Developing techniques for the biological control of Canada thistle, *Cirsium arvense*, using the rust fungus, *Puccinia punctiformis*

Spangler , A.J.[1], BACKMAN, P.A.[2], and CONAWAY, S.A.[2]

Pennsylvania State University, [1]Dept. Crop and Soil Science and [2]Dept. of Plant Pathology, University Park, PA 16802

Introduction

Canada thistle (*Cirsium arvense)*

- Canada thistle, *Cirsium* arvense, is a noxious weed found in a variety of locations including crop fields, pastures, and rangelands.
- Control of *C. arvense* is extremely challenging and often requires integrated control efforts due to its perennial lifecycle and complex root system.

Puccinia punctiformis as a Biological Control

- *Puccinia punctiformis,* a fungal pathogen specific to *C. arvense*, is being investigated as a biological control.
- Very promising due to its ability to kill systemically infected shoots and lateral roots.
- Obligate biotroph requiring a living host to survive and reproduce which complicates delivery as a biological control.
- Greenhouse *C. arvense* infected with *P. punctiformis* are tested for initiating epidemics in healthy patches.
- Recent observations of *P. punctiformis* have led to a revised understanding of the disease cycle. Characterizing the disease cycle will enable efficient use of the pathogen.

C. arvense systemically infected with *P. punctiformis.* Systemically infected shoots will die, and the teliospores from the shoots drive additional systemic infection.

C. arvense leaves with localized lesions. The infected shoots usually do not die, but the urediniospores can contribute to a sustained epidemic.

Goals

- Develop a method to deliver *P. punctiformis* to healthy *C. arvense* patches.
- Increase spore production and survival of systemically infected greenhouse *C. arvense* transplants.
- Establish sustained epidemics in healthy *C. arvense* patches.

Transplant Survival Study

A survival study was conducted at Penn State's Agronomy Research Farm in Rock Springs, Pennsylvania June 2008 - August 2008. The study determined the optimum transplant conditions for introducing diseased *C. arvense* into field patches. The study was separated into two experiments.

Experiment 1

- Factors tested included root ball size and moisture retention gel.
- Healthy greenhouse transplants of four pot sizes were used to approximate effects on diseased transplants.

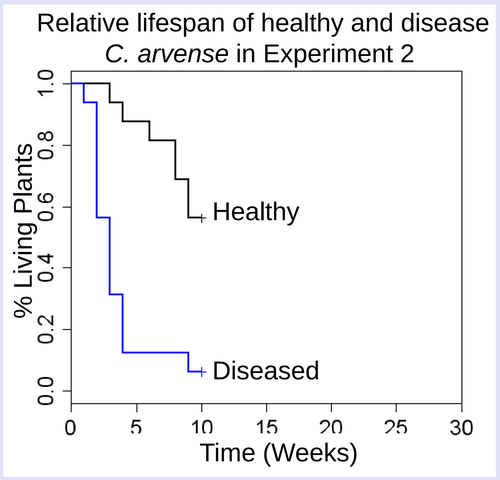
Experiment 2

- Factors tested included root ball size, moisture retention gel, and presence of disease.
- Progression of disease from diseased field transplants to healthy field transplants was observed.

The protocol from the transplant survival study may be used to inform techniques for planting diseased transplants

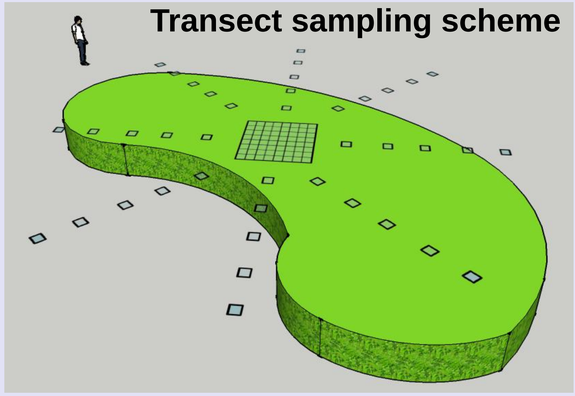
Transplant Survival Study Results & Conclusions

- Root ball size did not have an effect on survival in Experiment 1 or Experiment 2.
- Larger root masses had more shoots at the beginning and at the end of the experiment.
- Moisture did not affect survival. Conditions were likely not dry enough to require supplemental moisture.
- *P. punctiformis* spread throughout Experiment 2 from diseased to healthy *C. arvense* causing local lesions to form.
- The lifespan of healthy *C. arvense* was significantly longer than diseased plants, with 50% of diseased plants dead 2 weeks after transplant.



Diseased Transplant Introduction Study

- Field dug *C. arvense,* systemically infected with *P. punctiformis,* was planted into five healthy patches along Interstate-80 in Pennsylvania with five corresponding controls.
- Disease progression was monitored from June - August 2008 with a 2m x 2m quadrant placed four times around the diseased transplant to total sixty-four 25 x 25 cm squares. Eight transects extended from the diseased transplant, and information was recorded every meter within a 25 x 25 cm square.
- The sampling method was designed to record the rate at which the epidemic would spread throughout the patch from the diseased transplant.
- Higher sampling intensity was present around the transplant. The transects defined the shape of the patch.



Diseased Transplant Introduction Results & Conclusions

Epidemics failed to establish in the patches and could be due to the following:

- Healthy *C. arvense* in the patches are genetically resistant to *P. punctiformis.*
- Inoculum levels were too low. Diseased thistle were stressed from the pathogen and transplanting. They did not produce enough spores to cause an epidemic.
- Diseased *C. arvense* were transplanted outside environmental or host window for infection.

Acknowledgements

USDA, CSREES, NRI Weedy Invasive Species grant, 2007-55320-18376, Pennsylvania Department of Transportation