NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

The SEEDS organic puck- an innovative system for establishing native plants on disturbed sites.

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SEEDS

“Seed Enhanced Ecological Delivery System”

Background

- Plants use many propagule strategies to reproduce
- Vinge and Larsen (2007) used this strategy to develop first SEEDS pucks
- Formulations and configurations were not ideal

Acknowledgements

- COSIA (Canada's Oil Sands Innovation Alliance)
  - Nexen (Champion)
  - CNRL
  - ConocoPhillips
  - Devon
  - Imperial Oil
  - Statoil
  - Suncor

Purpose

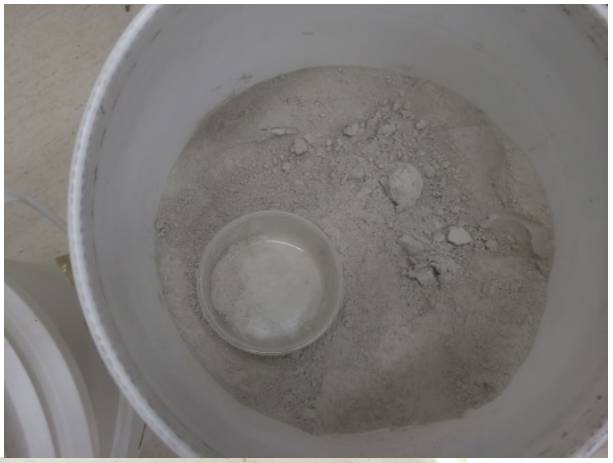
To develop and test a seed delivery technology that improves the emergence and early establishment of native plants (trees, shrubs and herbaceous) for the reclamation of disturbed boreal forest sites

Objectives

1. To determine the optimal ingredient, puck coating and seed coating combinations;
2. To test the effectiveness of coatings for maintaining moisture in the packages; and,
3. To test the formulations under nursery and field conditions.

Recipe/Puck Development Phase

- Multiple ingredients tested



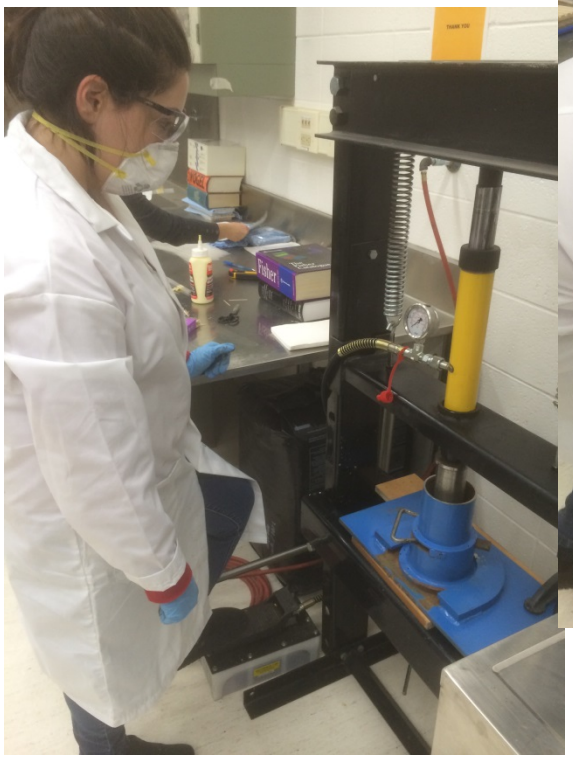
Recipe/Puck Development Phase

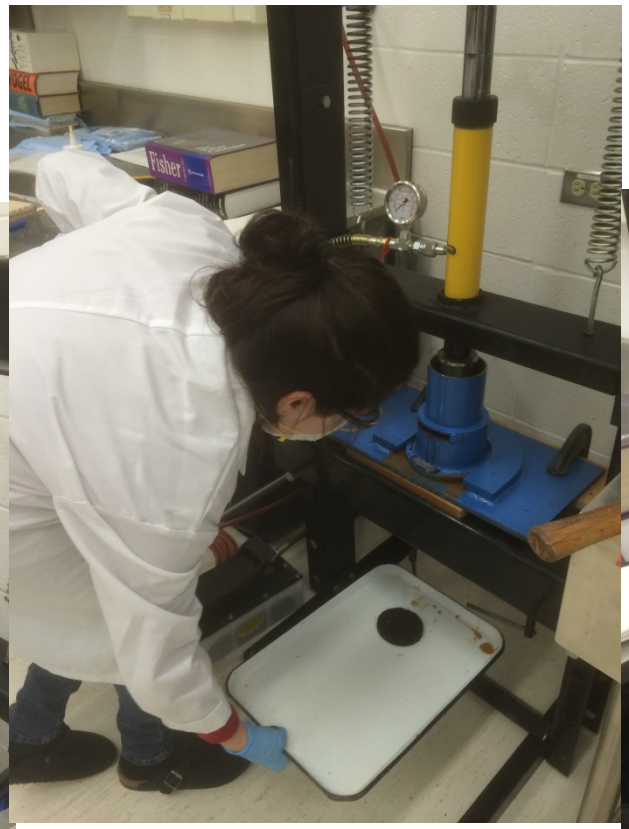
- Varying ratios of ingredients
  - Primary-> bulk
  - Secondary-> sticking and additives
- Varying volume of materials-> puck thickness
- Varying compression pressures -3-10 K psi
- Shape is being discussed-> disk, concave, dome, cone

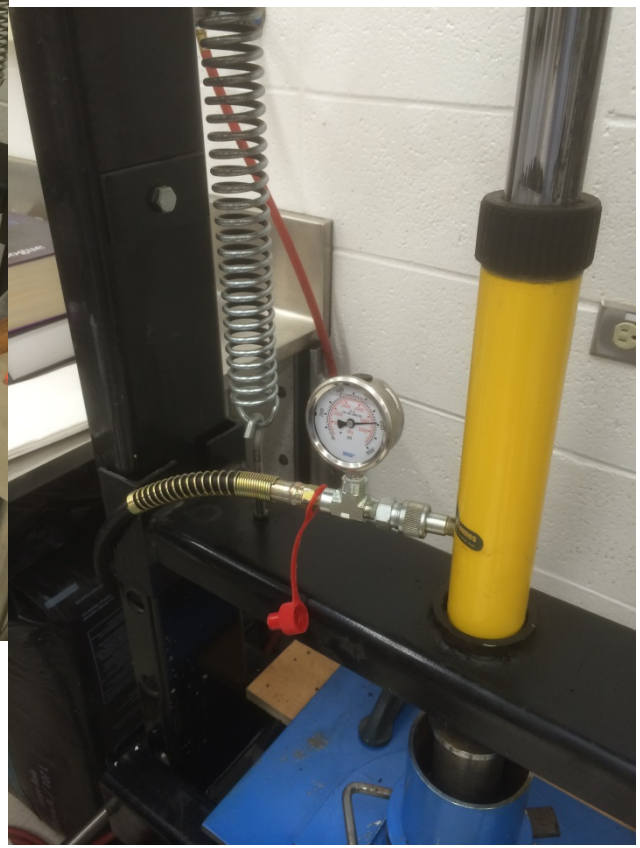
Recipe/Puck Development Phase

Recipe/Puck Development Phase

- Process







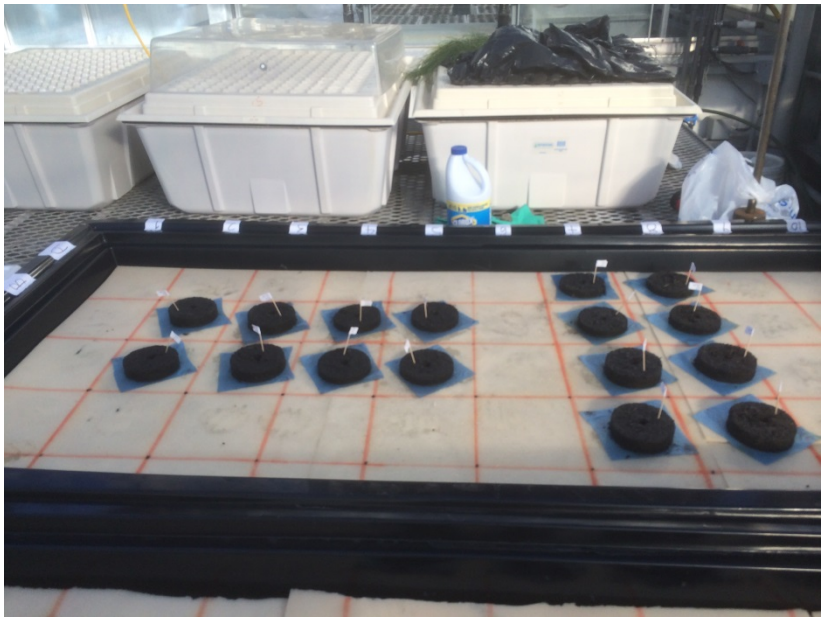
Recipe/Puck Development Phase

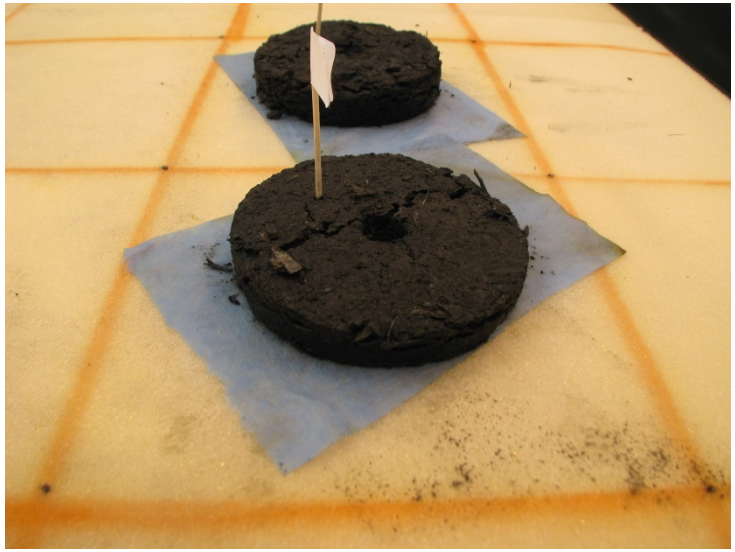
Target Characteristics

- Sturdy when air/oven dried for ease of storage, transport and deployment
  - Frozen storage/deployment?
- Rehydrates quickly when placed on soil or exposed to moisture (precipitation, snow melt)
- Does not wick moisture easily after rehydration
- Readily breaks down
- Does not impede germination or shoot/root egress
- Proper nutrient balance, C/N ratio and chemistry

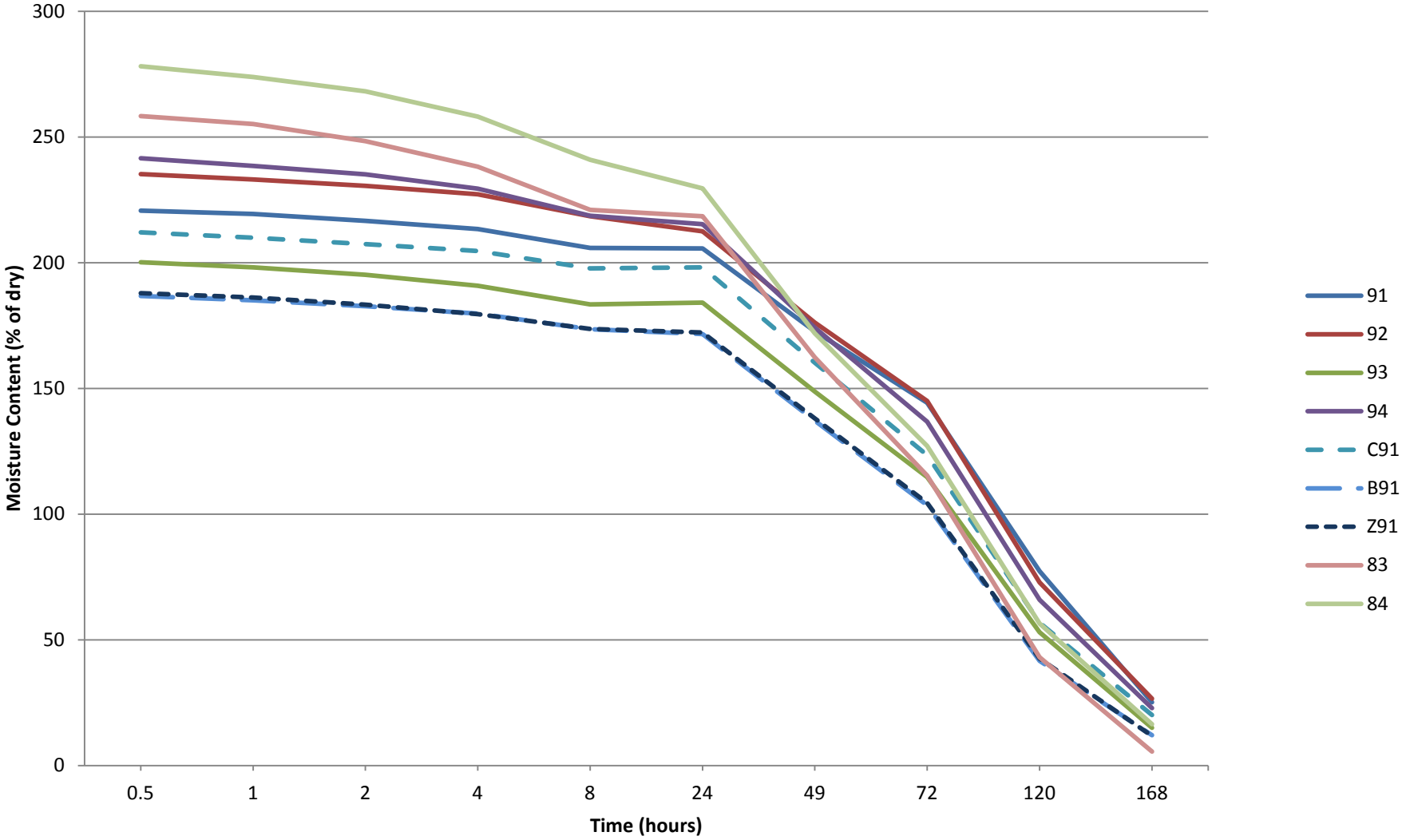
Early Results

- Tested on wetting and drying benches in the greenhouse





Results- Drying



Results

- Based on wetting and drying bench tests, and small tray soil tests in the greenhouse
  - Eliminated peat moss and coconut coir from recipes
  - Organic sticking/bonding agents not suitable
    - Using methylcellulose
- Pressure is a critical factor
- pH varies with formulation- pH adjusted
- Formulation impacts dry stability

Greenhouse Trial

Tested

- Dogwood
- Green Alder
- Black Spruce
- Blueberry

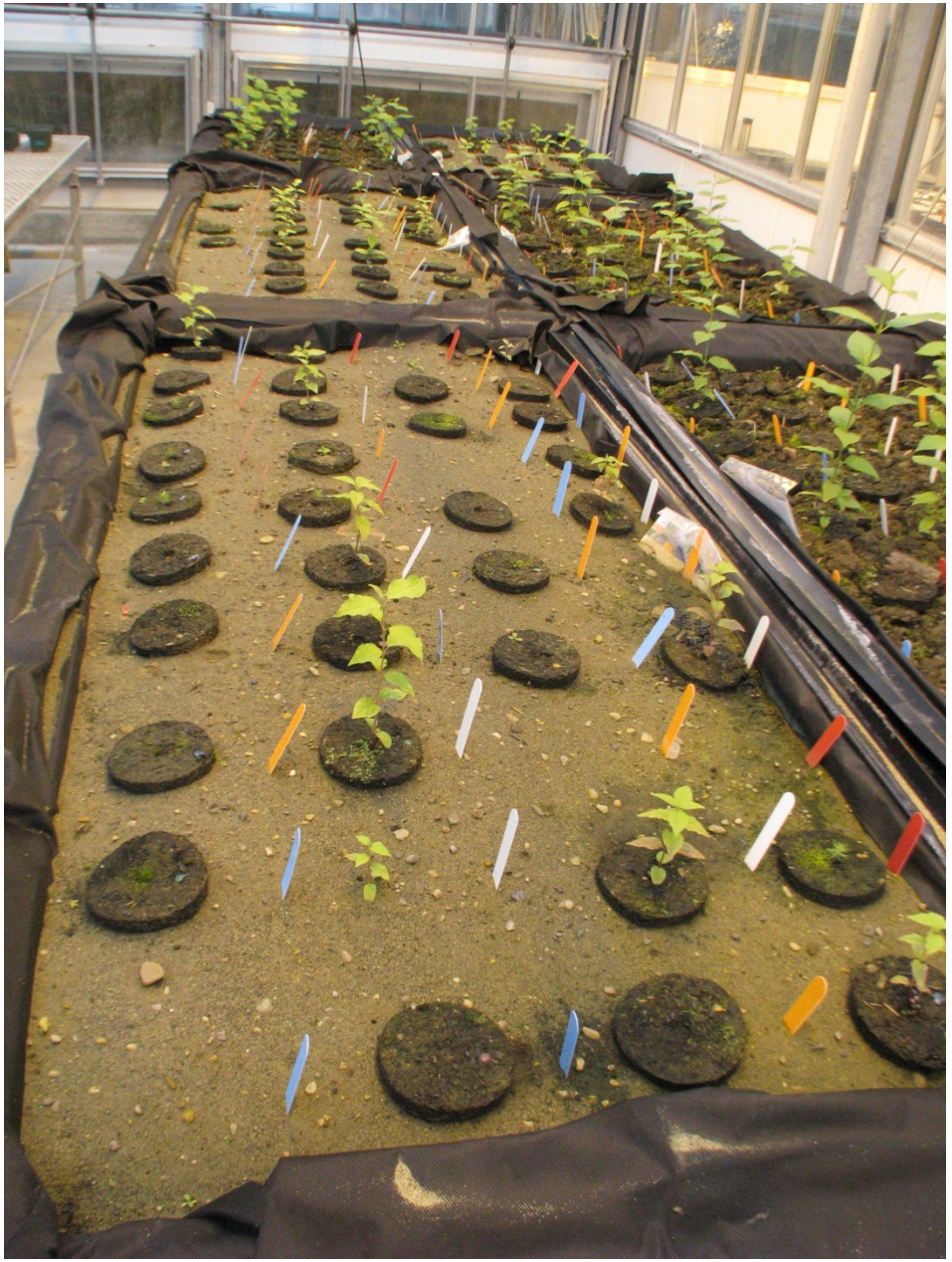
4 recipes

2 soil types

- Sand
- Clay loam

Greenhouse Trial

- All pucks placed September 3
- Dogwood Harvested November 25th



Greenhouse Trial- root assessment

Root egress from puck

Greenhouse Trial- root assessment

Greenhouse Trial- Black Spruce

MINI-FIELD TRIAL

Objective

- The mini-field study was established to test the best puck formulations from lab and greenhouse trials on a small field site
- Objectives:
  - To assess puck physical characteristics in the field after deployment in the fall
  - To assess the impacts on the germination and growth of alder, blueberry, dogwood and black spruce.

Methods

- The experiment was conducted on the grounds of Northern Forestry Centre
- Installed in the fall of 2014.

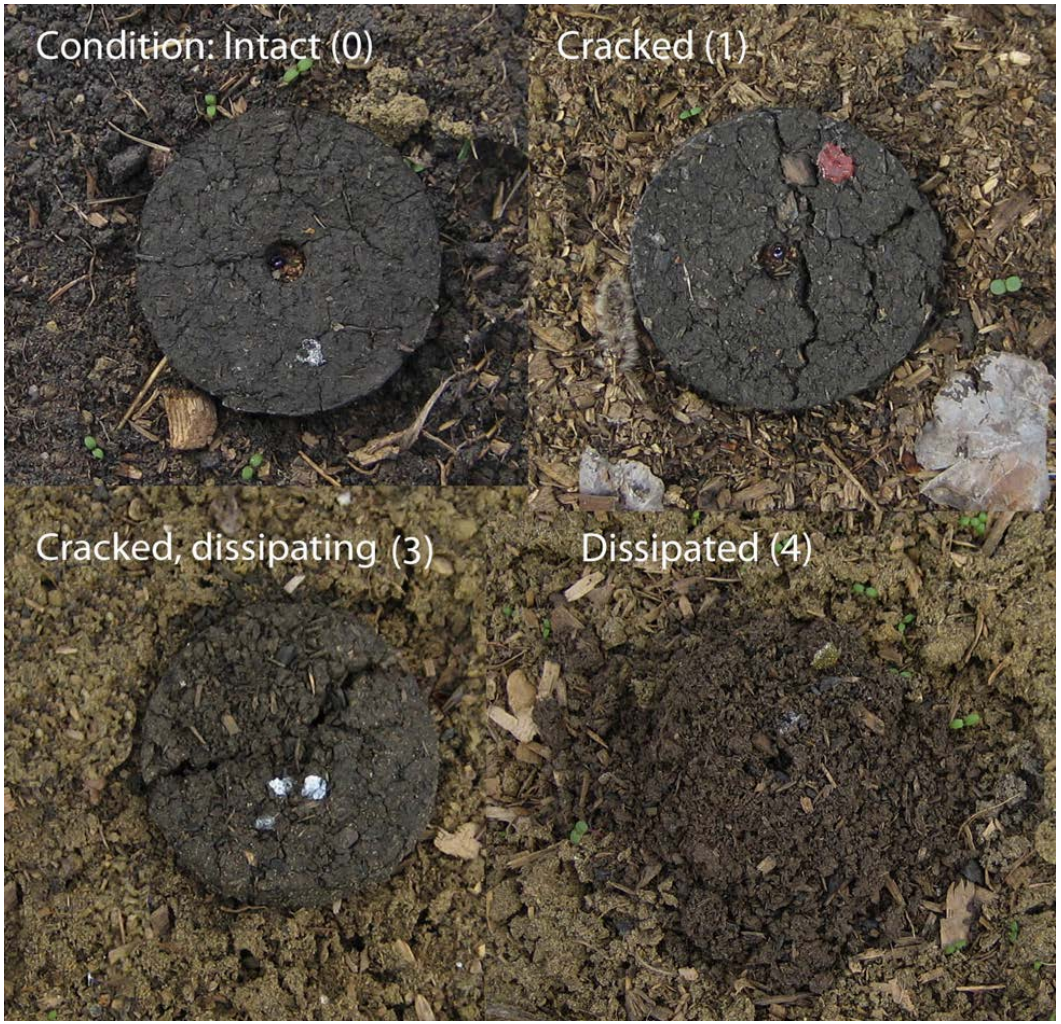
Mini-Field Trial

Mini-Field Trial

After first snowfall

Total 80 positions per plot were marked with cotton thread grid were marked for each puck or “no puck” treatment and each square of the grid was randomly assigned for the treatments. Pucks were laid on the soil on Nov 7th, 2014.

Code for the evaluation of the puck condition



Puck condition codes:
Top left: Intact=0
Top right: cracked=1
(Not shown) Intact with some dissipation=2
Bottom right: cracked and dissipating=3
Bottom right: dissipated=4

Conclusions

- Puck recipes developed and tested in the greenhouse were proven to decompose in the field within one growing season, creating a fiber-rich mulch on the surface of the soil
- There was an effect of the puck recipe on dissipation rate: pucks contained more compost tend to dissipate faster.
- Soil and temperature conditions significantly affected the rate of puck dissipation.
- The extreme drought of the spring 2015 negatively impacted germination of the seeds of the species tested
- Seed were damaged between spring melt and the time of extraction because of drought
- A means of reducing moisture loss from the pucks is required

EFFECT OF PUCK SURFACE COVERS ON DRYING RATE

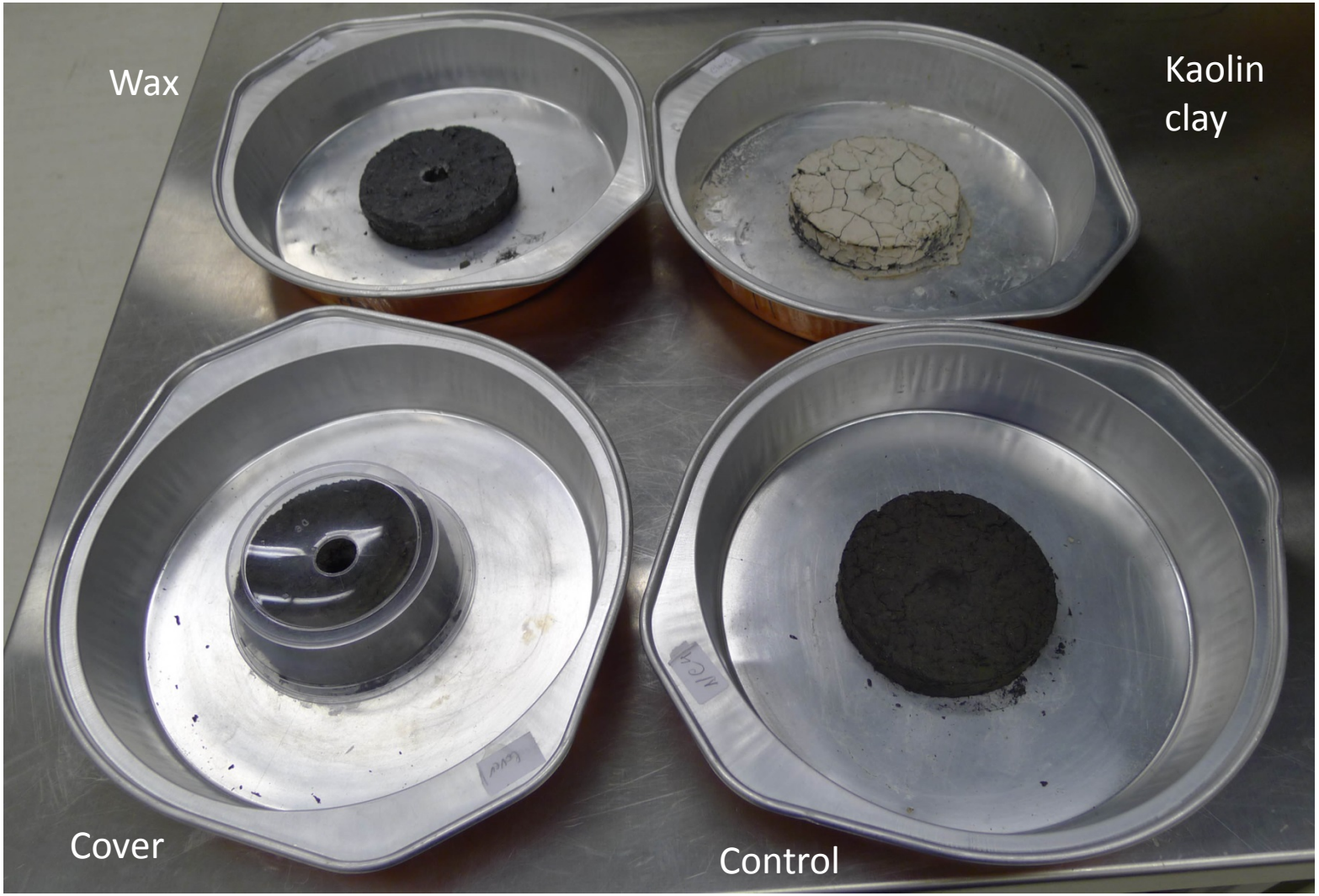
Rationale

- Drought conditions severely impacted seed germination in the mini-field trial.
  - Between April 1 and June 30th, Edmonton received approximately 25% of the normal average precipitation
- A means of retaining moisture in the pucks is required
- Multiple solutions were trialled- ease of application, compatibility with puck manufacture process
  - 3 best were tested in a small replicated bench trial

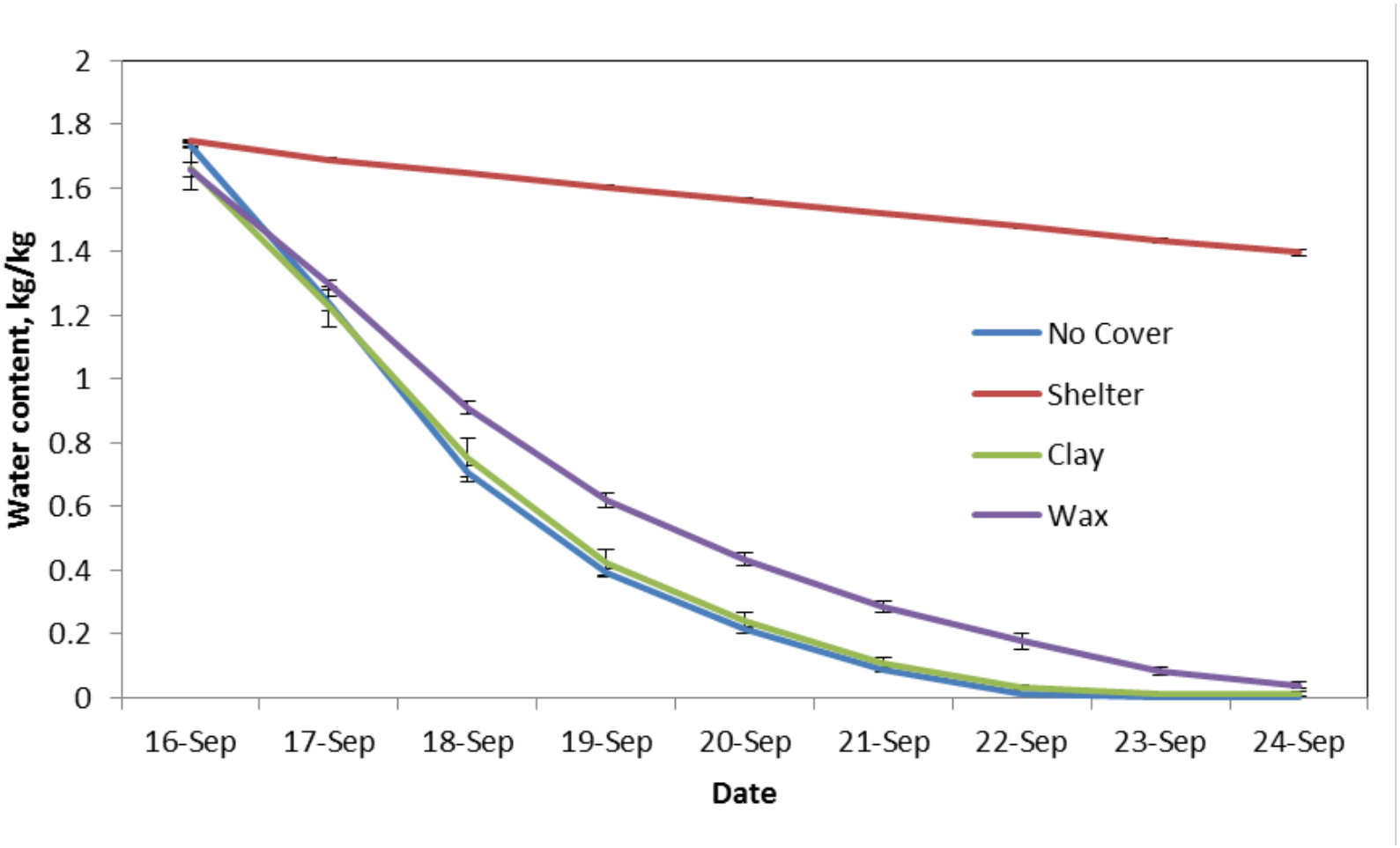
Methods

- Pucks were prepared and treated with different covers:
  - Uncovered (control)
  - Covered with a plastic shelter with a top opening
  - Dipped in kaolin clay
  - Dipped in wax (top surface only)
- Pucks were placed on a tin pie dish, watered, weighed and placed on the lab bench.
- The pucks were weighed daily to assess moisture loss

Experimental setup



Puck drying curves



Conclusions

- Clay cover did not have a significant effect on the rate of the puck drying.
- Wax cover retarded drying slightly when compared to other coating treatments.
- Plastic shelter reduced the rate of drying by an order of magnitude.
- Results might be altered in the presence of a living plant and/or in contact with soil.

Mini-Field Trial Puck Coating Test

- Test the coatings and the shelter in another mini-field trial to determine if this makes a difference to seed germination in a field situation

Greenhouse Puck Coating Test

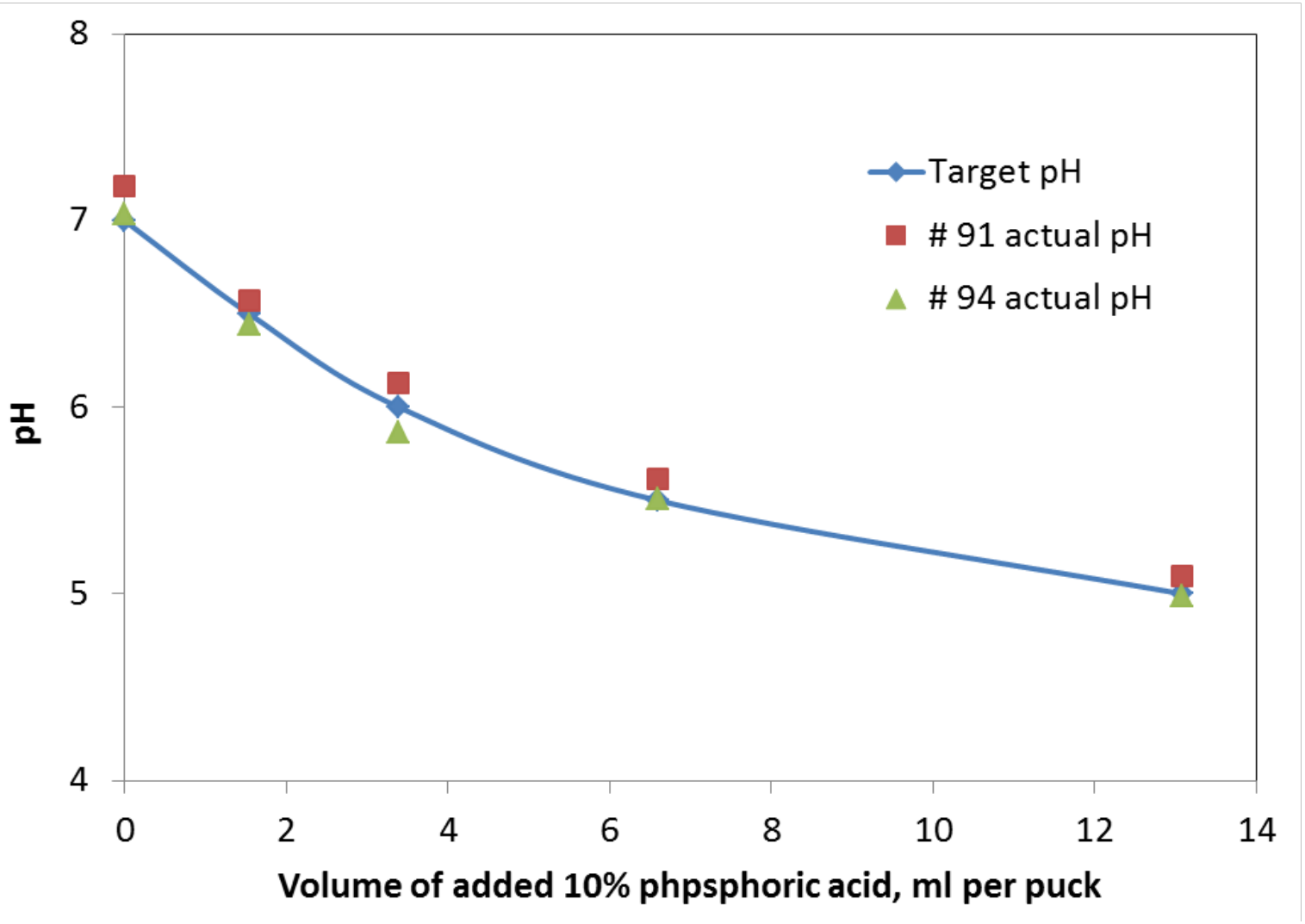
- Same test on greenhouse soil test bed- get quantifiable understanding of moisture relations

PUCK ACIDIFICATION TRIAL- EFFECTS ON BLUEBERRY GERMINATION

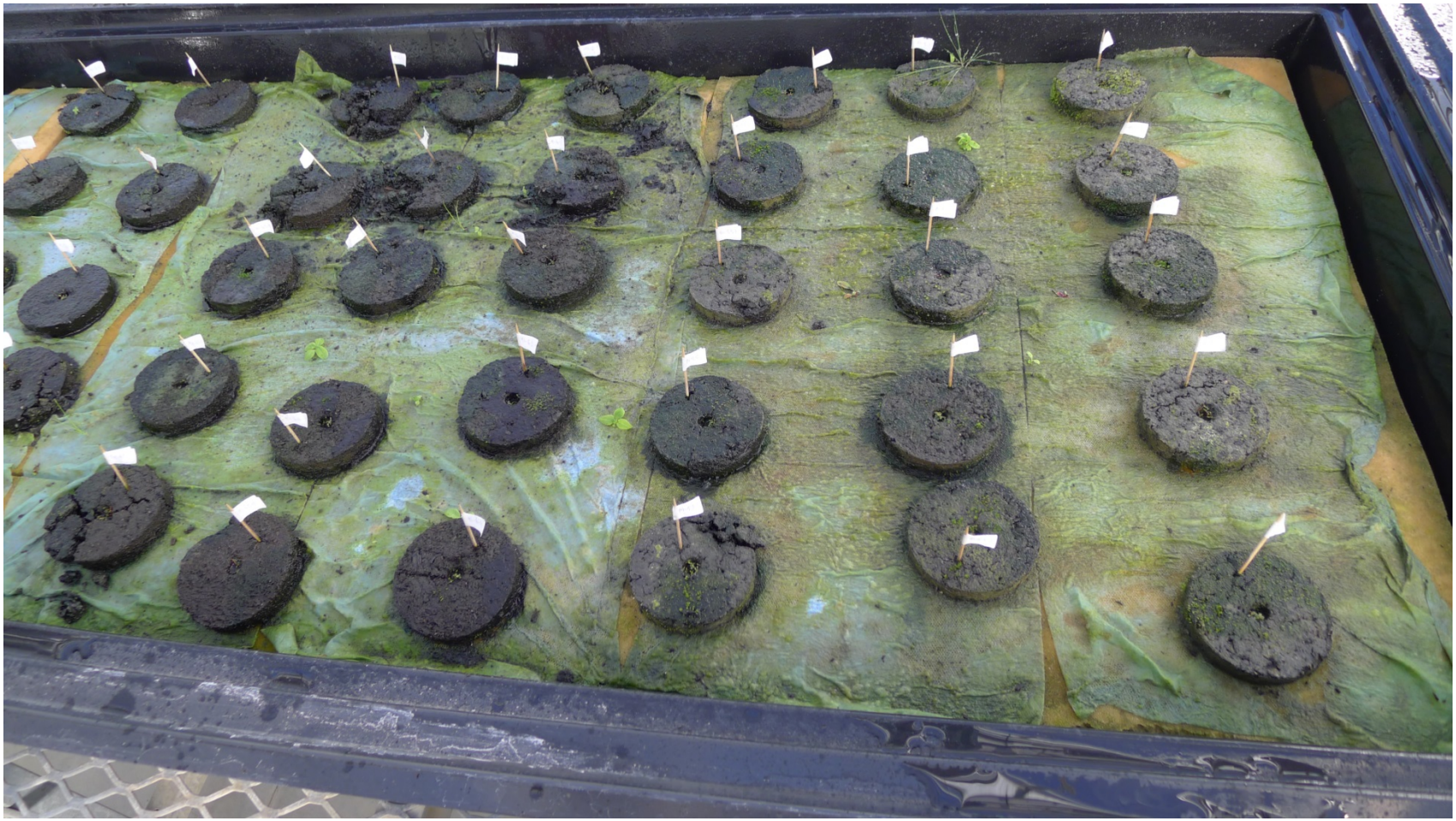
Introduction

- Some Boreal species are adapted to acidic environment, with pH values as low as 4- blueberry is a prime example
- In this study we attempted to evaluate the effect of pH on blueberry germination and growth.
- Two recipes acidified

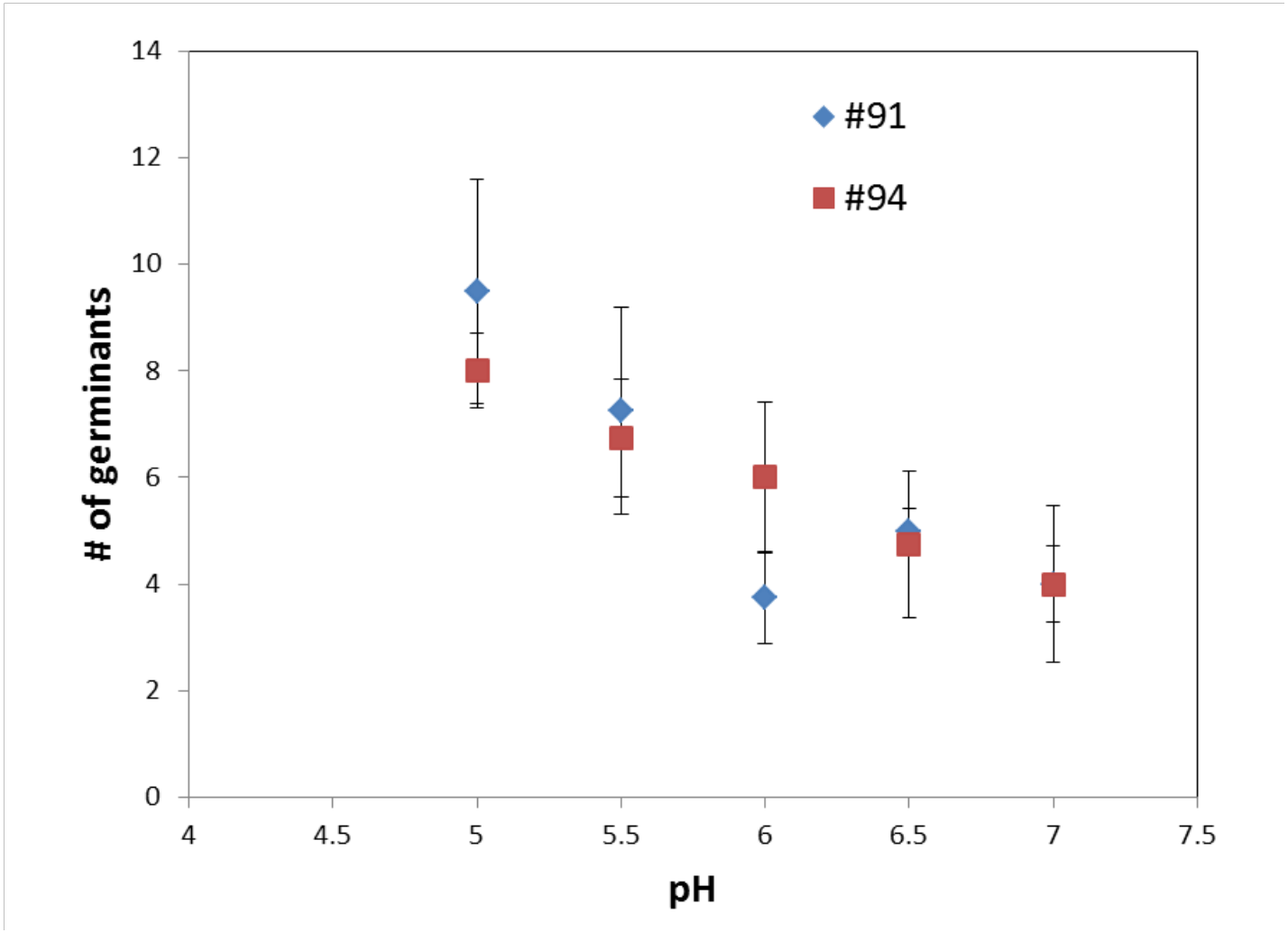
Puck acidification curves



Experimental setup. Pucks on the left have neutral pH, on the right pH5, with intermediate pH values in the middle



Effect of pH on blueberry germination rates 33 days after seeding



Conclusions

- Blueberry germinated successfully in the pucks amended with phosphoric acid.
- pH levels evidently affect soil microflora as the volunteer growth of mold, fungus and moss differed between treatments
- At the early stages of germination blueberry appears to benefit from lower pH levels.

Evergreen Park Black Spruce Quick Trial

- 100 pucks each seeded with 3 to 4 black spruce seed where place on four year old mounds black spruce bog at Evergreen park GP in mid April.

Evergreen Park Black Spruce Quick Trial

- June/Sept
  - 75% of pucks had one or more healthy germinants
- 4 pucks where missing
- 3 pucks damaged

Next steps

- Evaluation of mini-field trial and greenhouse trial with coatings
- Exploration of other coatings/puck treatments
- Investigate scale-up of production
  - Equipment
  - Production costs
- Operational field trial only when confident in puck .

THANK YOU

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