How Artificial Intelligence Will Impact Weed Management Today and in the Future

Nathan S Boyd

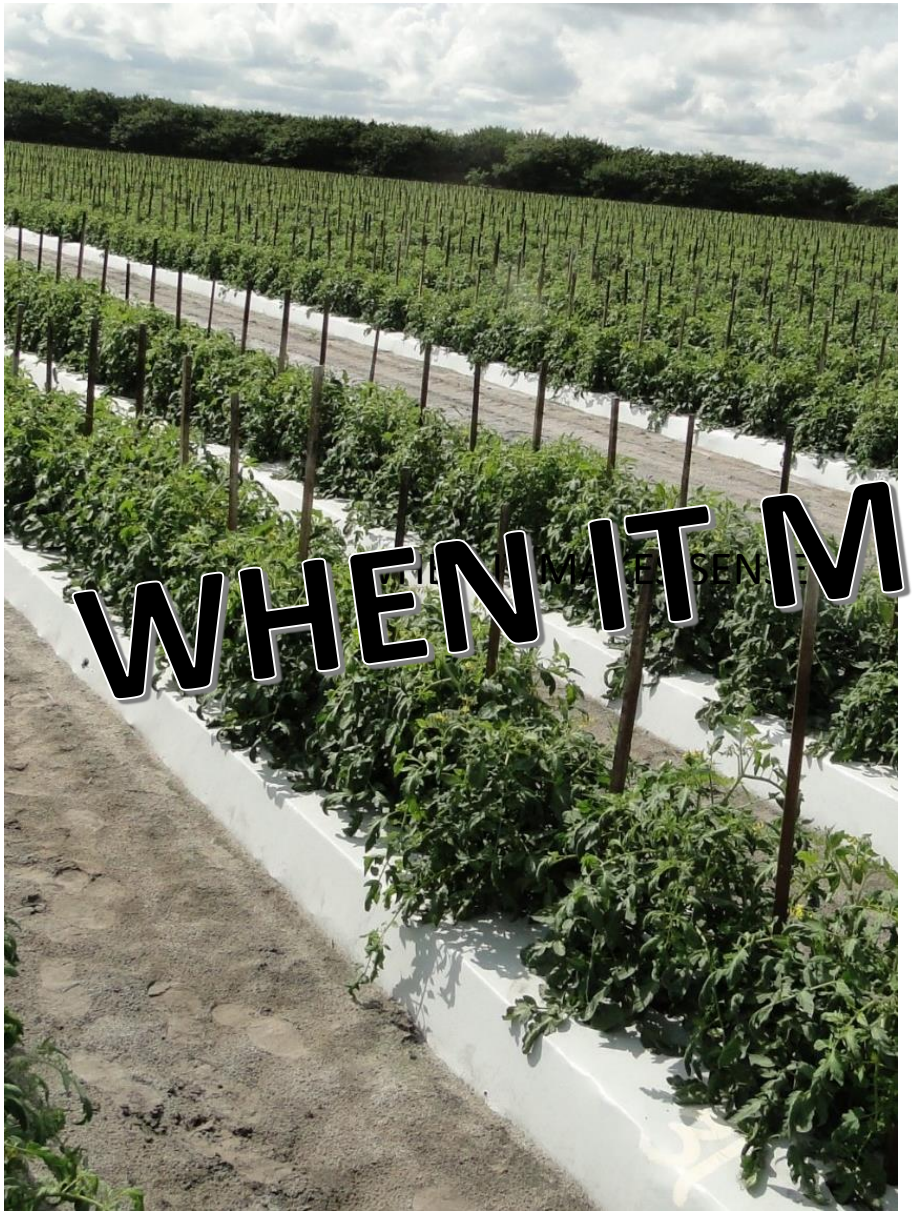
Ana Buzanini

Renato Herrig

Alex Rodriquez

Arnold Schumann

Farmers frequently…



WHEN IT MAKES SENSE

…adopt new technologies

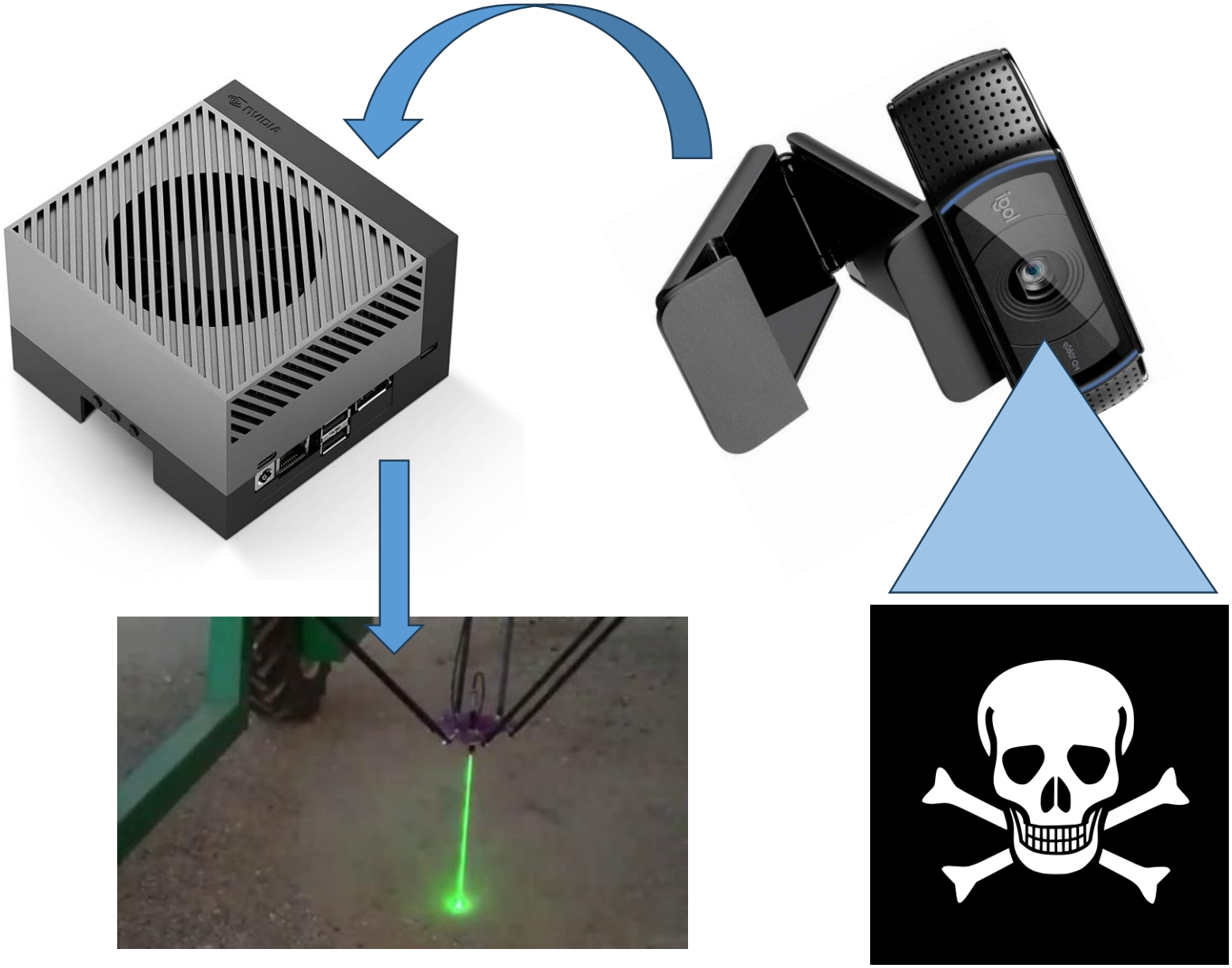
Evolution of Modern Agriculture

- Bigger
- Stronger
- Faster

Artificial Intelligence

- Automated
- Easy to use
- Targeted

Real-Time Targeted Weed Management



Alternative Actuators

Mechanical Weed Removal

Targeted Herbicide Applications

Targeted Weed Management

- Actuators and herbicides that were not economically feasible for broadcast applications may be feasible on a targeted scale.
- Alternative weed control options in reduced or no-till systems.
- Opportunities to make equipment lighter (less soil compaction) with reduced fossil fuel consumption (climate change).

Targeted Weed Management Only Effective if:

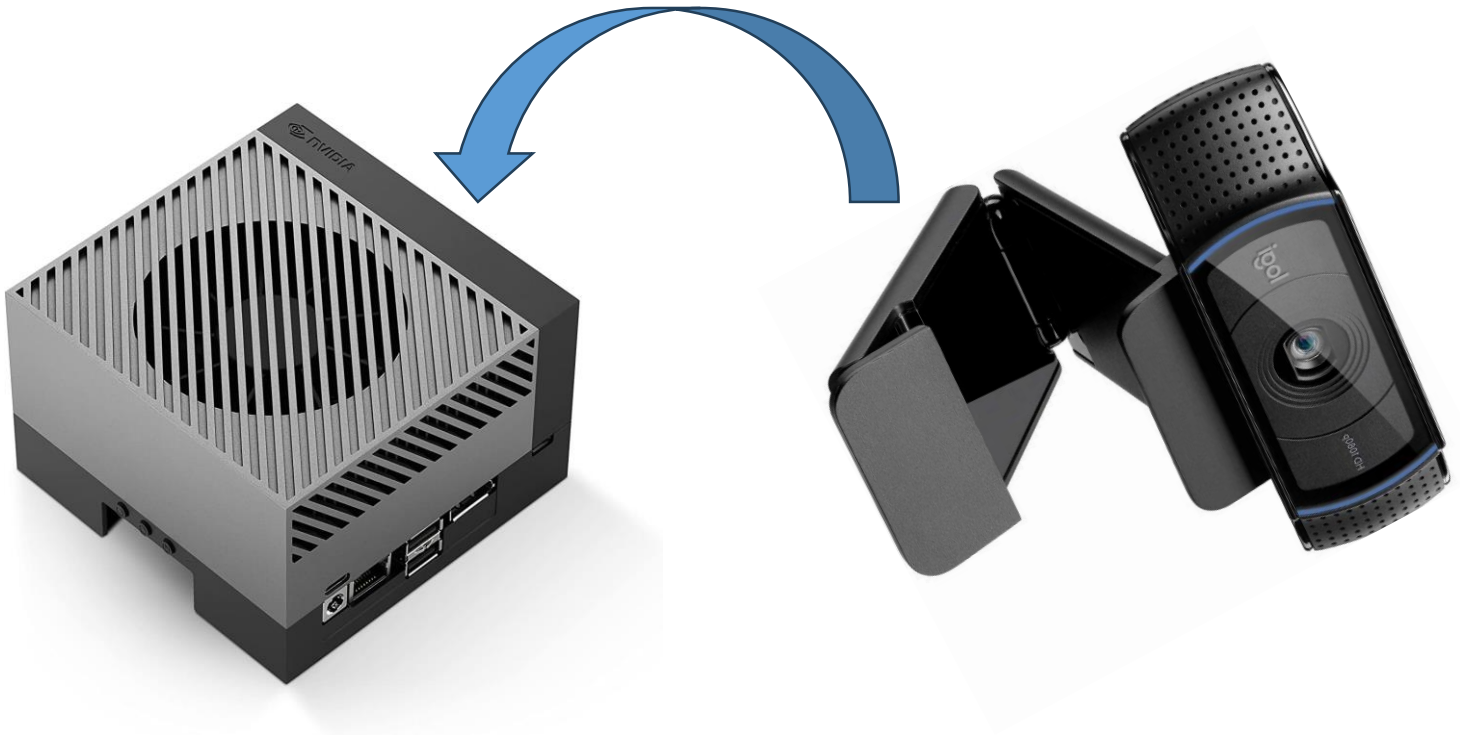
- Weeds density is low enough that broadcast applications are not required.
  - Technology must be used within an IWM
  - Preemergence herbicides may be required
- Weed density is high enough to warrant action.
- Weeds occur in a non-uniform pattern on a field scale.
- There are herbicides registered for use in the desired crop.
- Weeds are not resistant to the registered herbicides.

Integrate Targeted Weed Management Technologies Into An IWM Program for Tomato

Objective: Apply herbicides only where needed to adequately manage weeds.

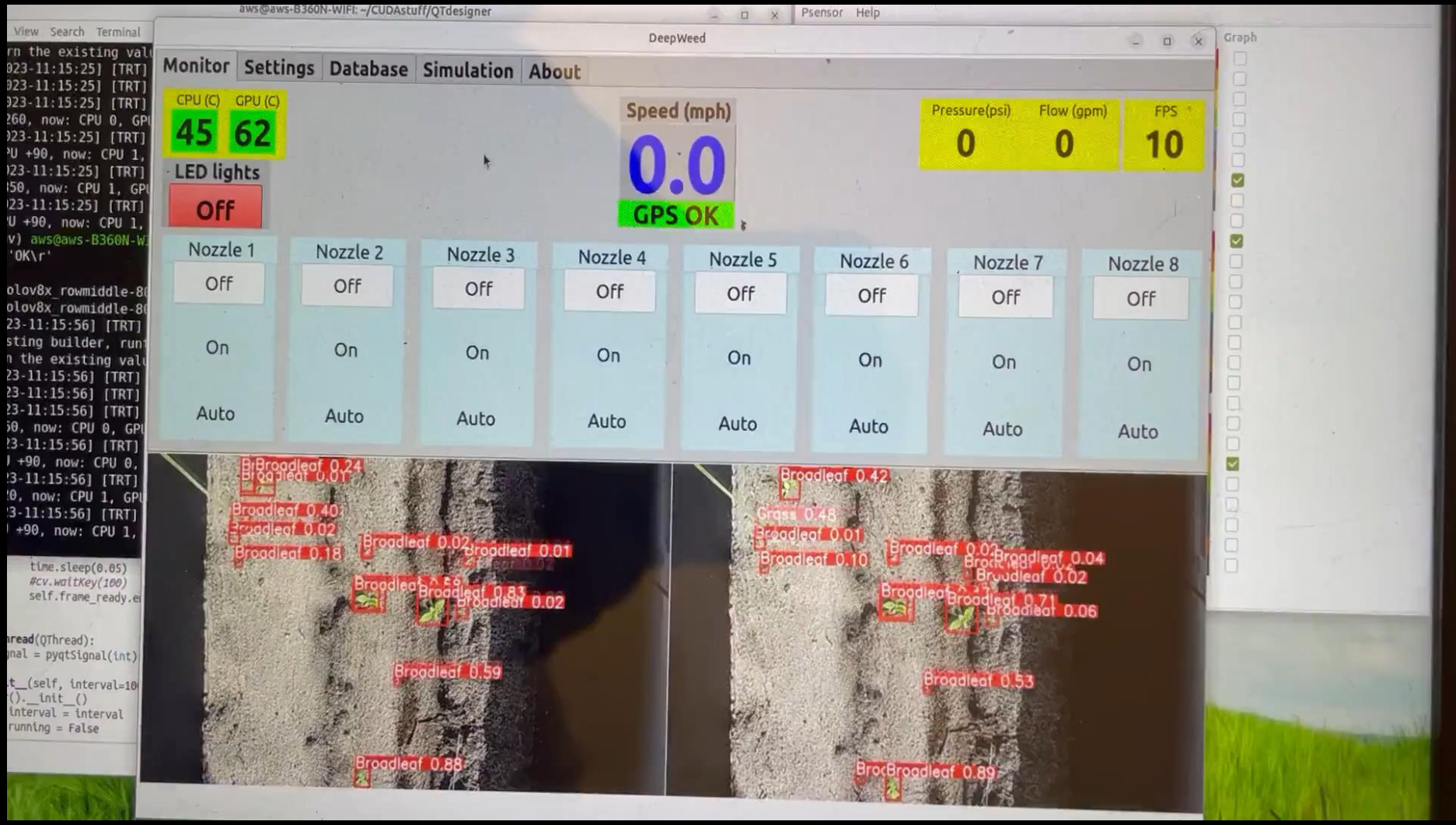
Test Crop: Tomato

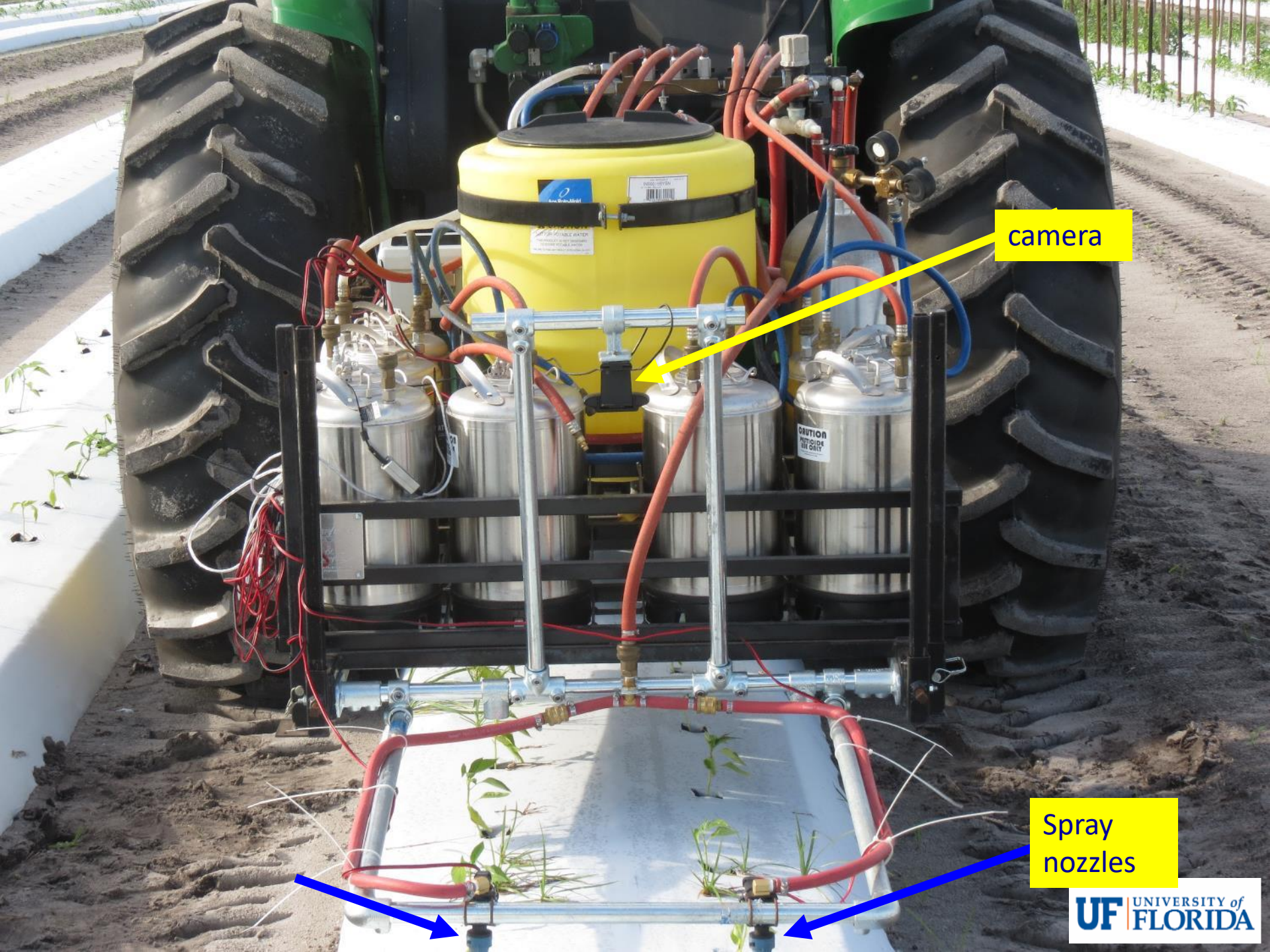
Real-Time Targeted Weed Management



Trained AI Programs ← RGB Cameras

Machine Vision


DeepWeed
Monitor
Settings
Database
Simulation
About
CPU (C)
45
GPU (C)
62
LED lights
Off
Speed (mph)
0.0
GPS OK
Pressure(psi)
0
Flow (gpm)
0
FPS
10
Nozzle 1
Nozzle 2
Nozzle 3
Nozzle 4
Nozzle 5
Nozzle 6
Nozzle 7
Nozzle 8
Off
On
Auto
Broadleaf 0.24
Broadleaf 0.40
Broadleaf 0.18
Broadleaf 0.02
Broadleaf 0.01
Broadleaf 0.83
Broadleaf 0.59
Broadleaf 0.88
Broadleaf 0.42
Grass 0.48
Broadleaf 0.10
Broadleaf 0.04
Broadleaf 0.71
Broadleaf 0.06
Broadleaf 0.53
Broadleaf 0.89


camera
Spray nozzles
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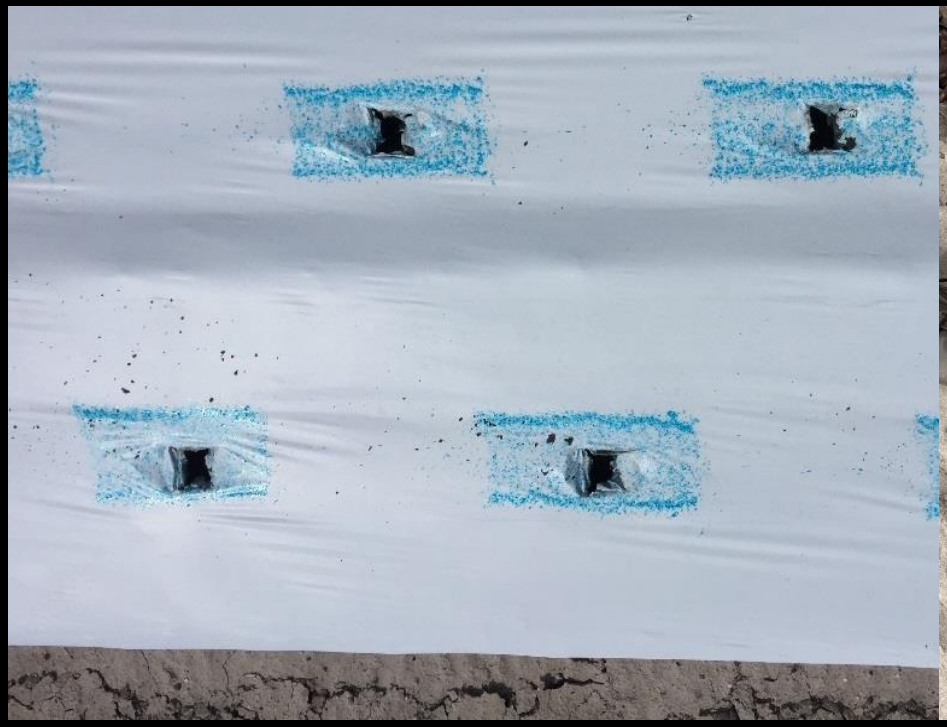
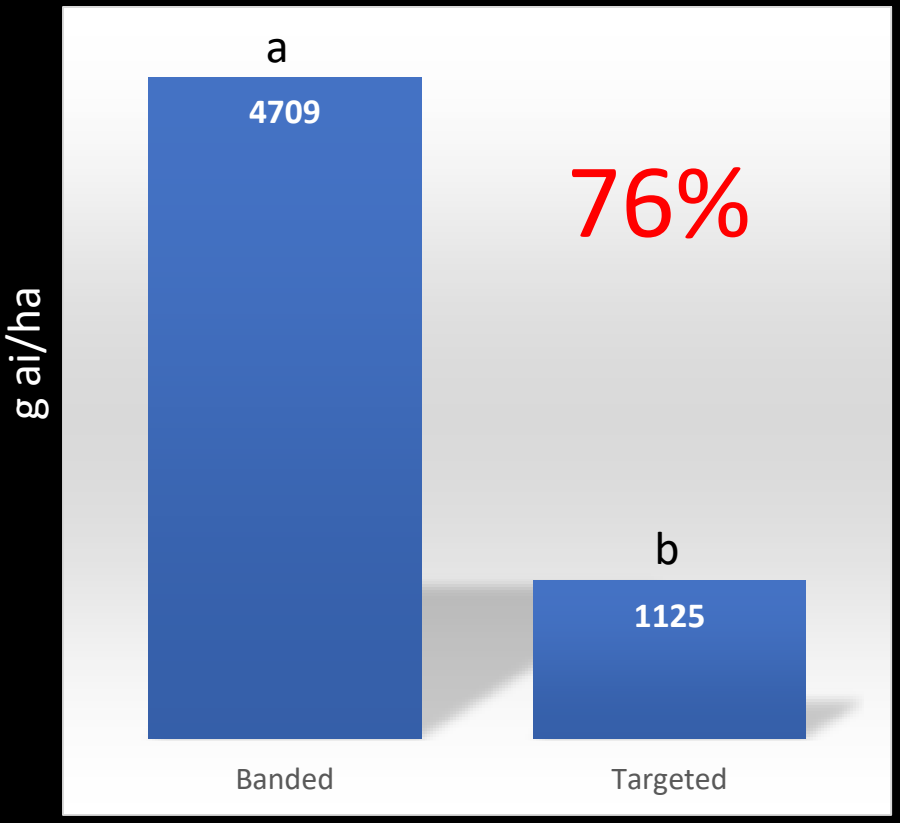
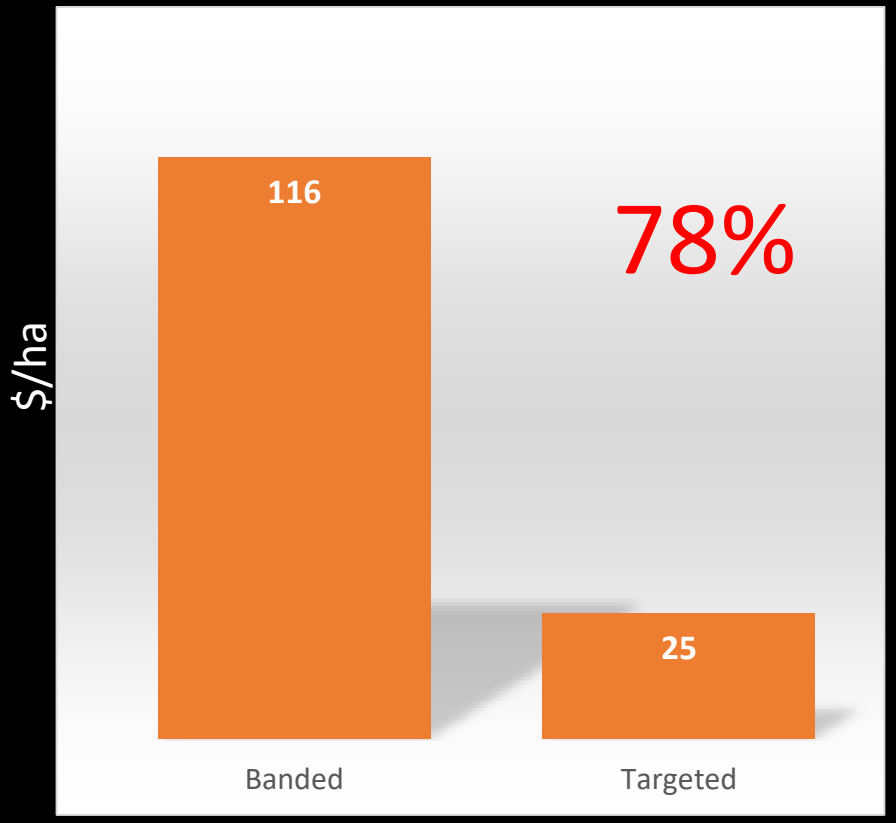


PRE Bed-Top Herbicide Applications (1/season)





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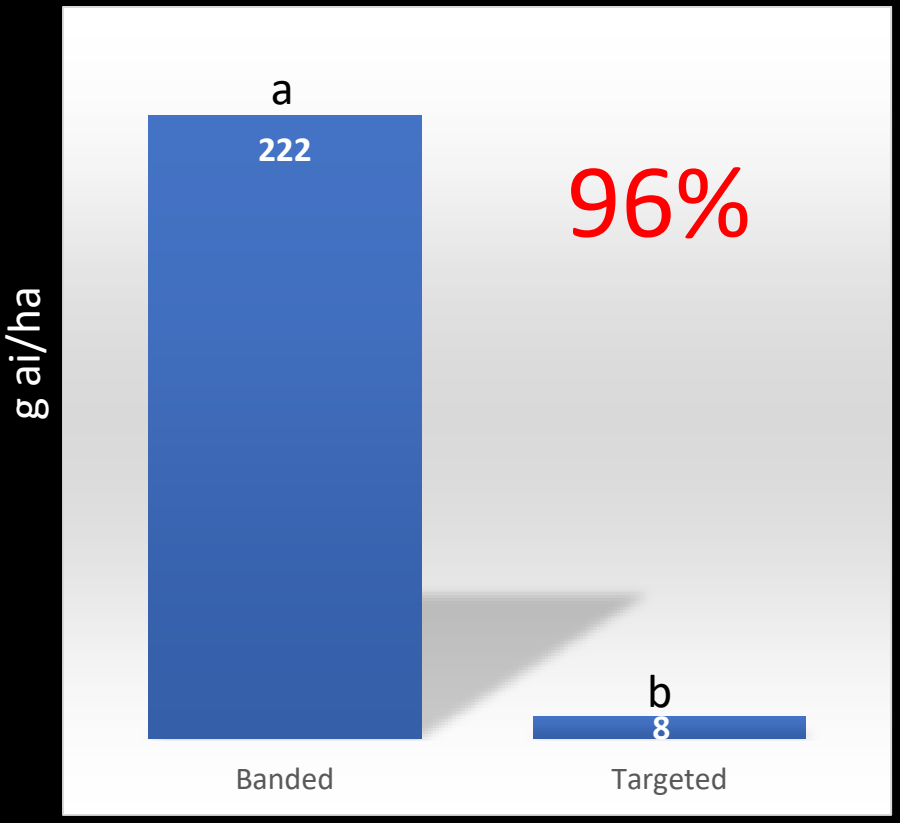
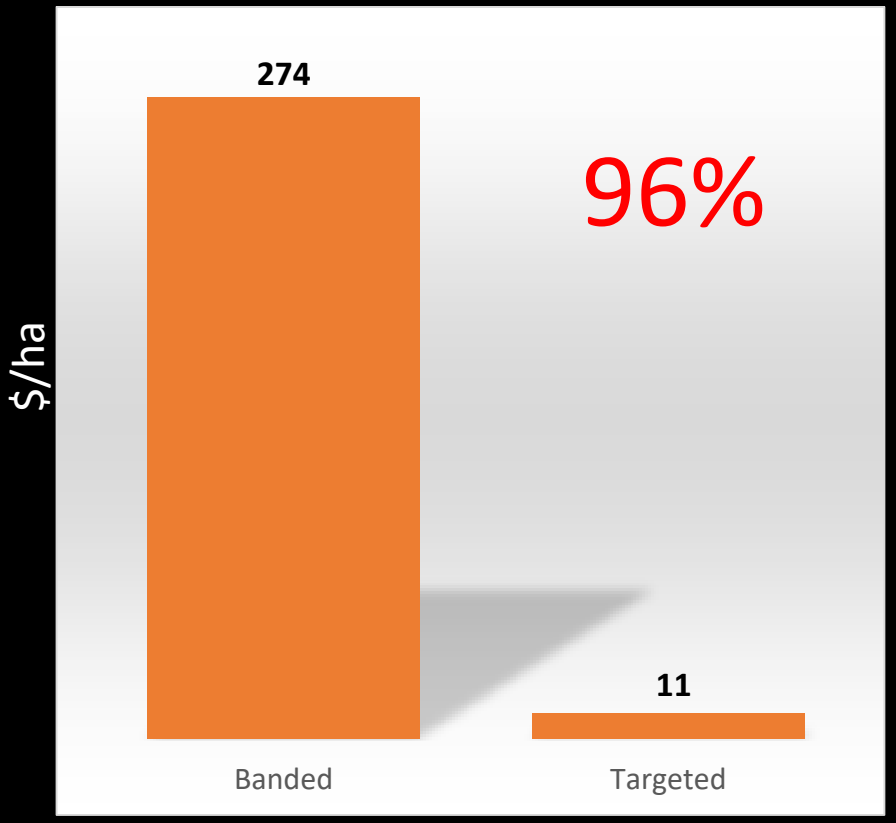
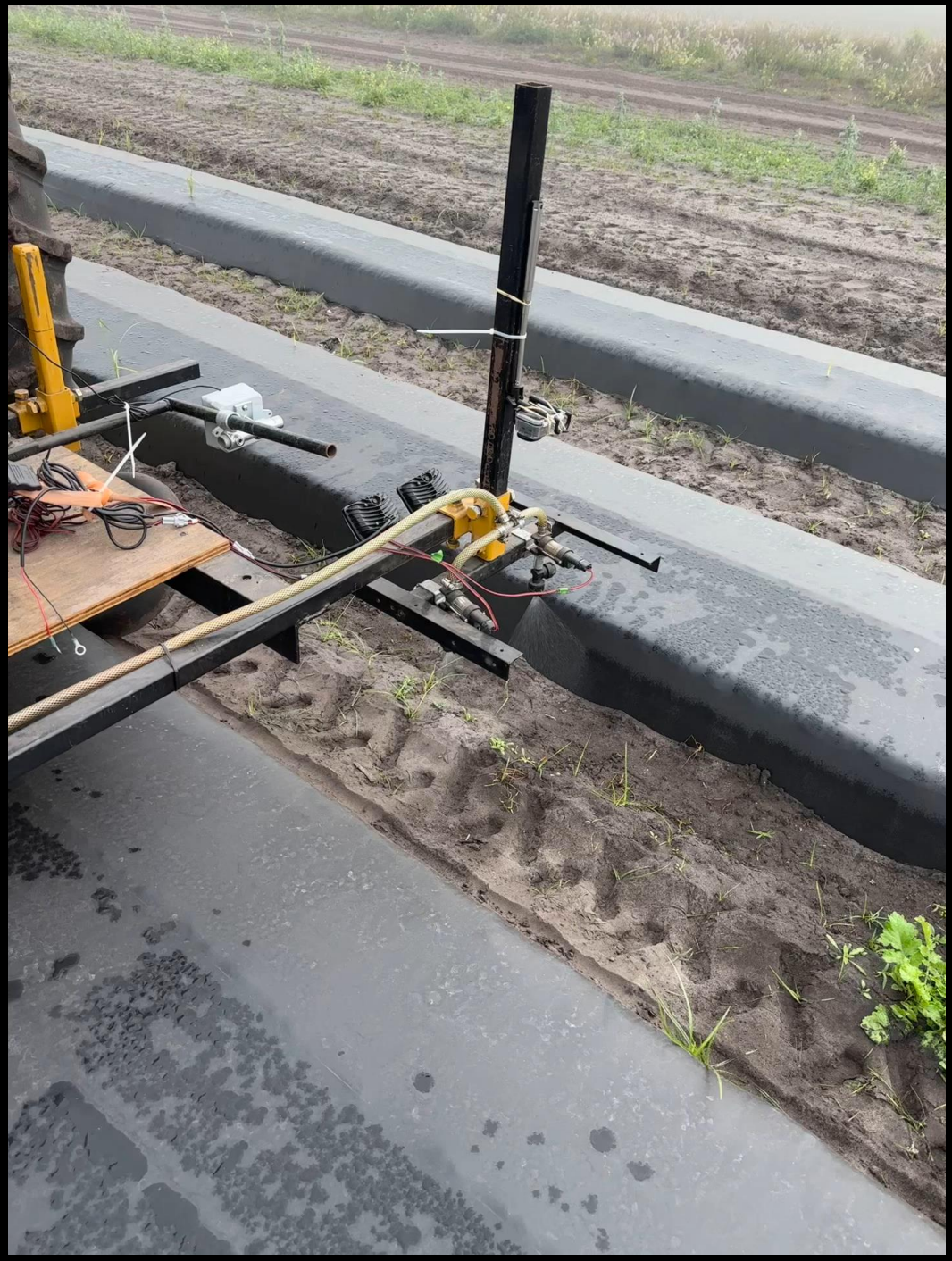
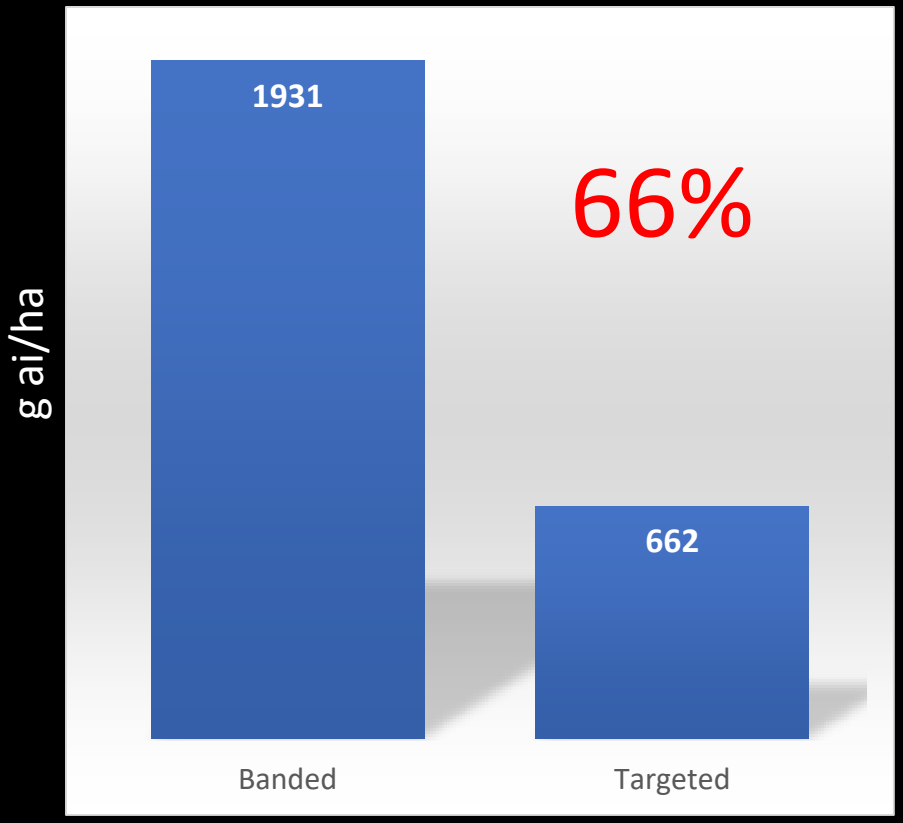
POST Bed-Top Herbicide Applications (1/season)



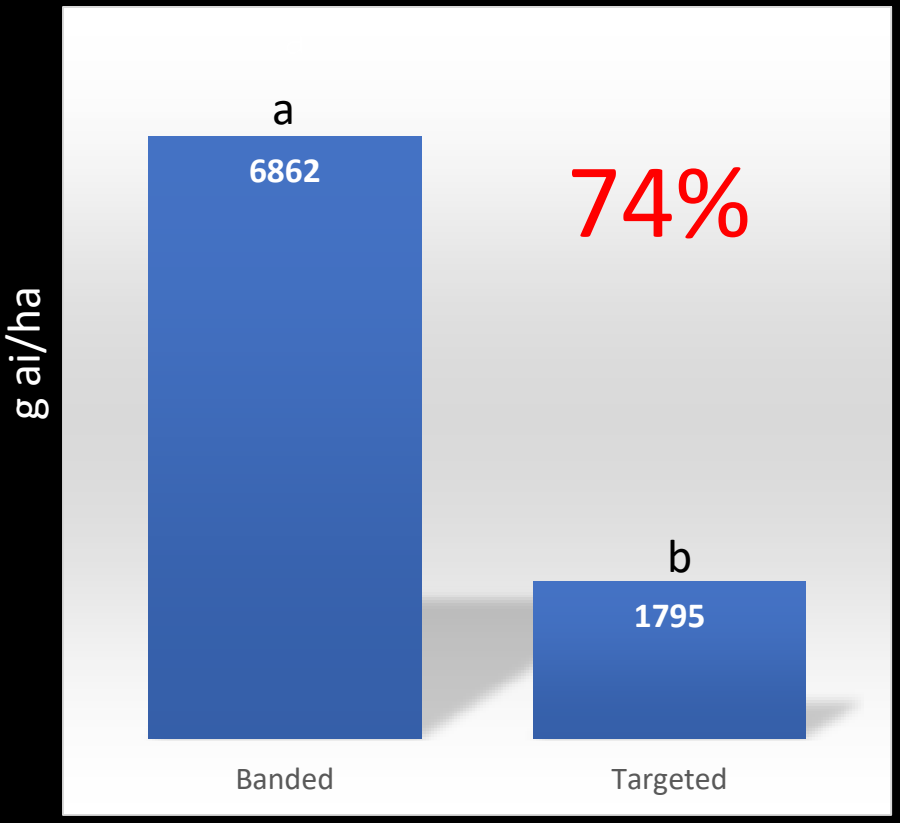


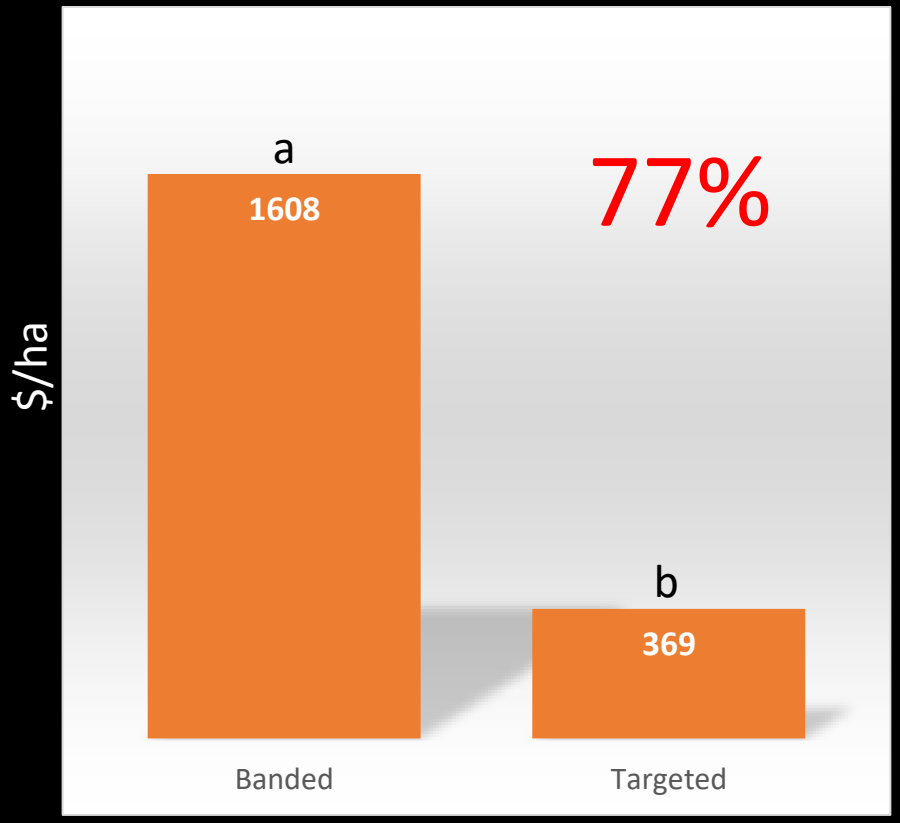


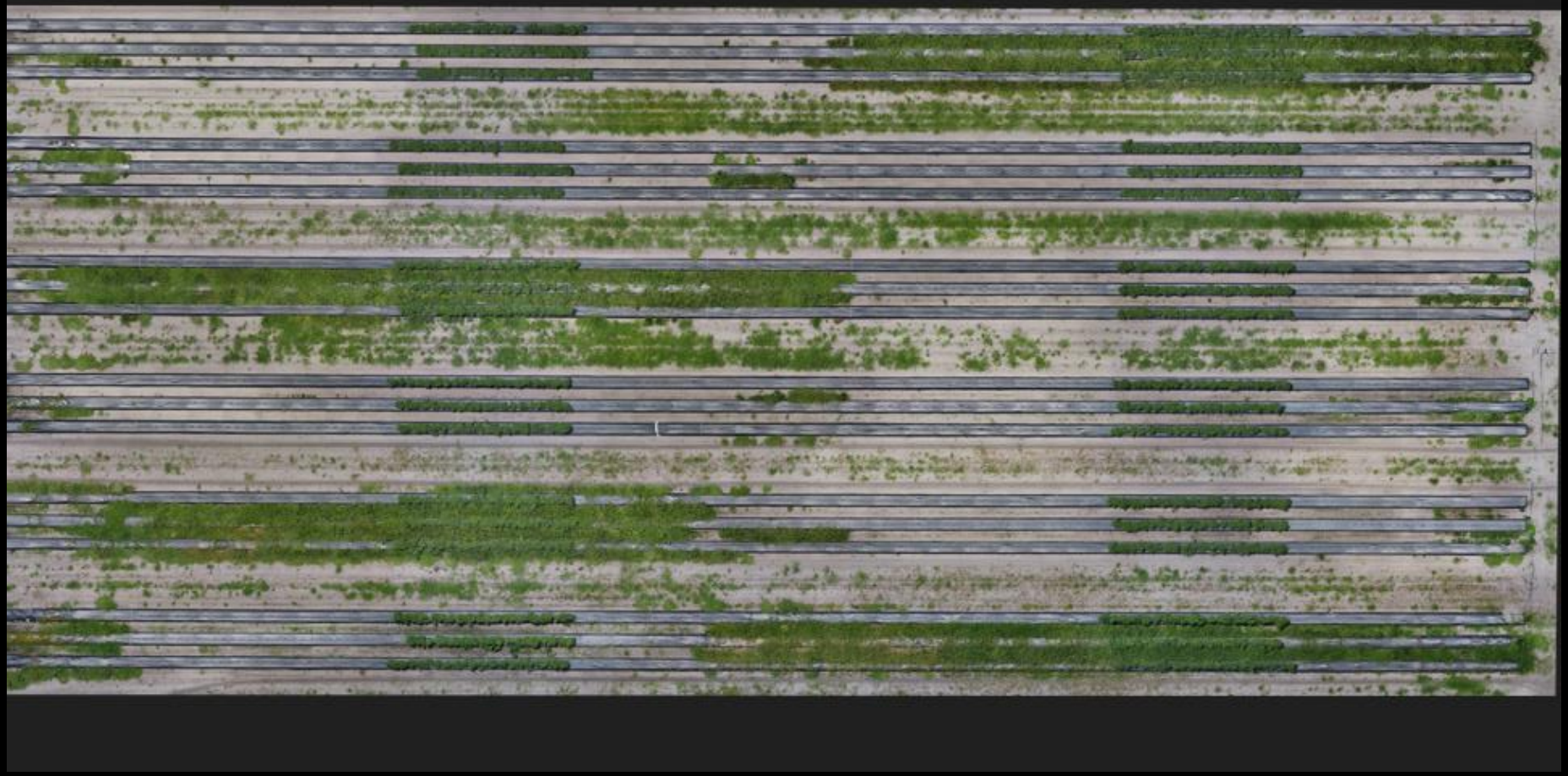
POST Row Middle Herbicide Applications (4/season)



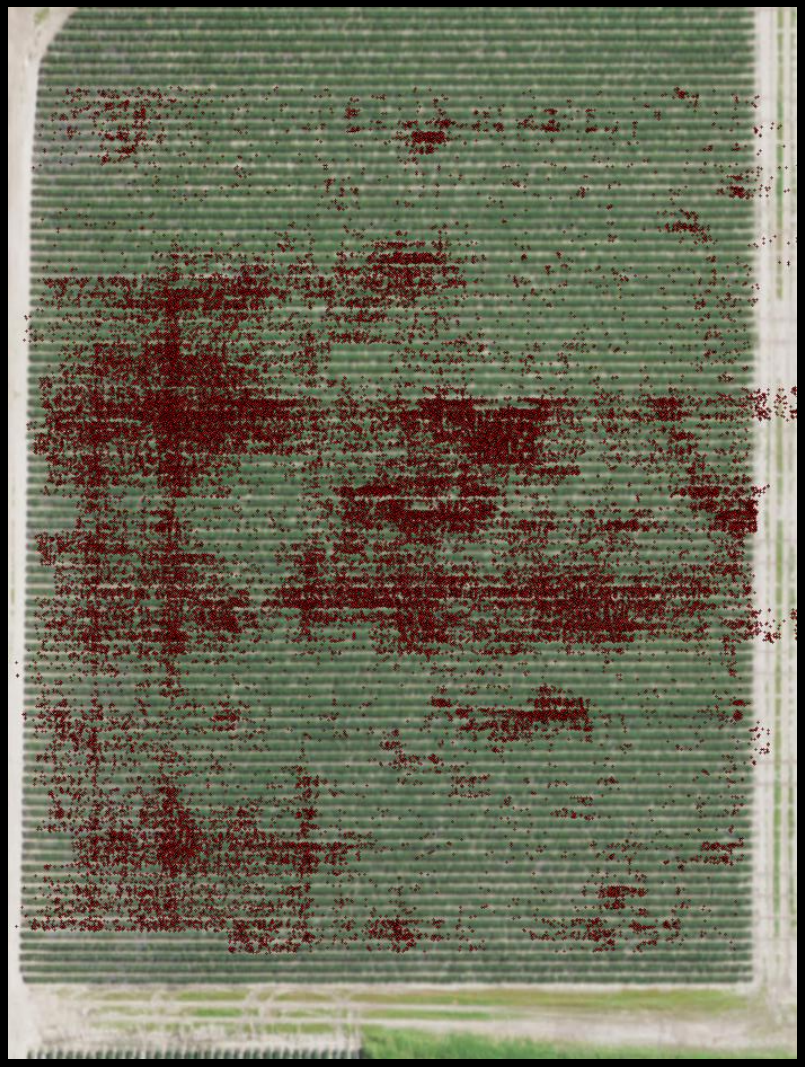
Total Applications (6/season)

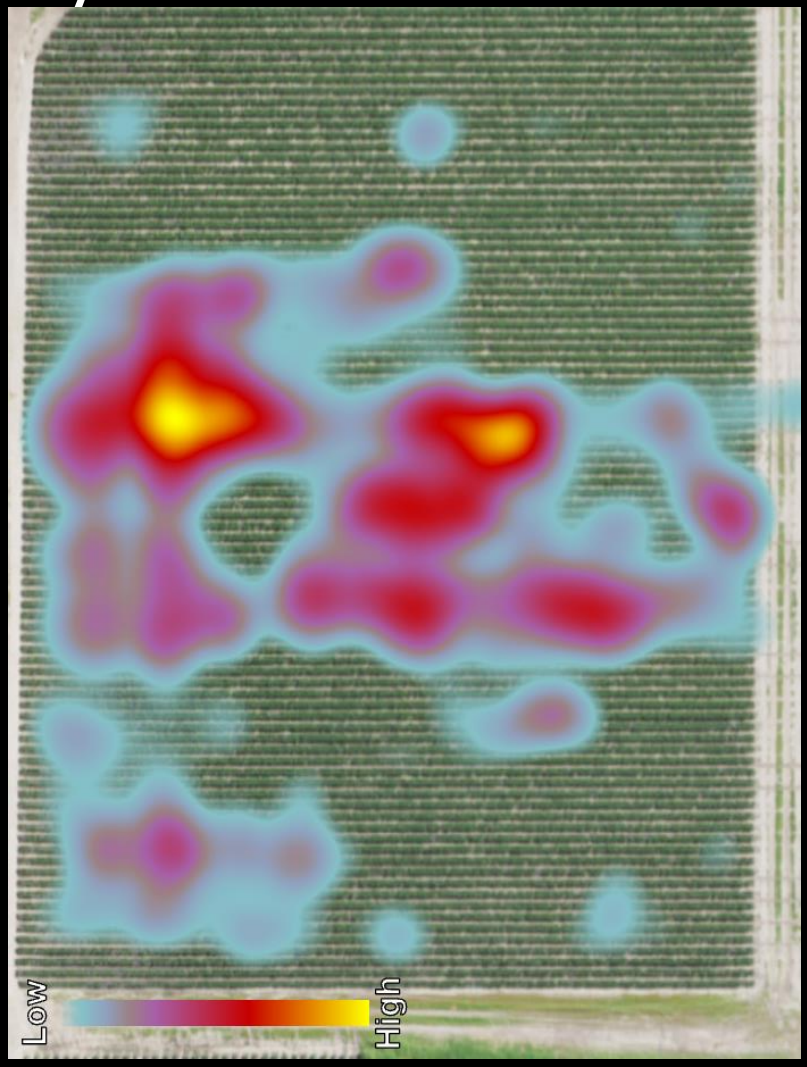






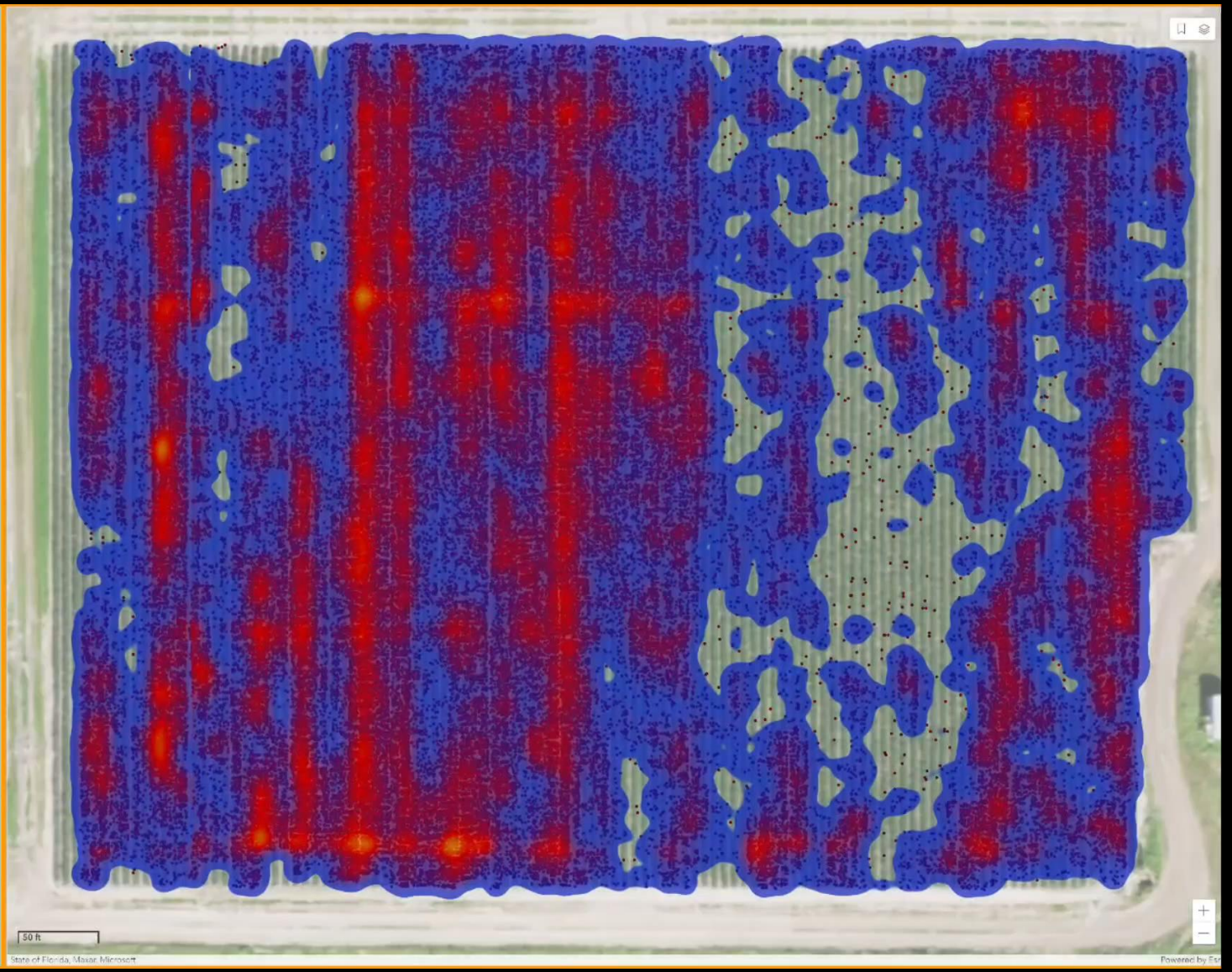
Purple nutsedge density in s strawberry field





Nutsedge population:

98.2k



Summary

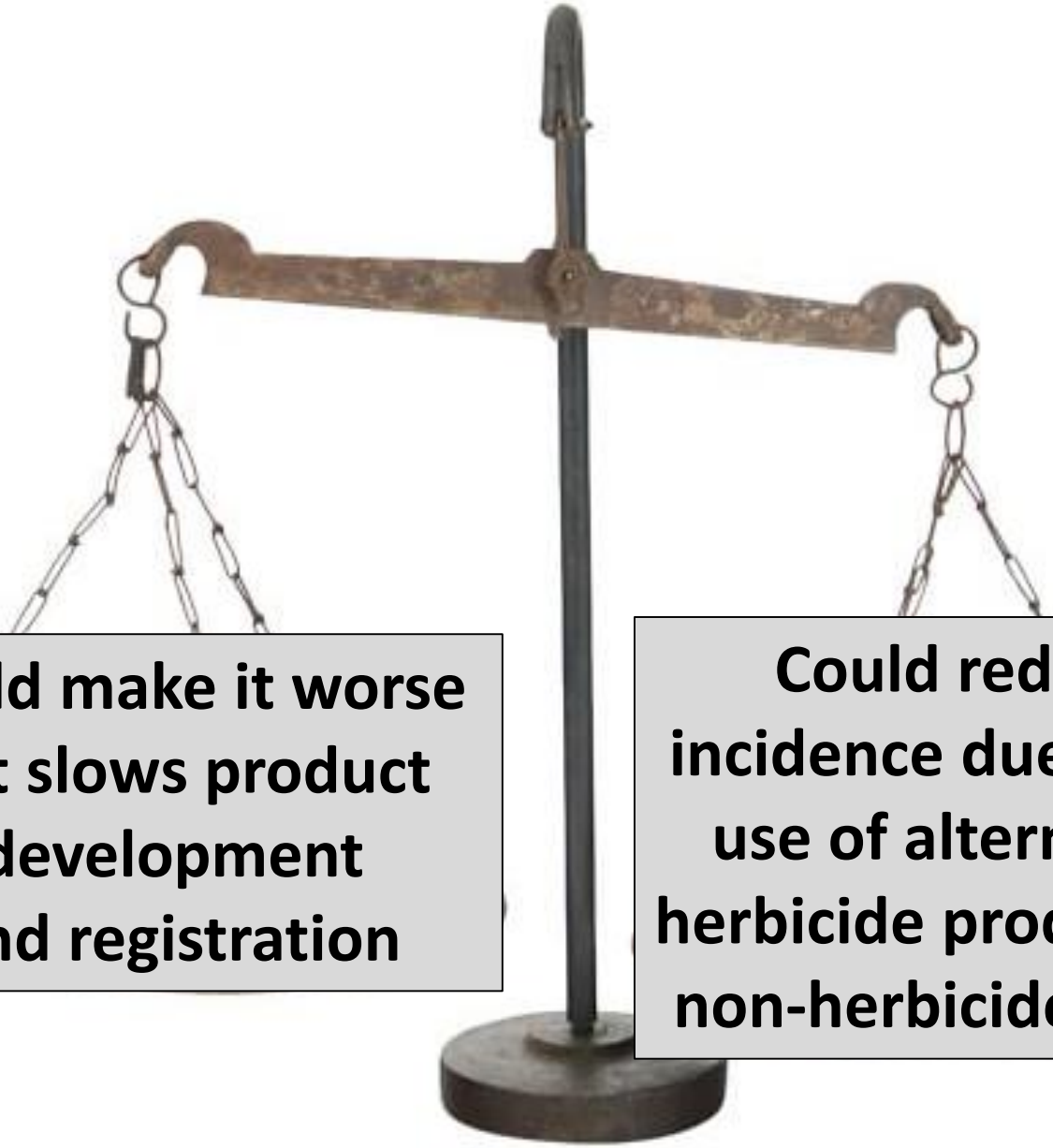
- Targeted spray systems accurately detect and identify weeds
- Targeted spray systems significantly reduce herbicide inputs and subsequently input costs
- Targeted spray systems reduce the potential for drift and crop damage.
- Weed control with targeted spray systems is as effective as standard industry practices
- Spray systems can be used to monitor weed populations over time.

Targeted Weed Management

Reduced herbicide use may have unintended consequences:

- Label changes
- Price increases
- Slowed product development

A.I. and Herbicide Resistance



Could make it worse if it slows product development and registration

Could reduce incidence due to the use of alternative herbicide products or non-herbicide tools.

End-Effector Development

- Improved targeting accuracy for herbicide application technology
- Continued improvements in alternative end-effectors such as lasers, grit blasters, heat, steam, etc, with an emphasis on energy efficiency and field hardening.
- Continued improvements in targeted mechanical cultivation.

Where are we going?

- Improved weed and crop detection models.
- Increase in the number and size of open access image databases with labelled images.
- Improved user interfaces to make it easier for people with no programming experience to train deep learning models.
- Improved actuators
- Fully integrated systems

Weed Management Is Changing Forever

Acknowledgments

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Thank you!

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Nathan S. Boyd, PhD
Gulf Coast Research and Education Center
14625 CR 672, Wimauma, FL, 33598
Phone: 813-419-6613
email: nsboyd@ufl.edu