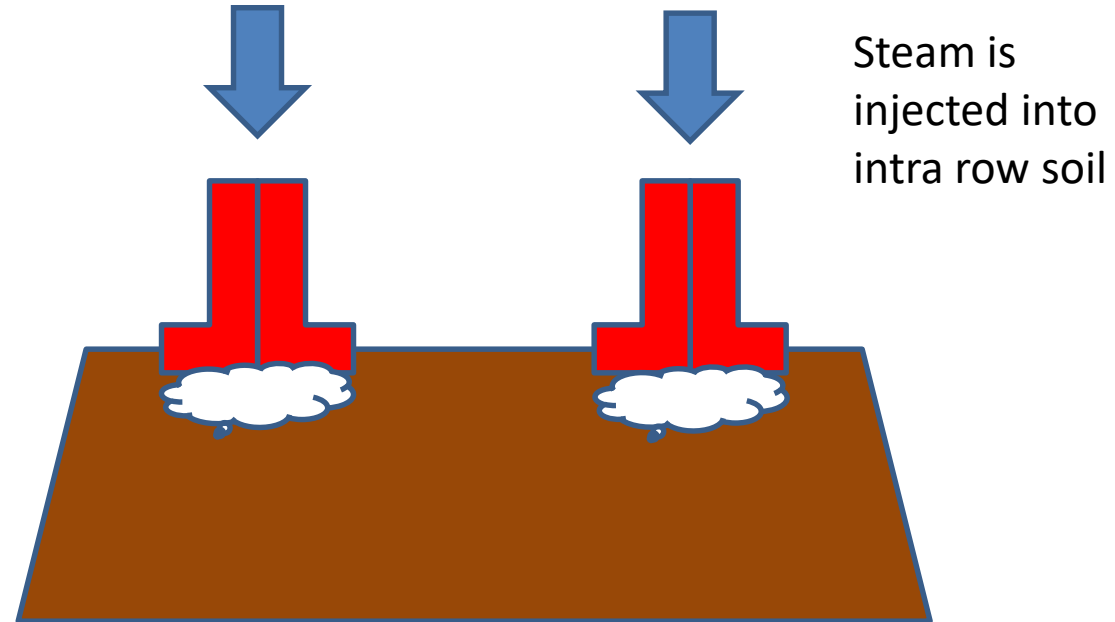
Richard Smith photos

Steam – another way to get the close weeds

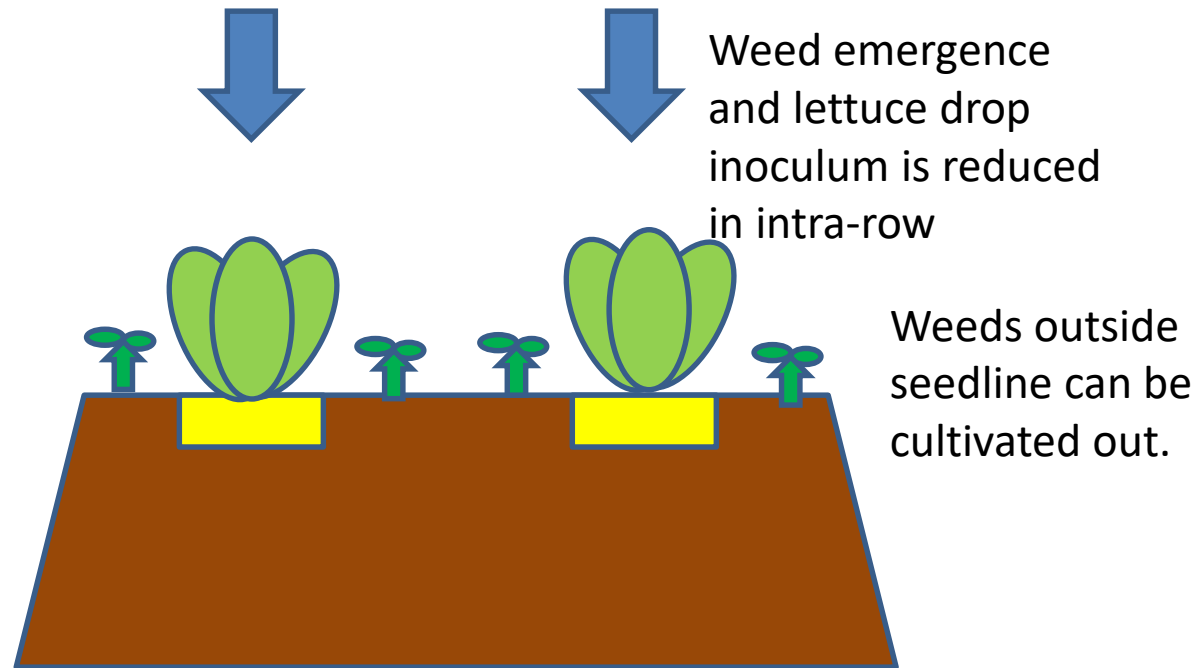
- Evaluate soil disinfestation with steam in lettuce for control of soilborne diseases and weeds.



Seed lines disinfested with steam



Seed lettuce into the disinfested band



Salinas field steam tests

- Lettuce – steam applied 5.3.22, planted 5.5.22, harvested 7.15.22 & 7.20.22.
- Steam was applied in a band 4 inches wide by 4 inches deep
- The field station trials were replicated 4 times and arranged in a RCBD

Data collected

- Weed densities, weeding times
- Pathogen control: *Pythium* spp., *Sclerotinia minor*,
- Lettuce yield

Weed control by species

- Purslane 99%
- Shepherd's-purse, nettleleaf goosefoot 88%
- Burning nettle, henbit, pigweed 100%
- Little mallow 42%



Weed densities & hand weeding times in lettuce with band steam

| Treatment | Weed densities | Weed time |
|-----------|----------------|-----------|
| | 1,000/A | Hr/A |
| Steam | 103 b | 22 b |
| No steam | 1080 a | 39 a |

***Pythium ultimum* control before & after steaming**

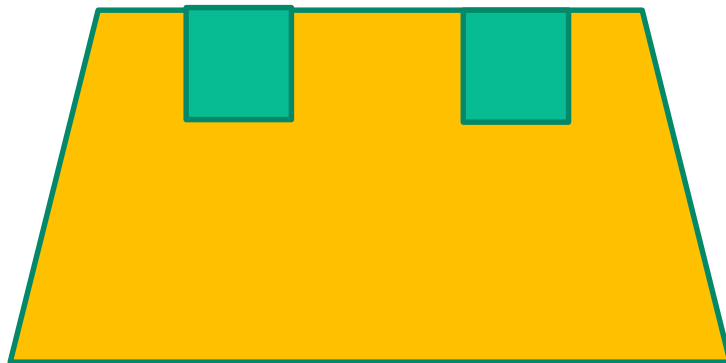
| Treatment | Before | After |
|------------------|-------------------|---------------|
| | CFU/g soil | |
| Steam | 563 | 77 b |
| No steam | 528 | 320 a |
| P-value | 0.447 | 0.0198 |

Lettuce yields

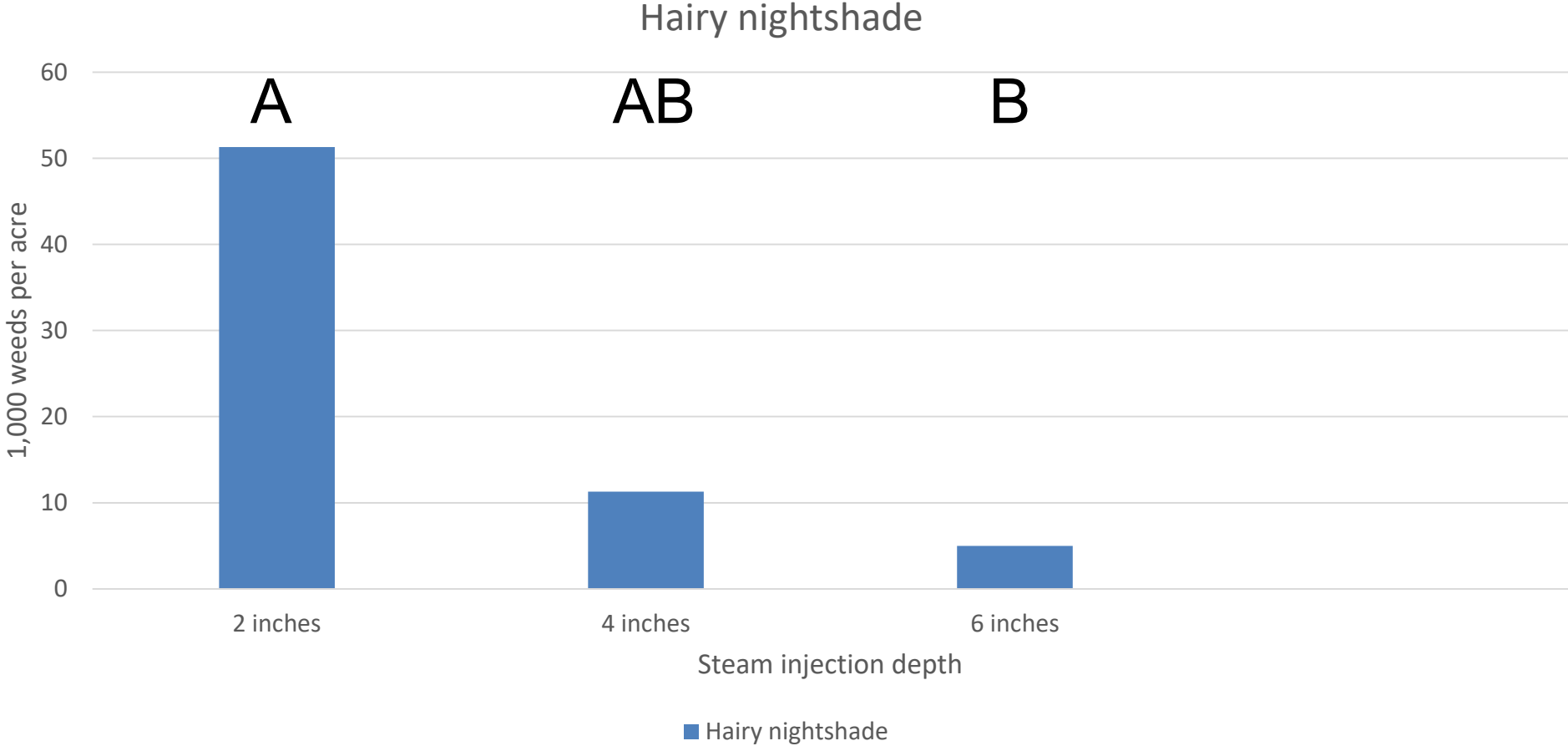
| Treatment | Yield |
|-----------|--------|
| | Tons/A |
| Steam | 21.2 |
| No steam | 22.1 |

Band Steam width and depth study

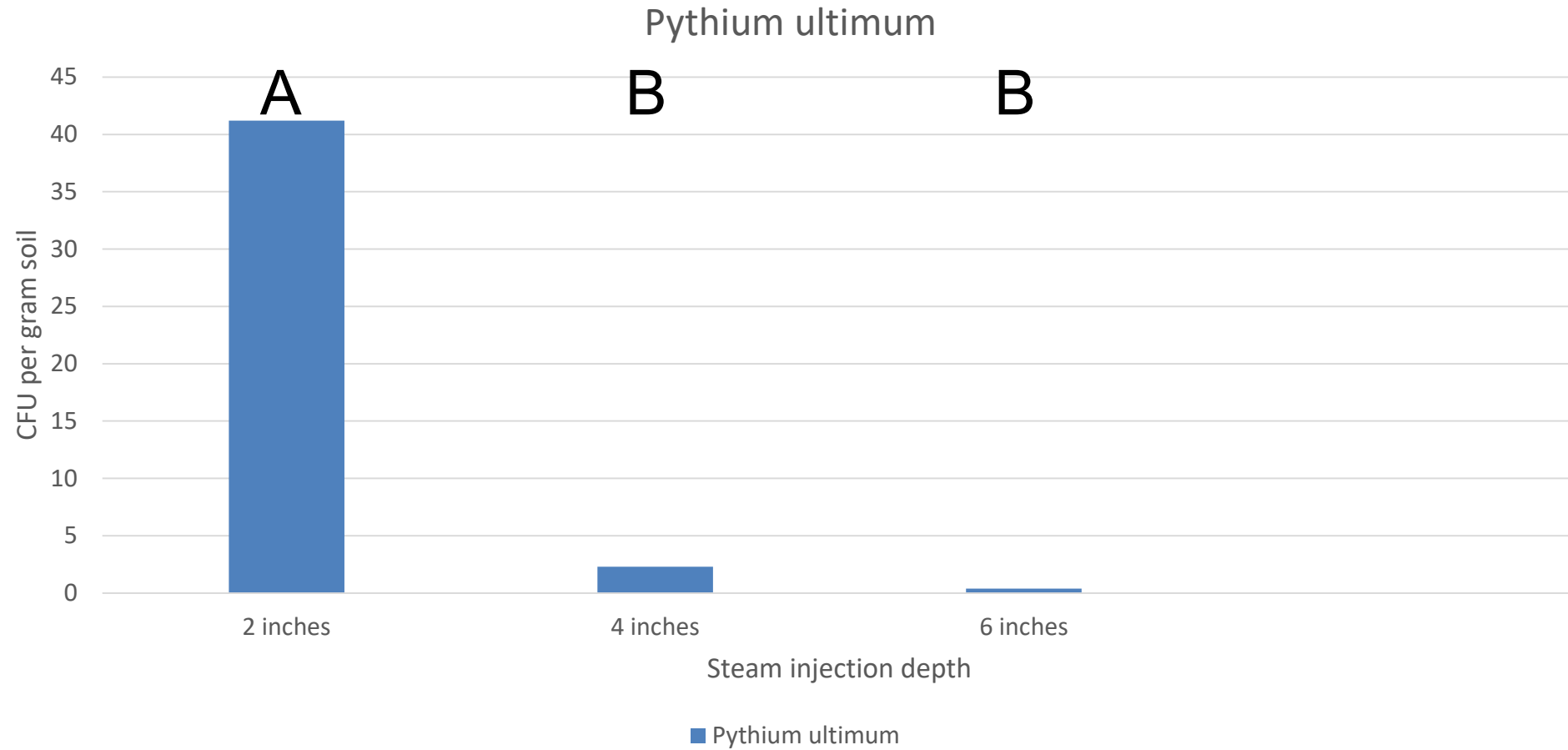
- Conducted to find the optimal depth and width of the band
- Widths tested were 2 and 4 inches
- Depths tested were 2, 4 and 6 inches
- Weed control, hand weed times, disease suppression



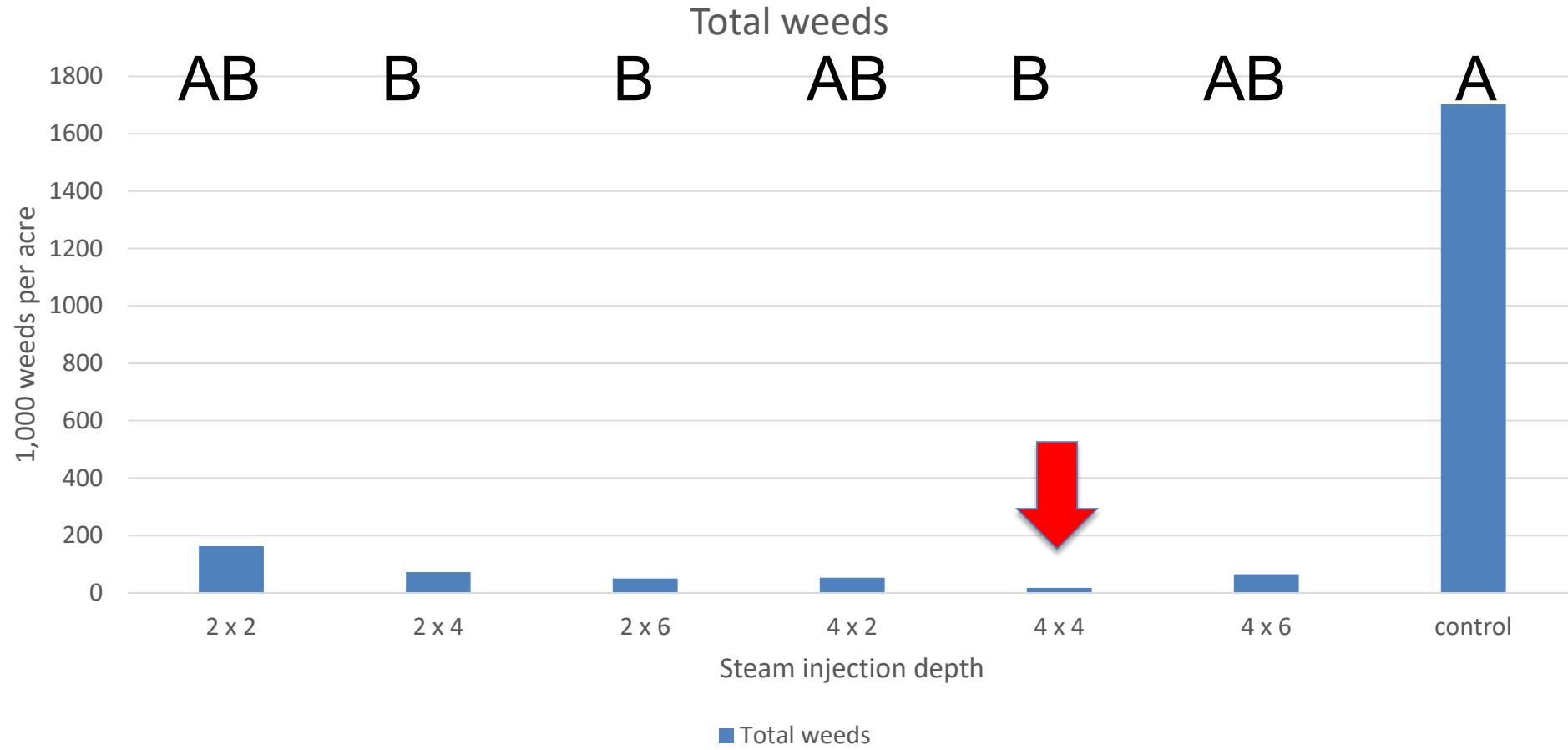
Steam injection depth effect on hairy nightshade control



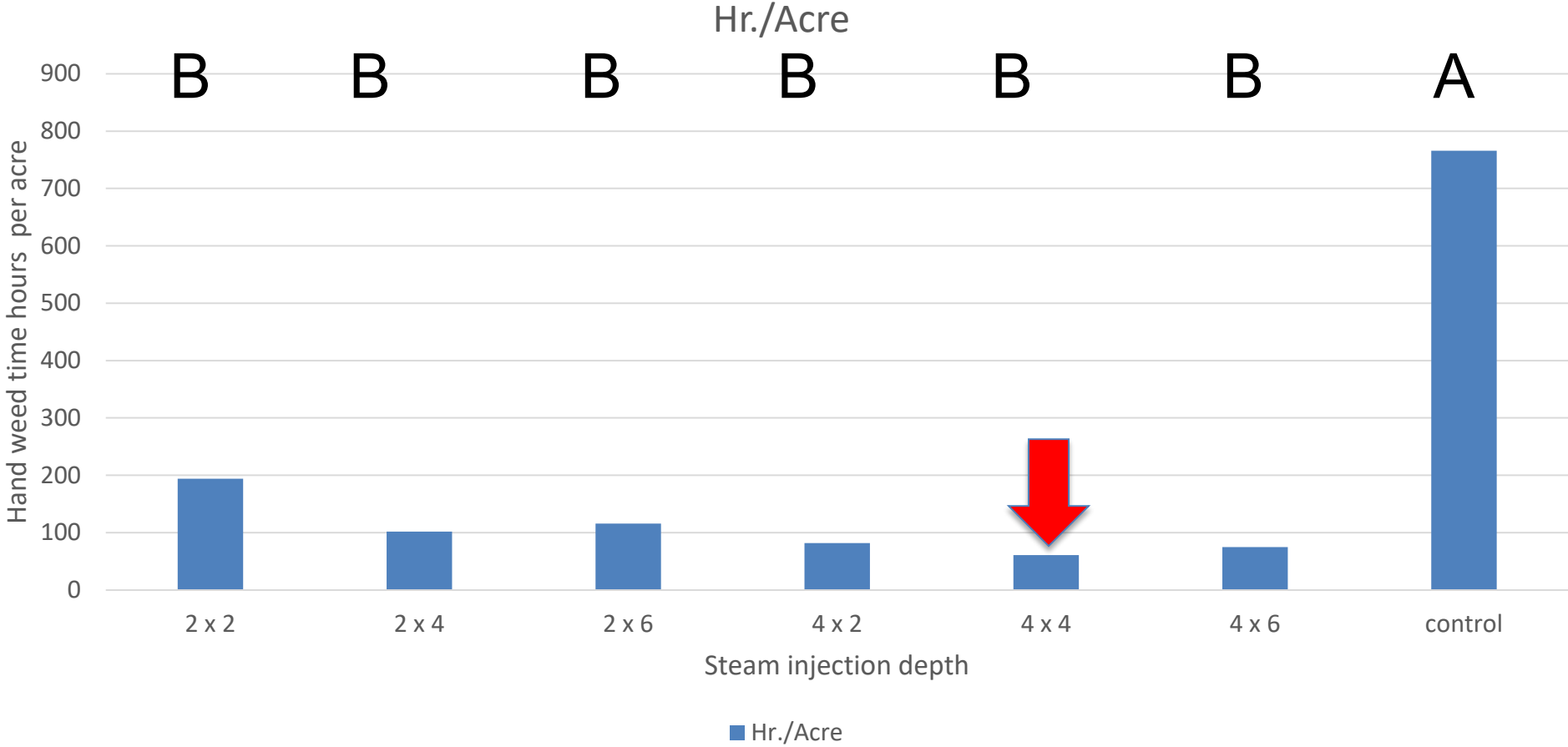
Steam injection depth effect on *Pythium ultimum*



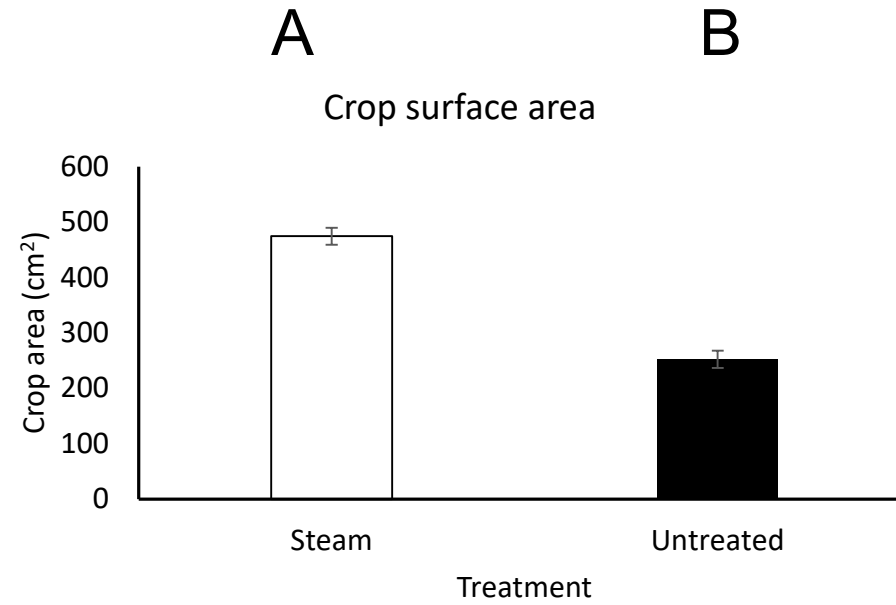
Steam injection width X depth effect on all weeds



Steam injection width X depth effect on hand weed time



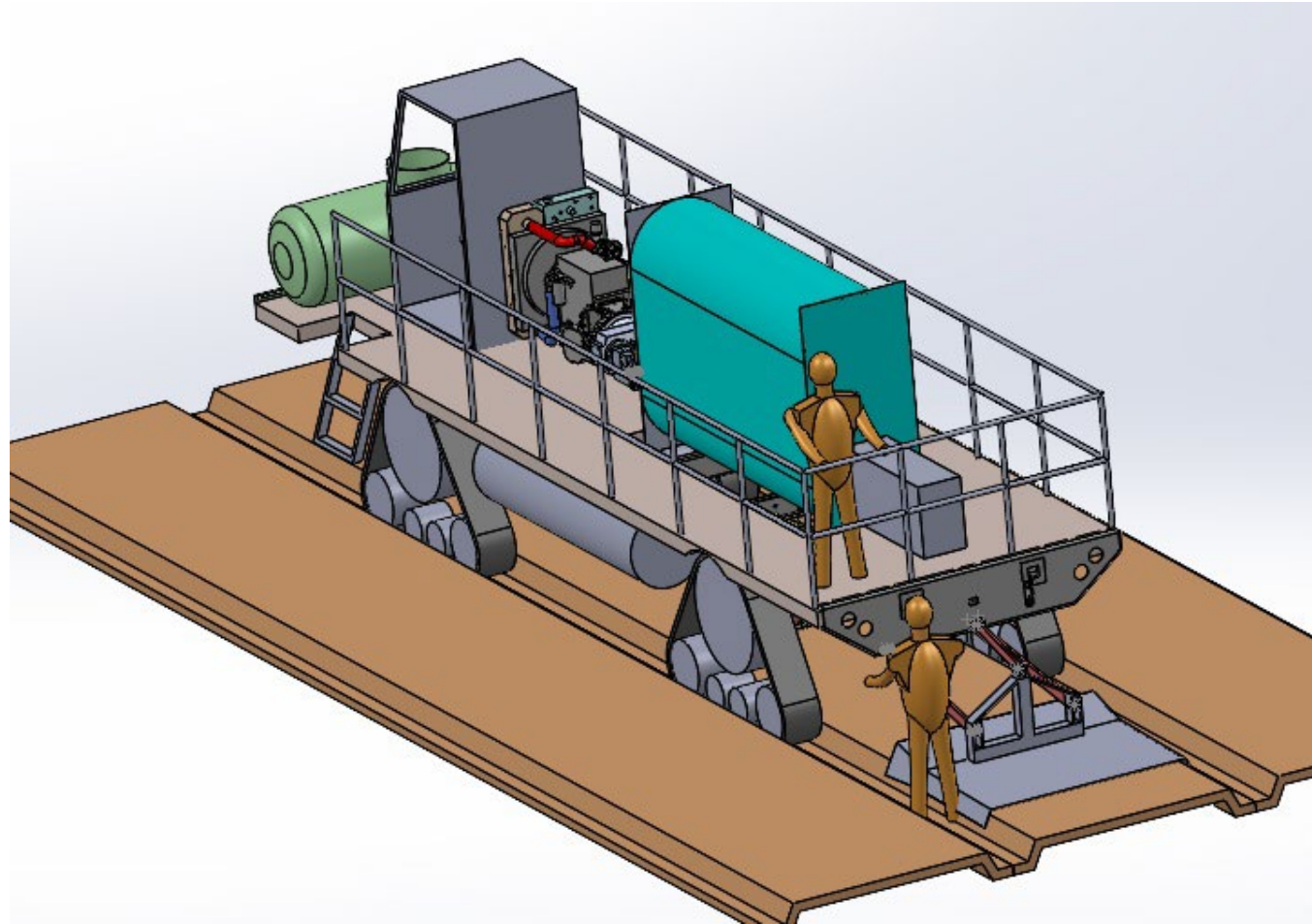
Lettuce plant size at harvest



Summary

- Steam controls weeds and *Pythium spp.* inoculum
- Steam boosted lettuce yield in our 2021 trial but not in 2022 due to less disease pressure
- For lettuce the band width of 4 inches wide by 4 inches deep is optimal for weed and *P. ultimum* control.

Commercial scale steam applicator



Steam plans

- 2022 Steam applicator is now in Yuma for winter work there with Mark Siemens
- Currently applying for private funding to build a commercial scale steam applicator

Acknowledgments

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- Carbon Robotics
- Grower partners and weeding crews
- Mark Siemens, University of Arizona, Yuma
- Connel Ching'anda & John Rachuy UCD