Field Based Evaluation of PST Interactions with Canada Thistle in Non-Disturbed Sites

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Introduction

- Canada thistle is classified as a noxious weed in WI and many other states.
- Few good management strategies exist in non-disturbed sites (pasture, CRP, roadsides, parks).
- Non-disturbed systems are a good fit for biological control.

Brief History of PST

- *Pseudomonas syringae* pv. *tagetis*; infects many plants in *Asteraceae*.
- By 1978, pathogen was observed in sunflower in WI, USA.
- Different PS pathovars have been widely studied.

PST

- PST produces a toxin (tagetitoxin) when it interacts with a recognized host's leaves.

- Toxin is symplastically translocated to apical growth areas.
- Inhibits RNA polymerase III – does not allow chloroplast biogenesis.

PST and C. Thistle

- Research at U of MN in 90's.
  - Adapted technology to a soybean system.
- Initial promising results prompted Mycogen to test as a potential commercial bioherbicide.
- Freeze dried formulation failed in multi-state trials (1995).

A New Idea

- Lack of progress on PST front did not go unnoticed.
- Prompted researchers at UW to take a “backyard” approach (2000).
- Infected thistle sap (with organosilicone surfactant) was applied onto healthy thistles.

- Some infection observed (30% disease incidence).

Objectives

That success lead to many new questions on how to achieve optimal infection:

- What time of year to apply?
- What concentration and volume should be used?
- How frequently should applications be made?

Materials and Methods

Field Trials:

- Bluegrass/bromegrass pastures or CRP sites.
- Randomized complete block design.
- Four replications.
- 10 by 10 ft plots with 5 ft buffers and 5 ft alleys.

Materials and Methods

Field Trials (cont'd):

- Broadcast applications with backpack sprayer (CO_2) at 40 gpa.
- Silwet L-77 was added to all spray solutions at 0.3%, v/v.
- Applied to thistles in vegetative to early bud stage (17 to 21 in)

Materials and Methods

Spray solution preparation:

- Infected shoots were harvested from naturally infected plants at various non-disturbed sites.
- Harvested shoots were immediately placed on ice until processing.
- Prior to blending, all shoots were cut into 2 in segments.

Materials and Methods

Spray solution preparation (cont'd):

- 65g (fresh weight) infect shoot material added to 1 qt of water in a standard kitchen blender.
- Blended for 30 seconds.
- After blending, chopped biomass layer removed by hand.

Materials and Methods

- Solution filtered a two filter system in a funnel:
  - Fiberglass (8 by 8 in) screen pre-filter at the mouth of the funnel.
  - Cheese cloth (double layer of 4 by in) in the funnel.
- After filtration, water added to the solution to bring it to 1 qt.

Materials and Methods

- Placed on ice until time of application.
- Solution was placed in 2 qt spray bottle and the L-77 added.
- Solution immediately placed on ice for transport to the field.

Materials and Methods

Treatment impact:

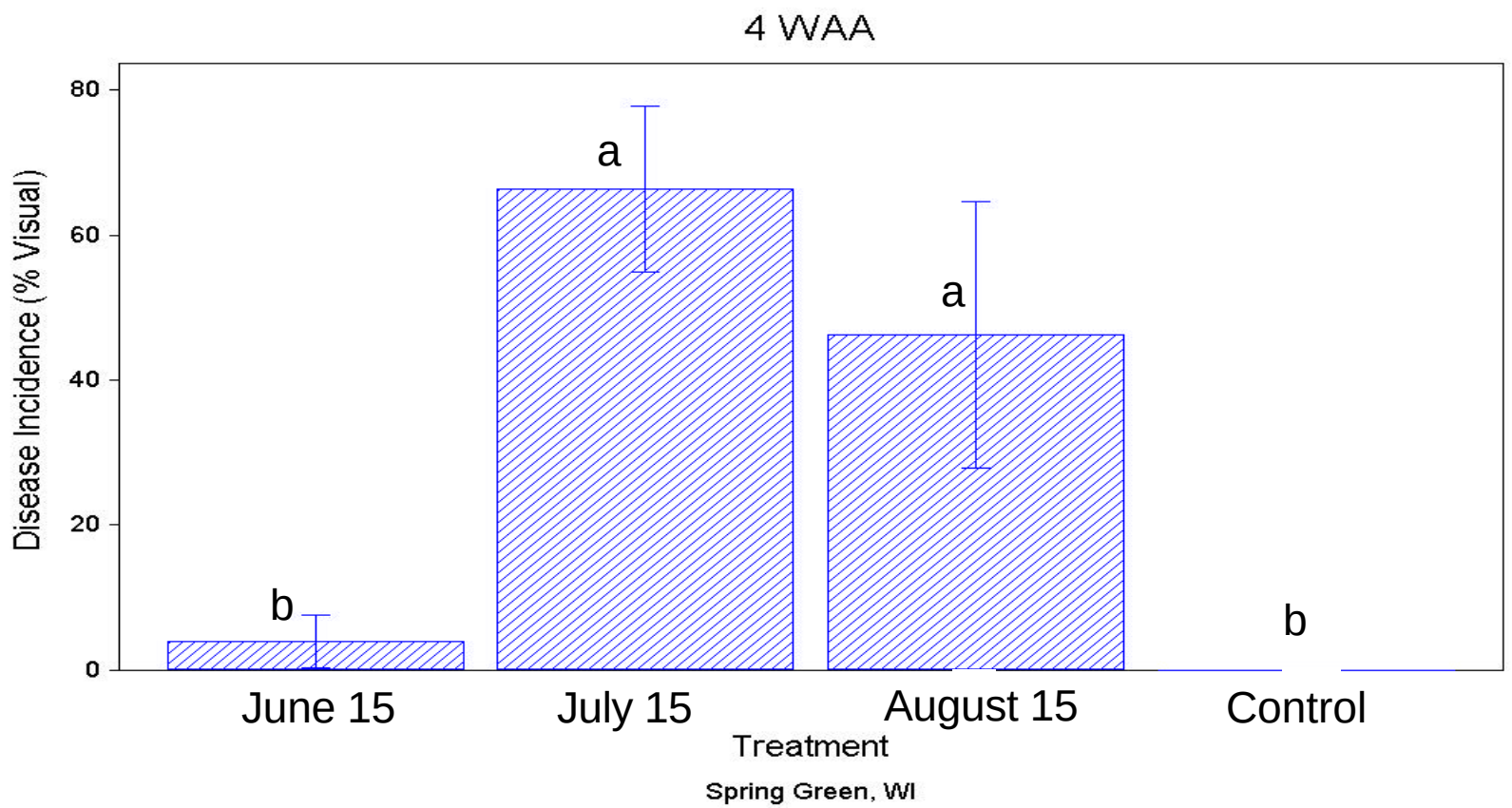
- Ratings taken 2, 4 and 8 weeks after application (WAA):
  - % Visual disease incidence (DI) and disease severity (DS).
  - Population counts of diseased versus healthy plants (CDI) at 8 WAA.
- All data analyzed using a one or two factor ANOVA.

Timing Study

PST applied three times in the summer of 2001:

- June 15
- July 15
- August 15

Timing Study



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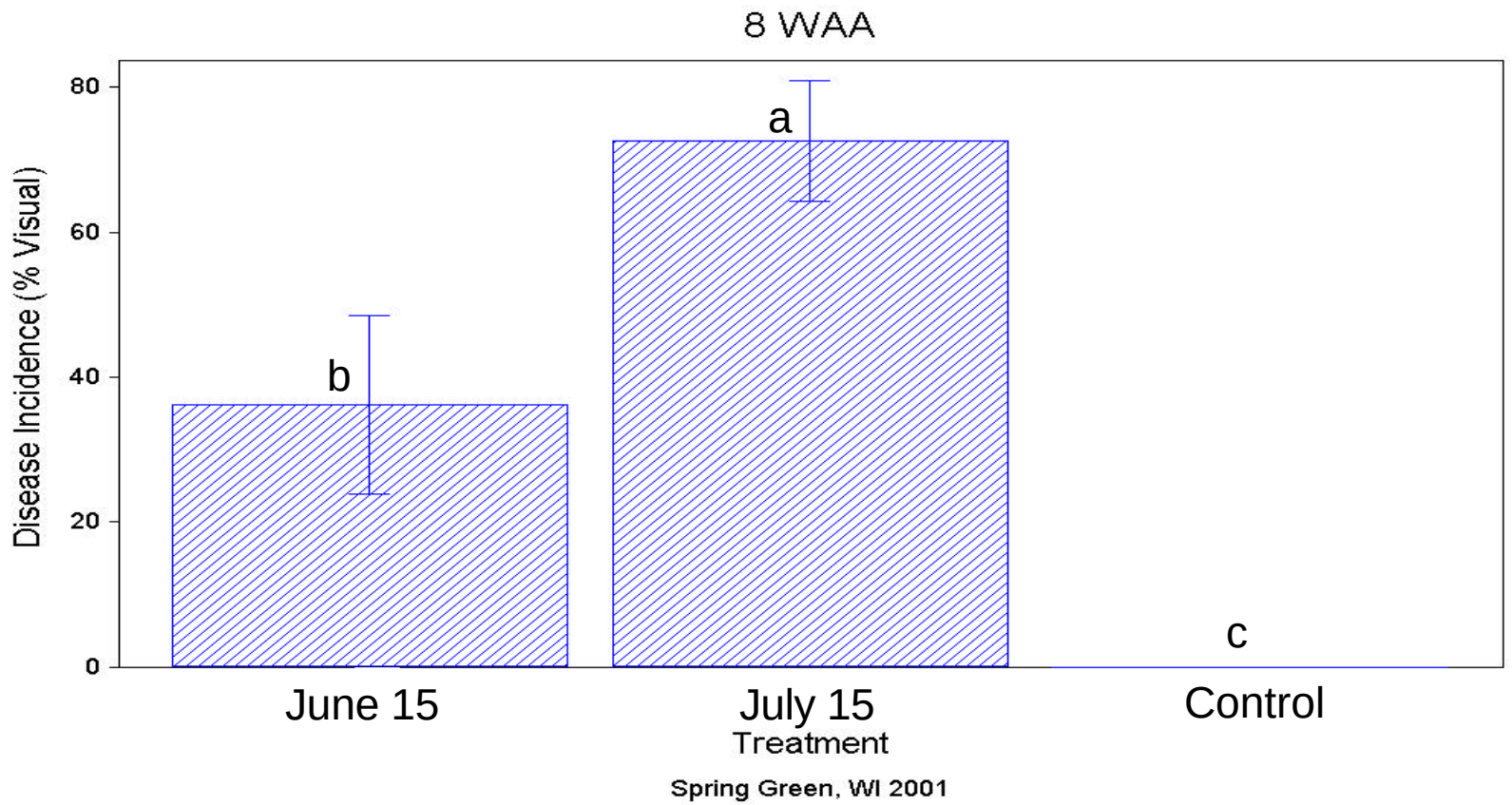

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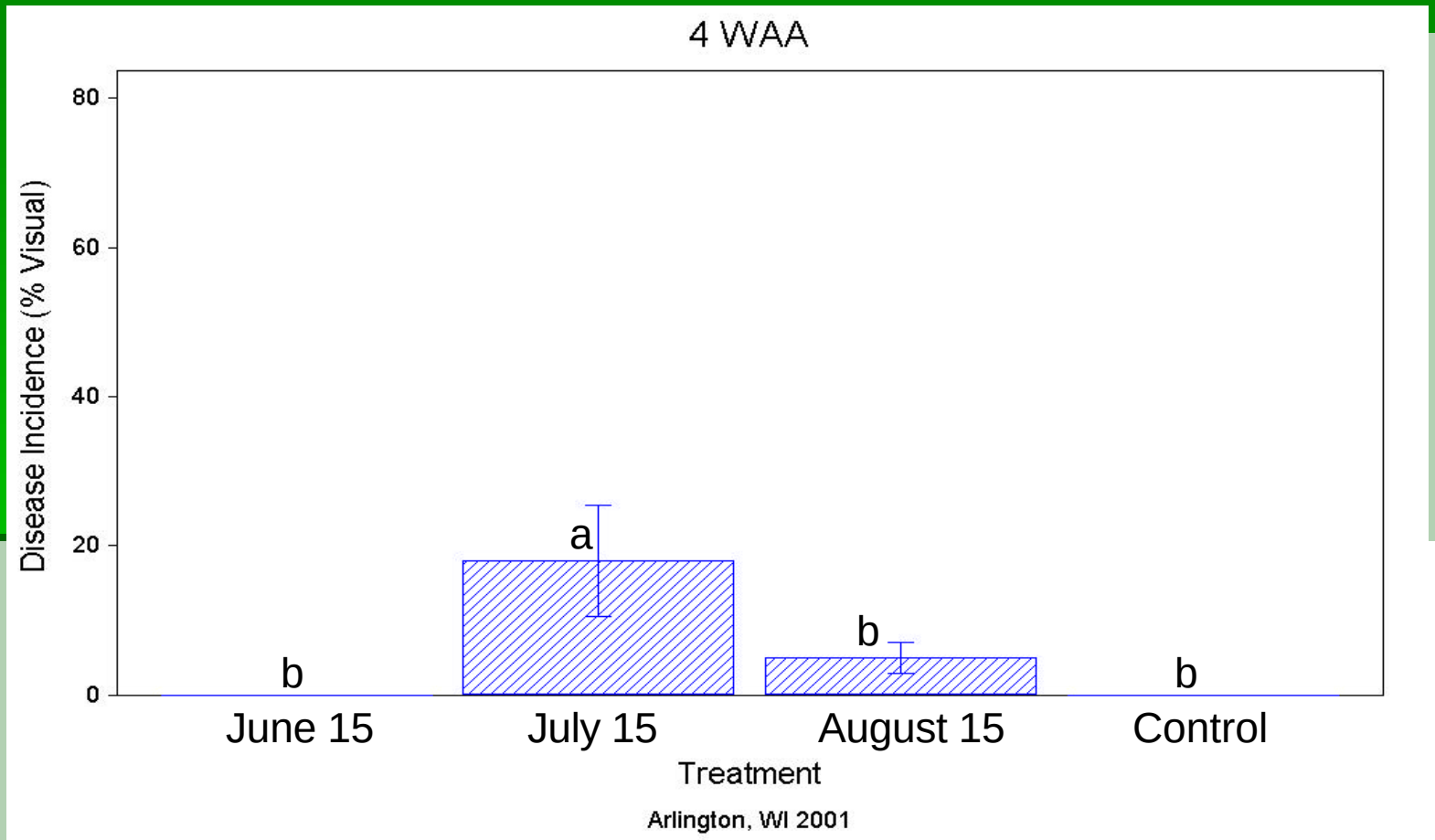

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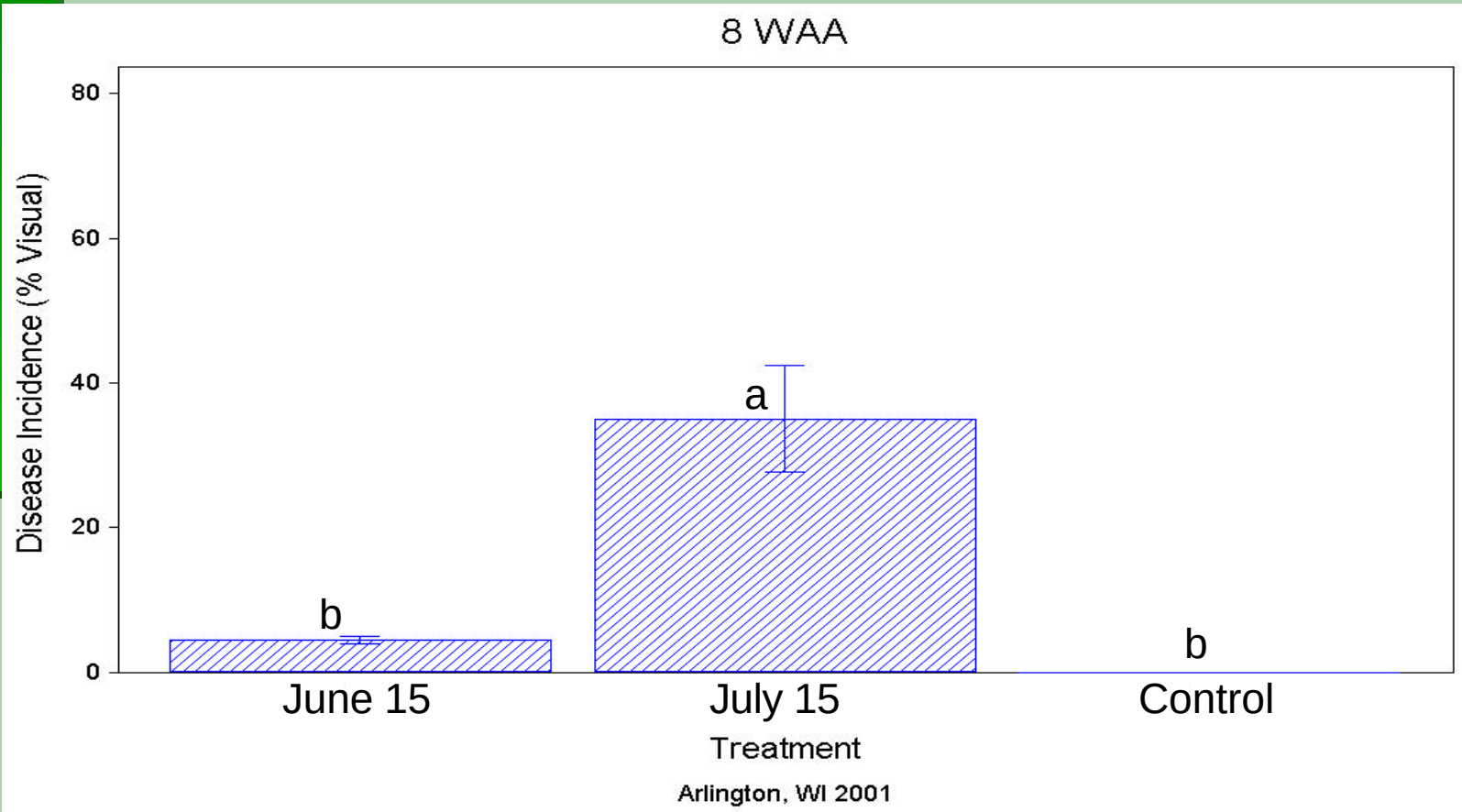


Timing Study Conclusions:

In 2001:

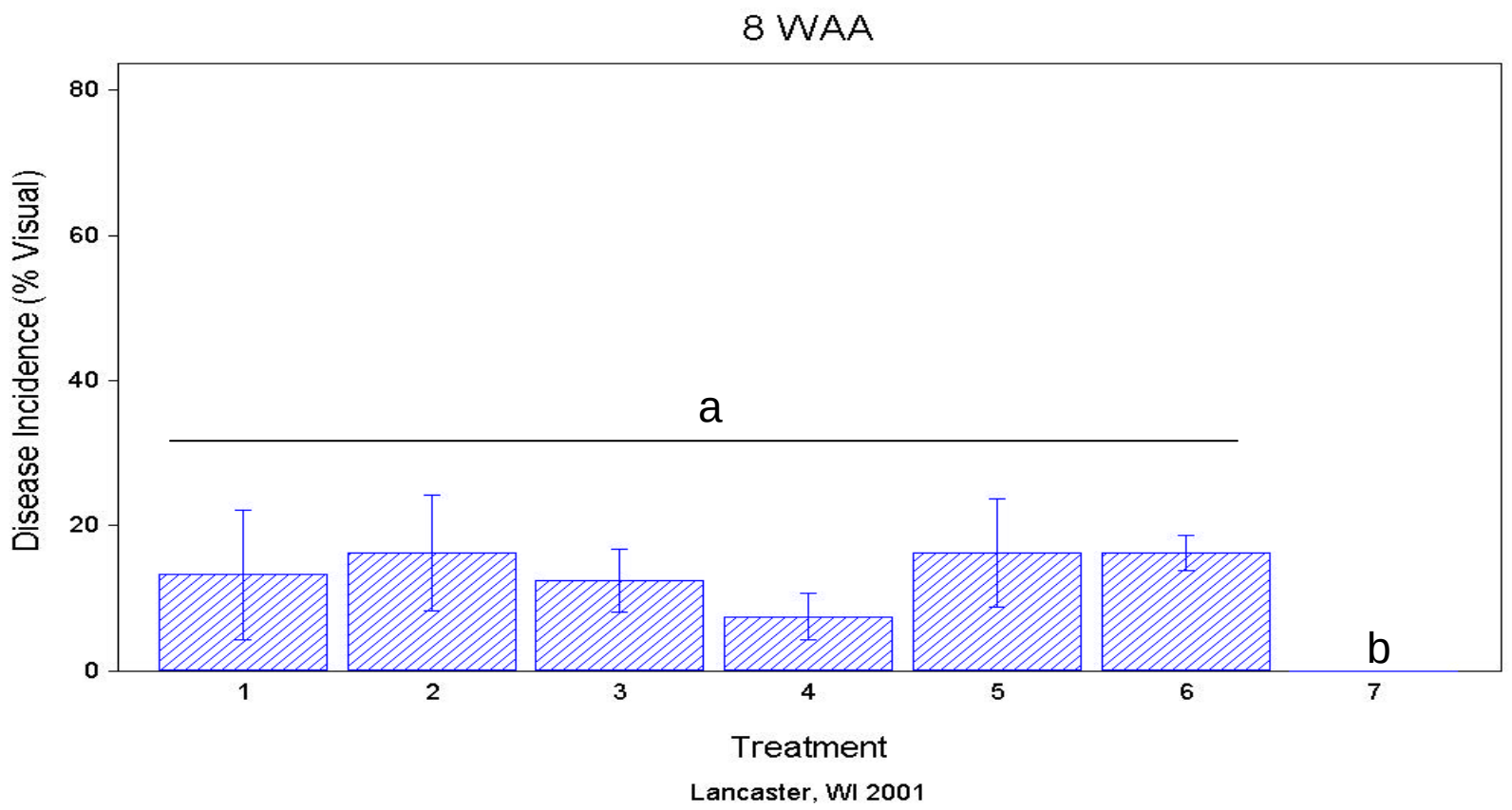
- July or August best time to apply PST at 4 WAA.
- July best month to apply PST at 8 WAA (compared to June).
- Likely weather implications.

Concentration x Volume Study

Treatments:

- Three spray volumes: 20, 40 and 80 gpa.
- Two “concentrations:” 65 and 130g C. thistle fresh weight/qt.

Concentration x Volume



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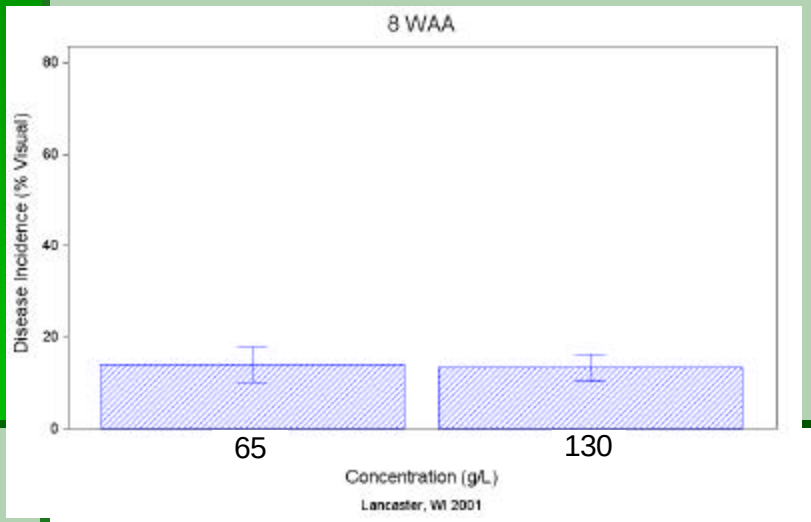

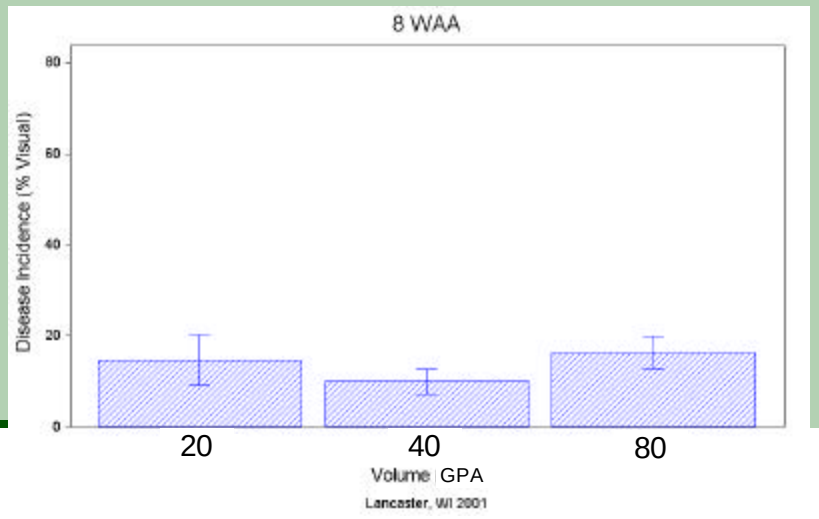

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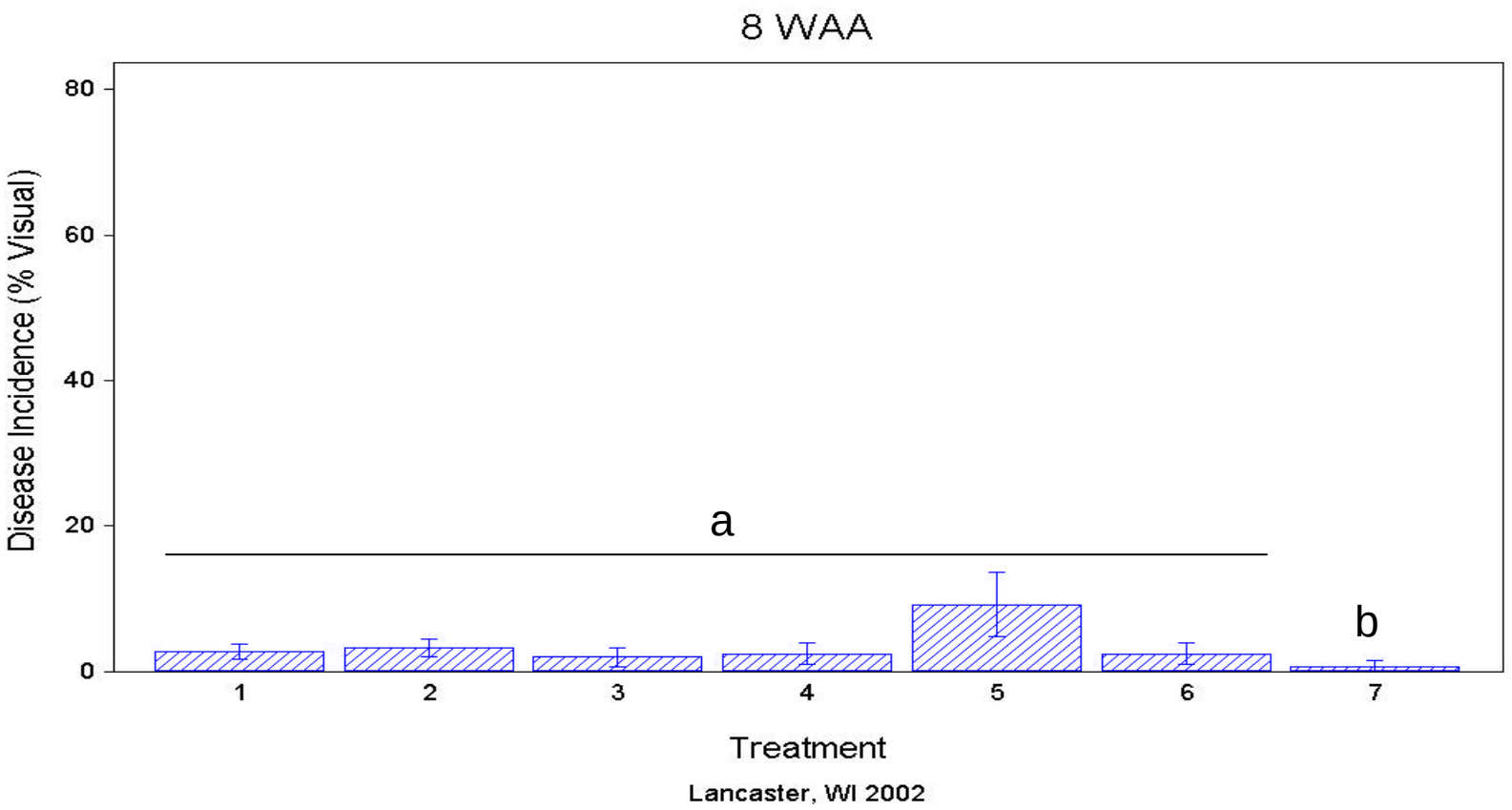

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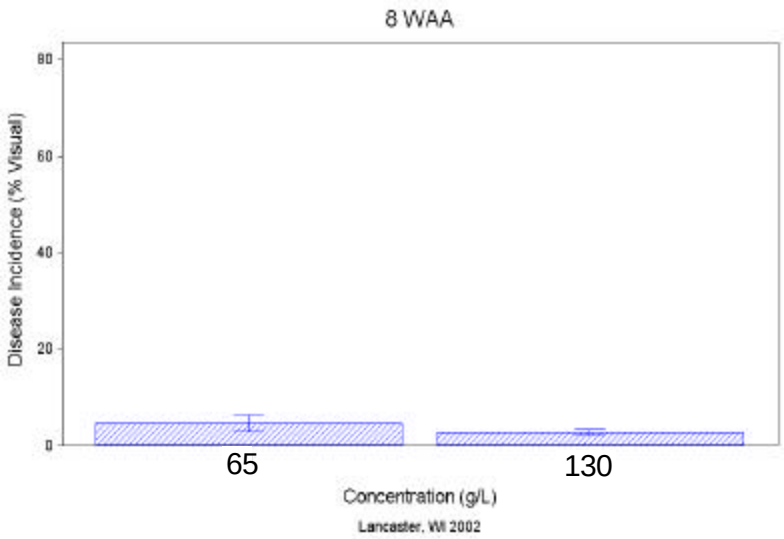

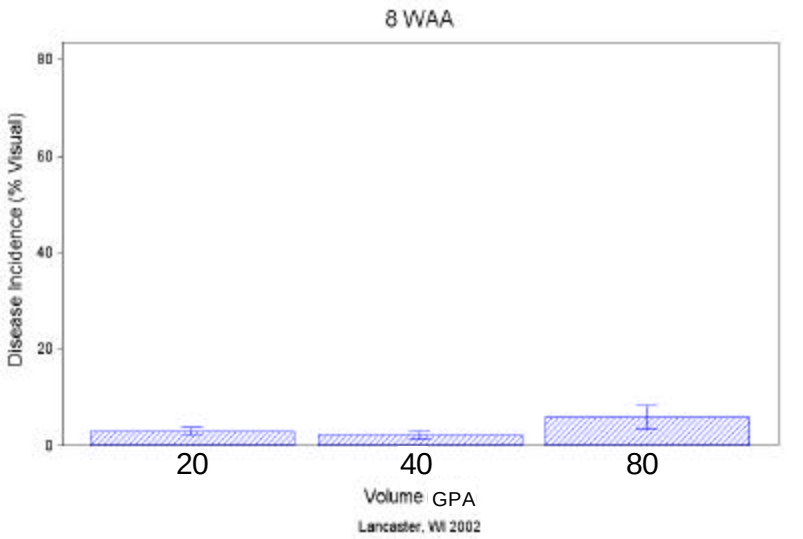

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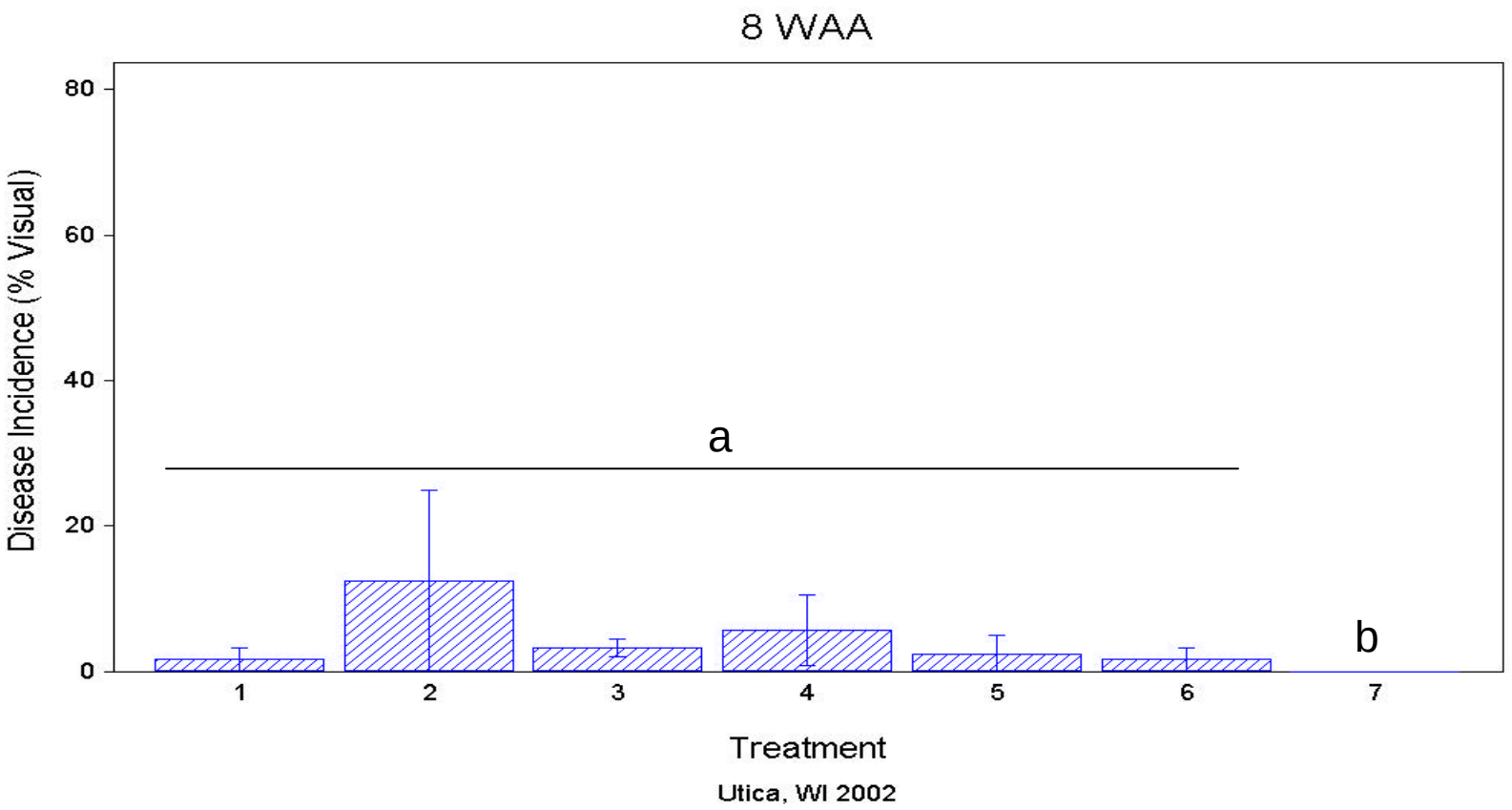

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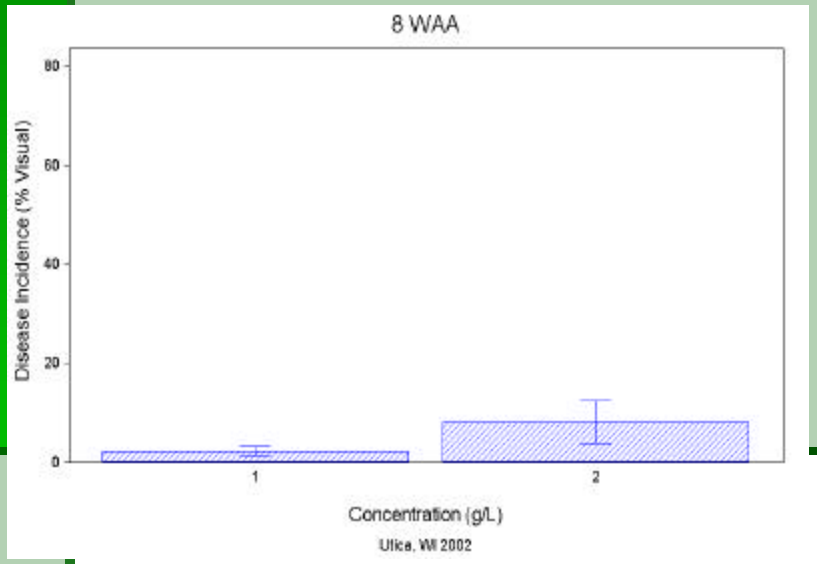
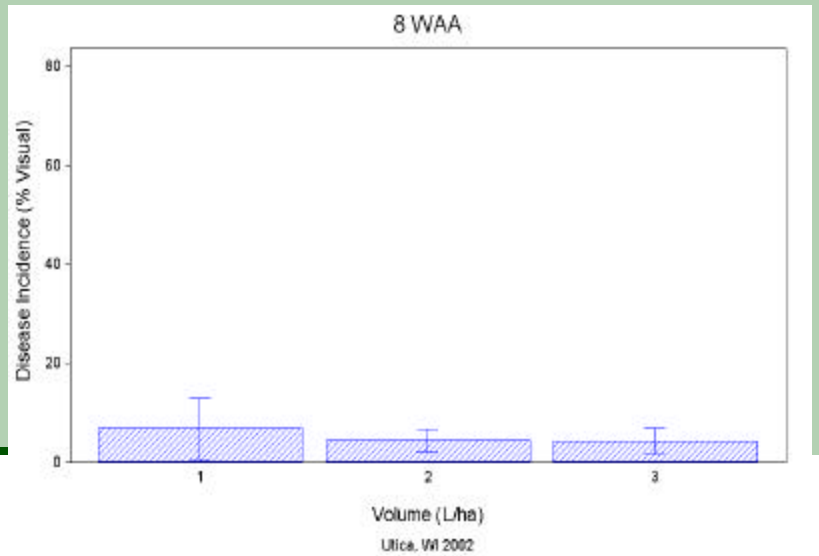




Conclusions

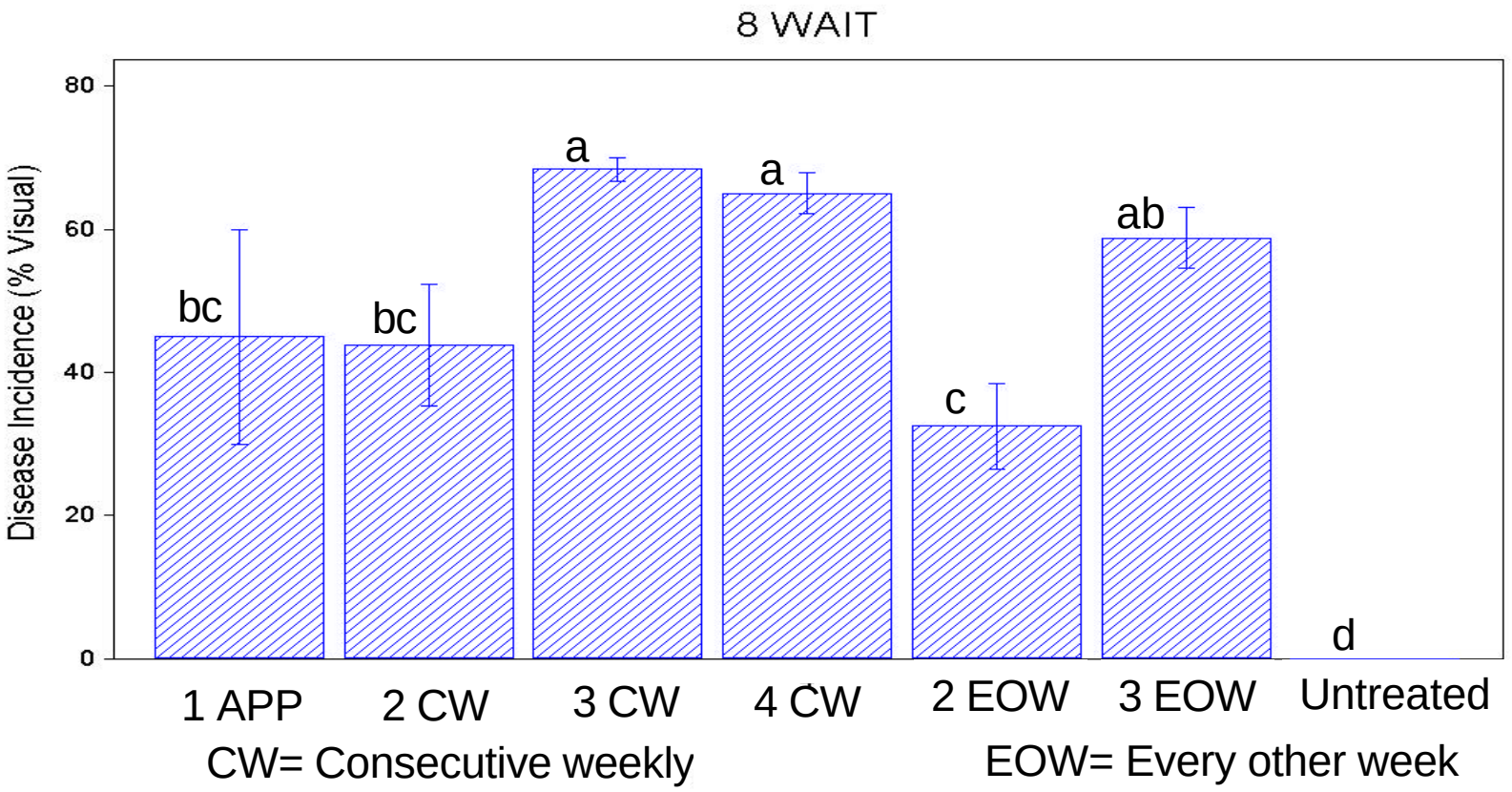
- Concentration and volumes at practical field rates do not affect the level of infection.
- Populations seem to be driven by other processes.

Application Frequency Study

Treatments:

1. One application.
2. Two consecutive weekly applications.
3. Three and four consecutive weekly applications.
4. Every other week (EOW) for three and five weeks.
5. Untreated control.

Application Frequency Study



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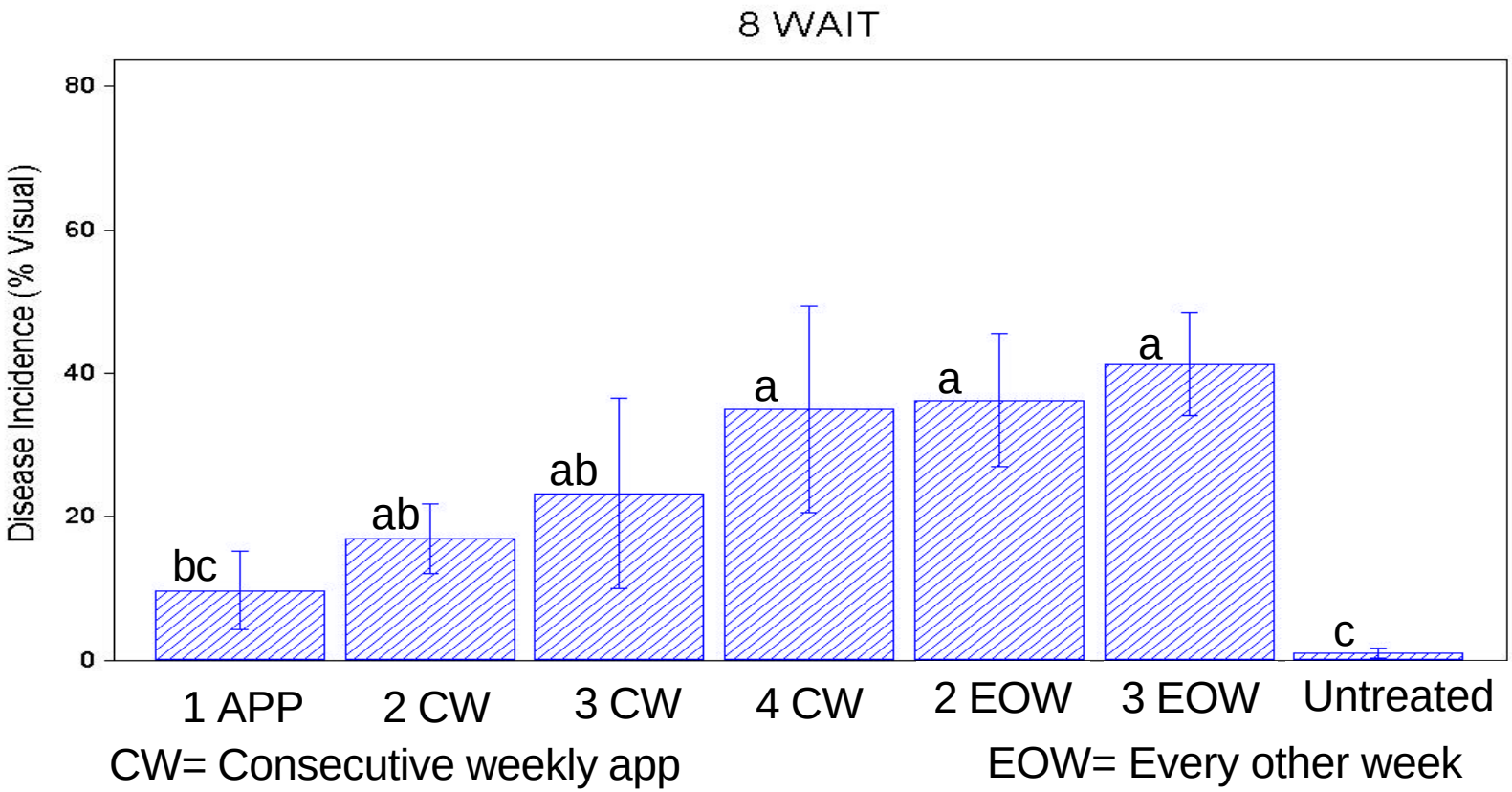


Applications Frequency Study Conclusions

- Generally, 2 or more applications did provide greater disease than one app.
- Three apps were optimal in 2001 (DI in the 60% range).
- Two apps were optimal in 2002 (DI=20 to 40%). (RF 85% below average in July).

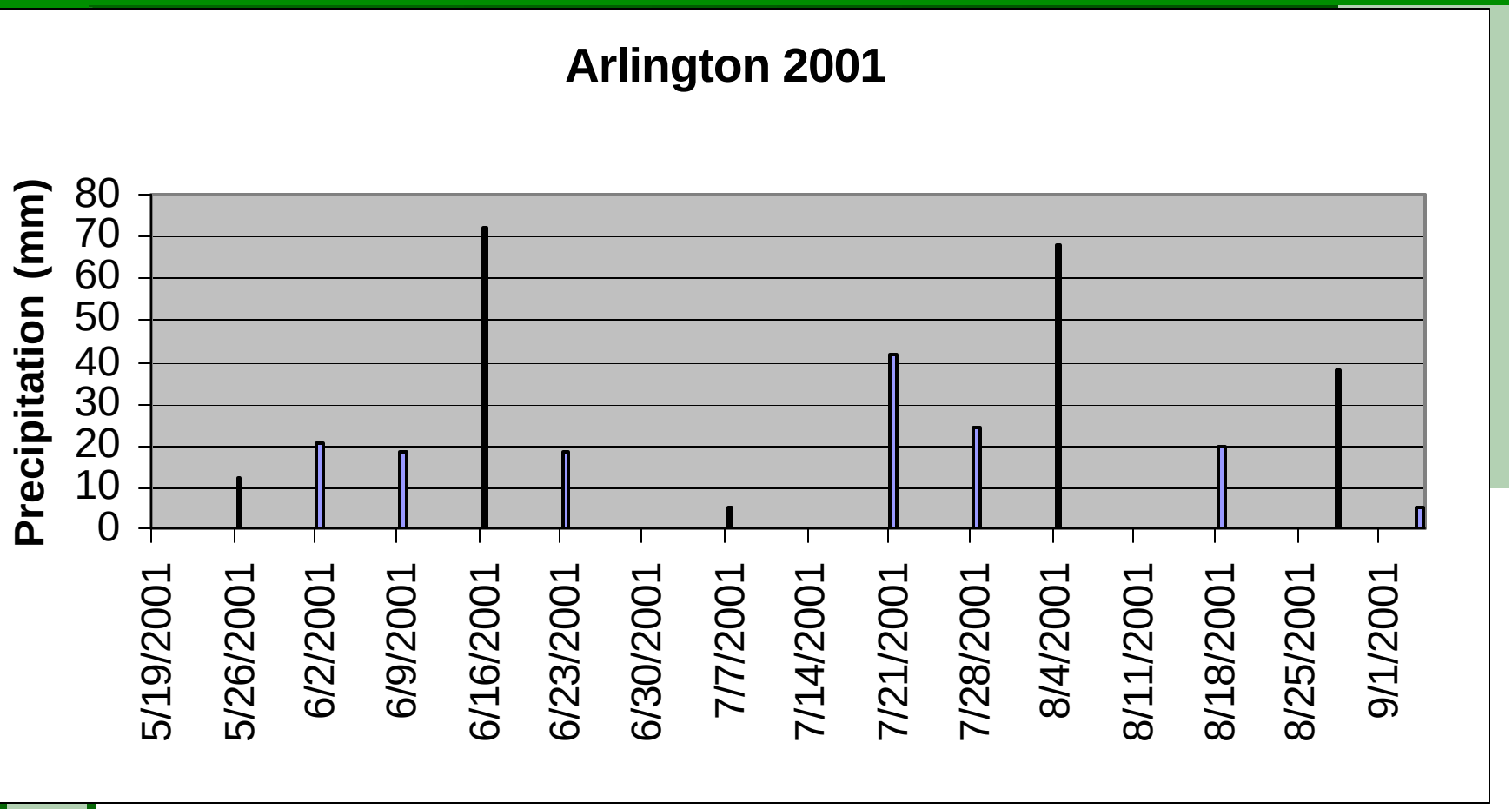
Summary

- What time of year to apply?
  - July proved to be the best time of the year to apply PST.
  - Weather likely was a key factor.
- What concentration/volume should be used?
  - Neither concentration nor volume affected the level and severity of disease observed.

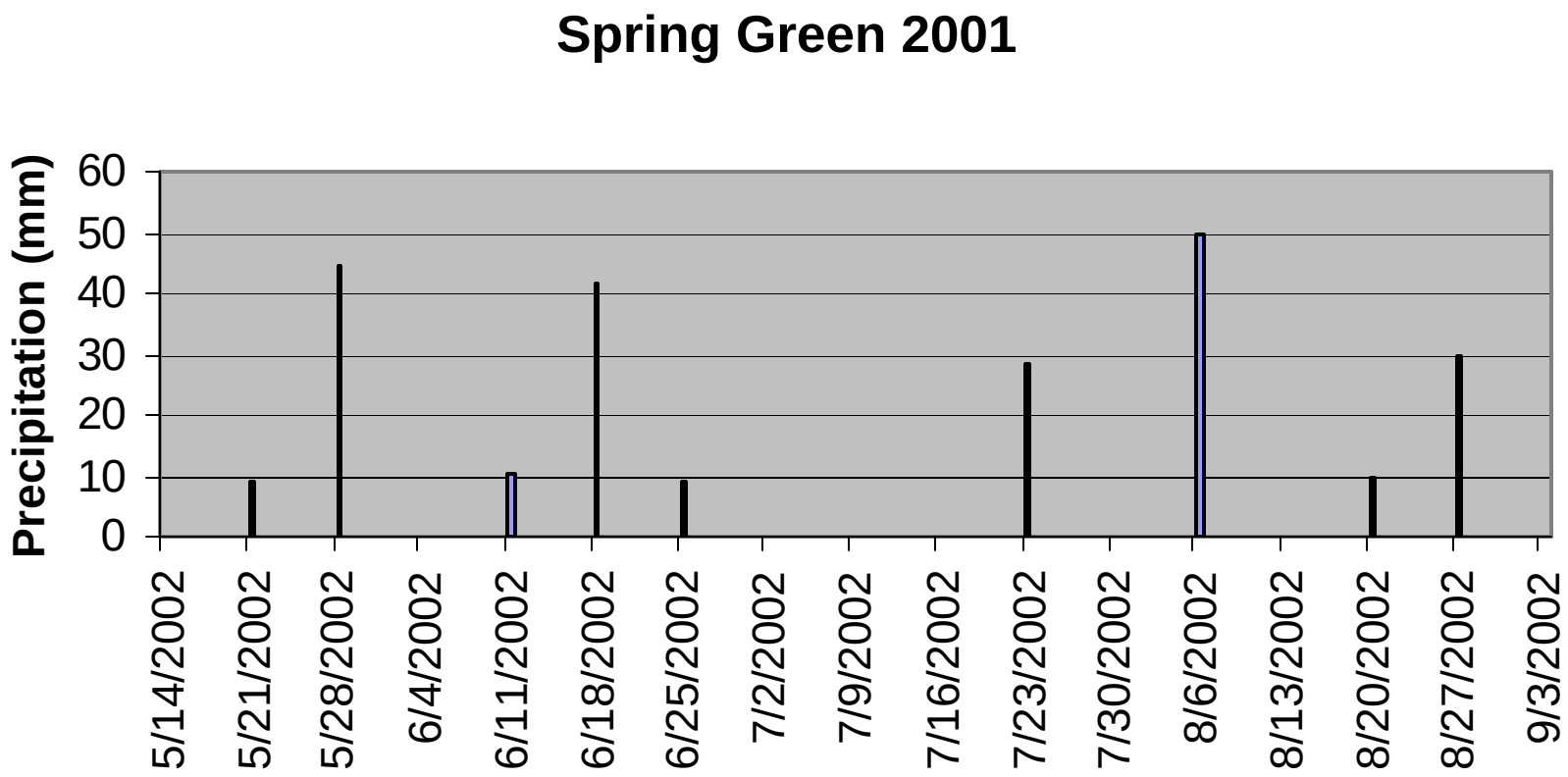
Summary

- How frequently should applications be made?
  - More applications proved to be beneficial at 8 WAIT.
  - Likely due to the proximity of later applications to rain events.

Rainfall 2001



Rainfall 2001



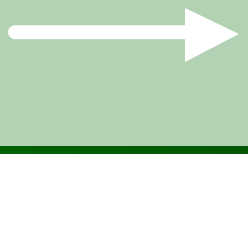
Overall Conclusions

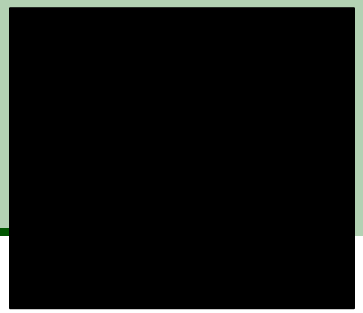
- Disease incidence levels must be increased for PST to become a more effective biocontrol agent.
  - At this point, no recommendation on how to use this technology to control C. thistle.

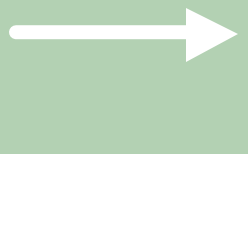
Overall Conclusions

PST and C. Thistle Leaf Interactions

- Volume
- Concentration
- Timing
- Multiple Apps







- Disease Incidence
- Disease Severity
- Growth Inhibition
- Seed Production
- Others

Overall Conclusions

- Disease incidence levels must be increased for PST to become a more effective biocontrol agent.
- Manipulating inputs into the PST/C. thistle system seems to have limited effects on outputs.
- Need increased understanding of the "black box" (i.e. population promoting/constraining factors) to increase disease incidence.

Overall Conclusions