Use of Abscisic Acid to Enhance the Survival of Fall Sown Seeds

Matthew Madsen, William Richardson, Dallin Whitaker, *Ryan Call, Bruce Roundy*

Acknowledgments

OREGON Fish & Wildlife

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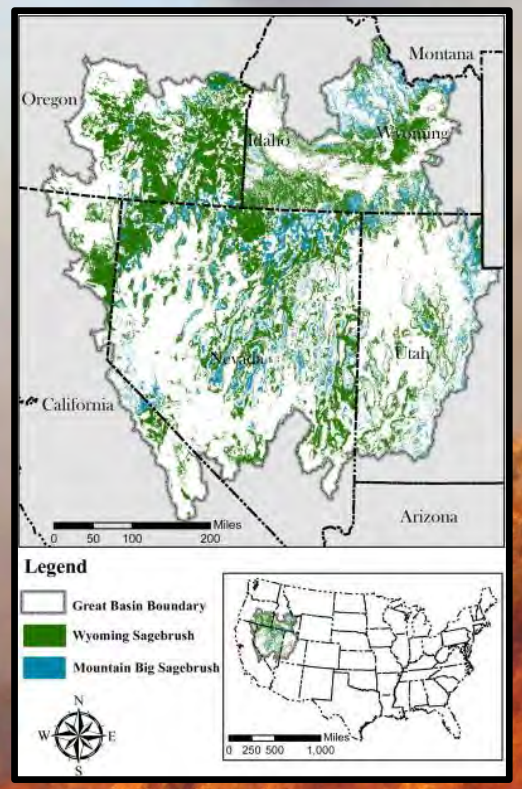
UTAH DNR
WILDLIFE RESOURCES

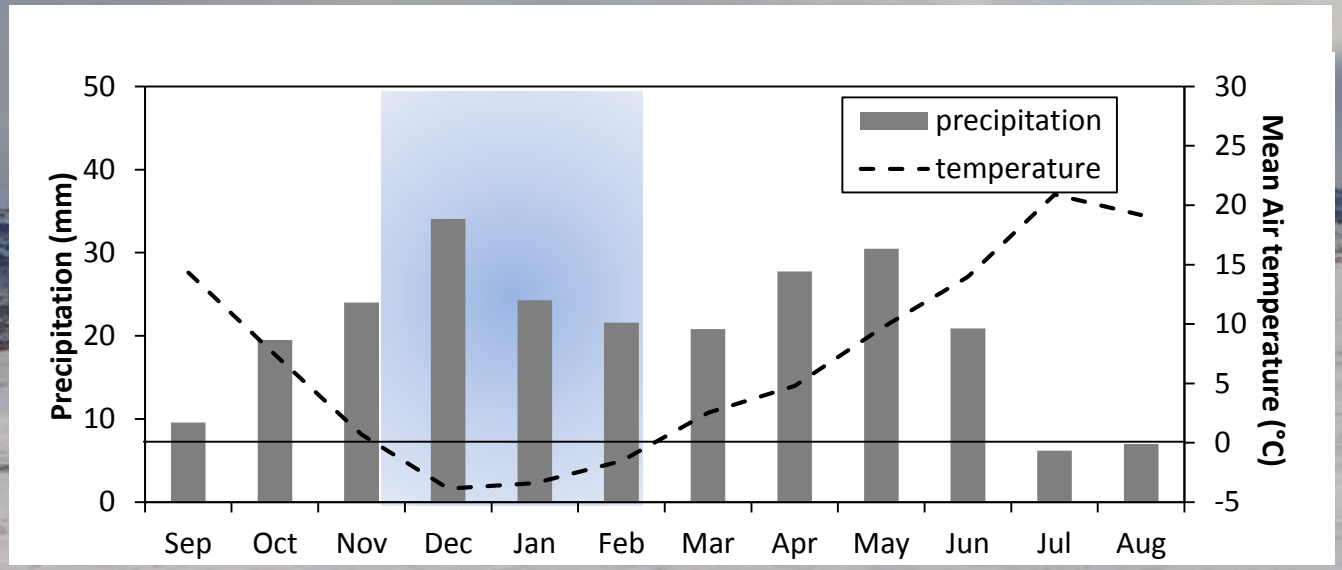


- Cheatgrass wildfire cycle, Great Basin

Photo: **Charlotte** Ganskopp

- Rangeland Seeding

Winter Mortality



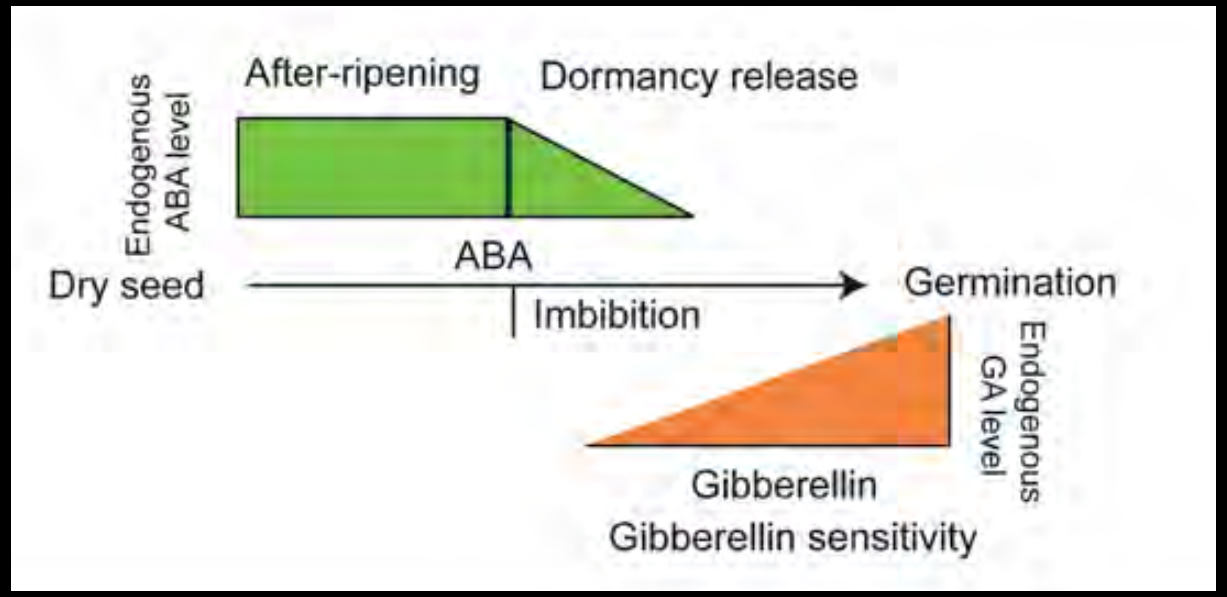
Demography Events

James et al. 2011, Boyd and James 2013

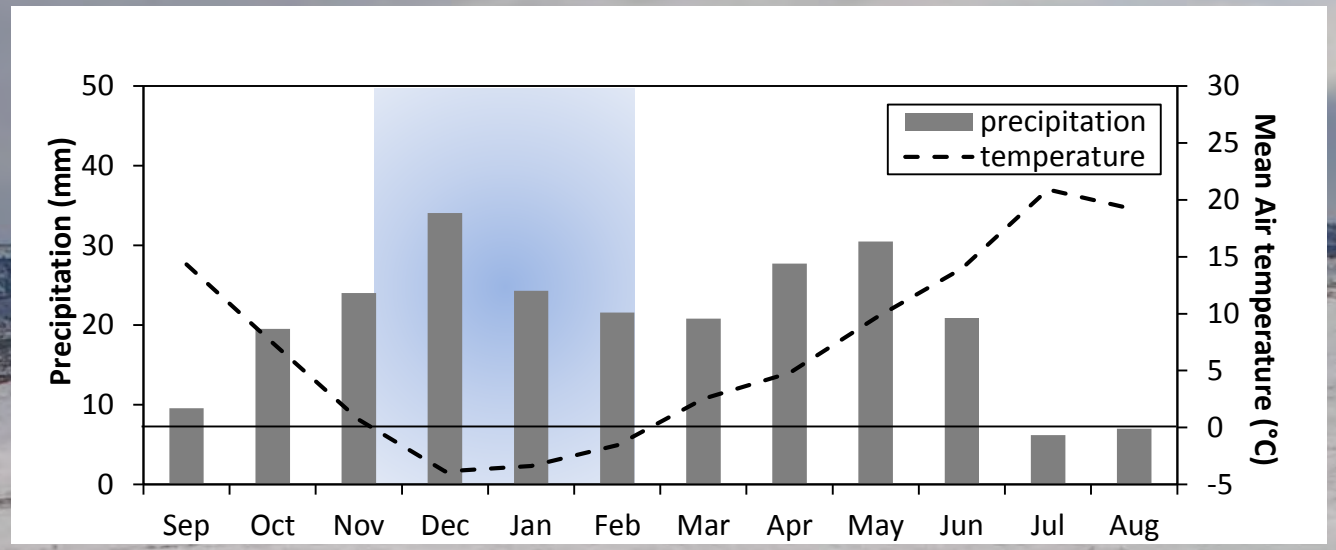
- Germination was rapid and high for fall seedings (Sept.-Oct.), with species obtaining up to 50-80% germination by December
- In general <10% of the seeds sown emerged from the soil surface

Seed Dormancy

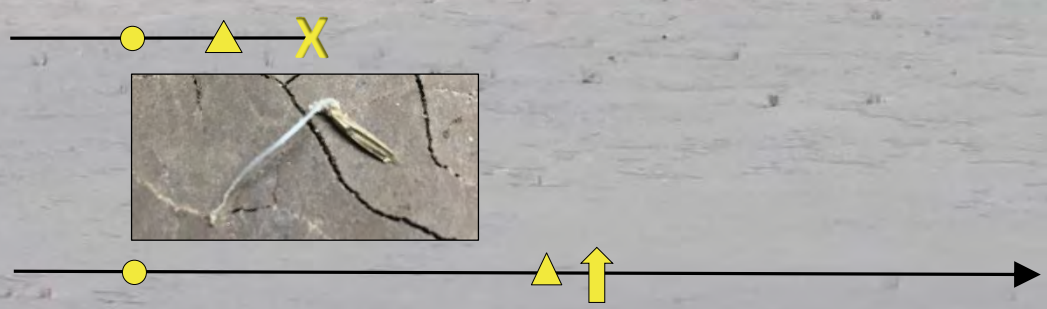
- Seed dormancy has been identified as a mechanism for preventing seed germination within a season that is unfavorable for establishing a new plant
- For water-permeable seed, dormancy is caused from elevated levels of abscisic acid (ABA)
- Dormancy levels decrease as a function of time (dry after-ripening)



ABA Seed Coating to Delay Seed Germination



Untreated seed



ABA coated seed

Species

- Bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) Löve)
- Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis*)

Objectives

1. Determine how ABA application rates within a seed coating influences seed germination rate and total germination under a range of constant temperatures

2. Estimate seed germination timing in the field by applying thermal accumulation models to soil moisture and temperature data sets

Seed Treatments

Bluebunch wheatgrass

- Treated seed with **BioNik**® plant growth regulator, which is a 25% formulation of abscisic acid (ABA).
- Treatments:
  1. left untreated (control)
  2. 0.25 g of BioNik/ 100 g of seed
  3. 0.5 g of BioNik/ 100 g of seed
  4. 1.0 g of BioNik/ 100 g of seed
  5. 1.5 g of BioNik/ 100 g of seed
  6. 2.0 g of BioNik/ 100 g of seed
  7. 4.0 g of BioNik/ 100 g of seed
  8. 6.0 g of BioNik/ 100 g of seed

VALENT BIOSCIENCES CORPORATION

BioNik™ PLANT GROWTH REGULATOR

Objective 1: ABA Influence on Germination

STUDY DESIGN

Germination medium:

- fine-sand placed in 2cm deep, 13X13 cm acrylic boxes
- Soil moisture = - 0.006 MPa

Temperatures:
5, 10, 15, 20, 25°C

- 7 repetitions for every treatment in each temperature

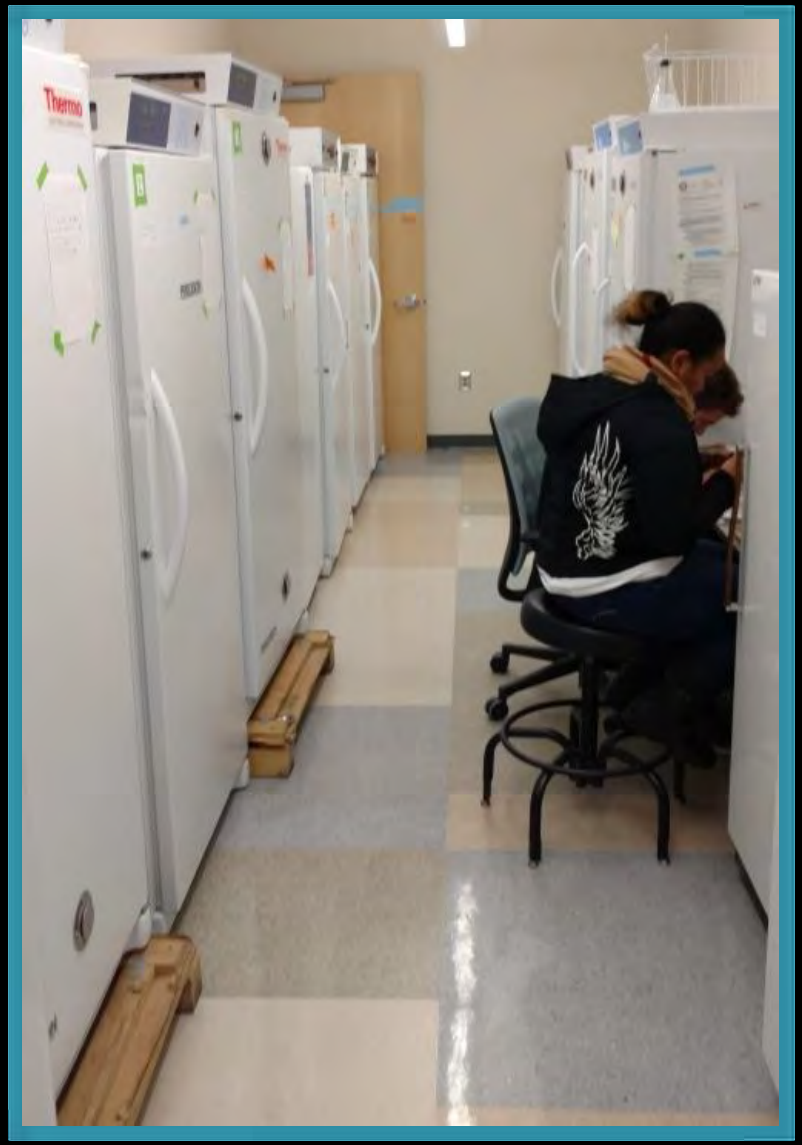
-Total boxes in study: 9 treatments X 5 temperatures X 7 reps = 315

Measurements:

- Germination was recorded every 2-3 days for 101 days

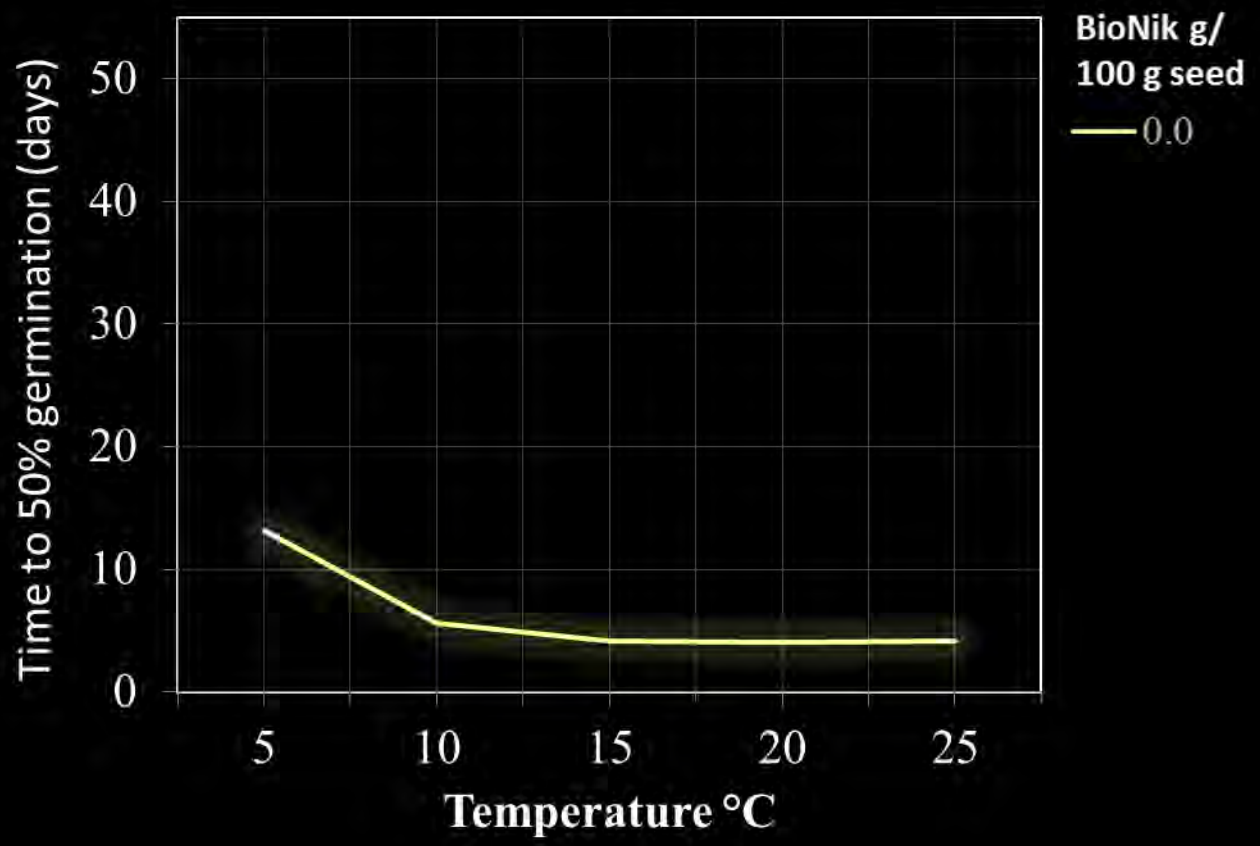
Statistics:

- A random general linear model was made to determine significance of the effects and interactions of ABA concentration in relation to the linear and quadratic covariates of incubation temperature.



Objective 1: ABA Influence on Germination

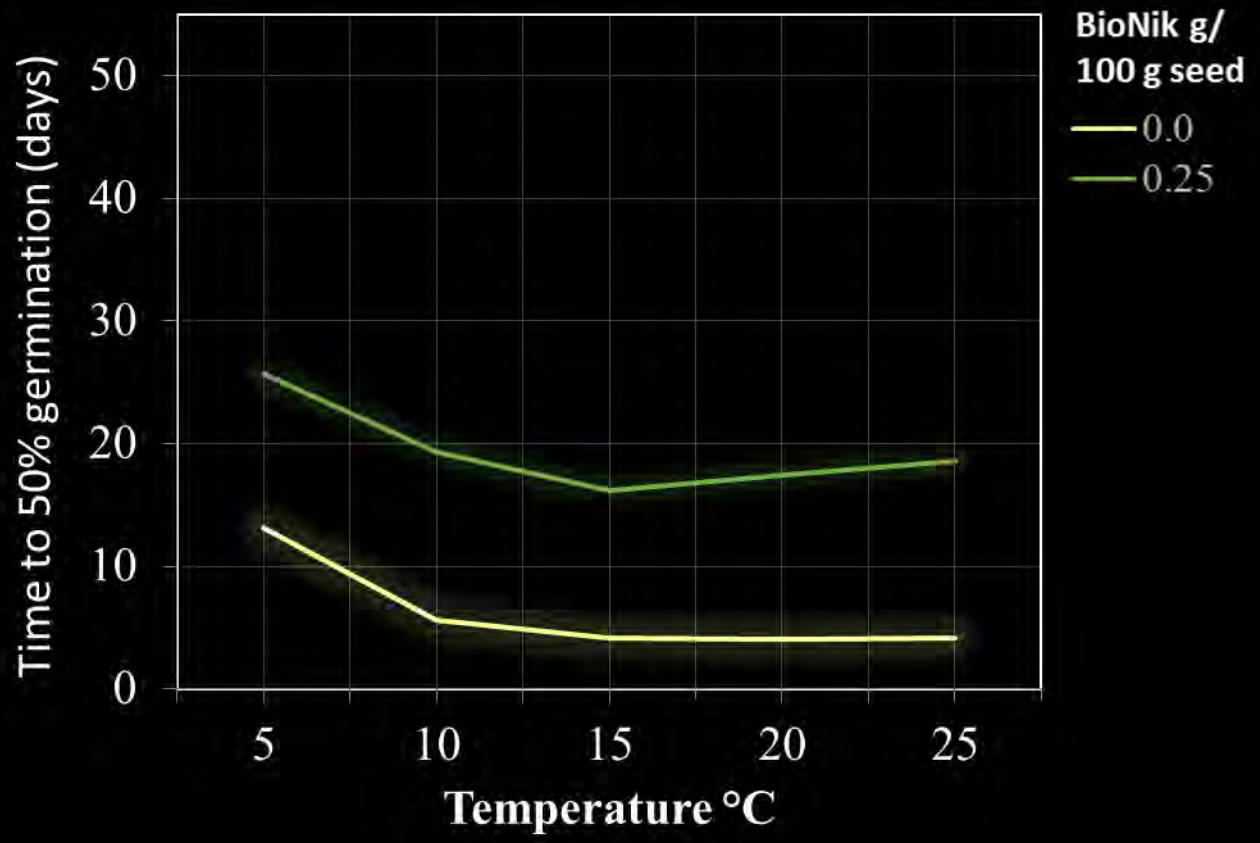
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A

Objective 1: ABA Influence on Germination

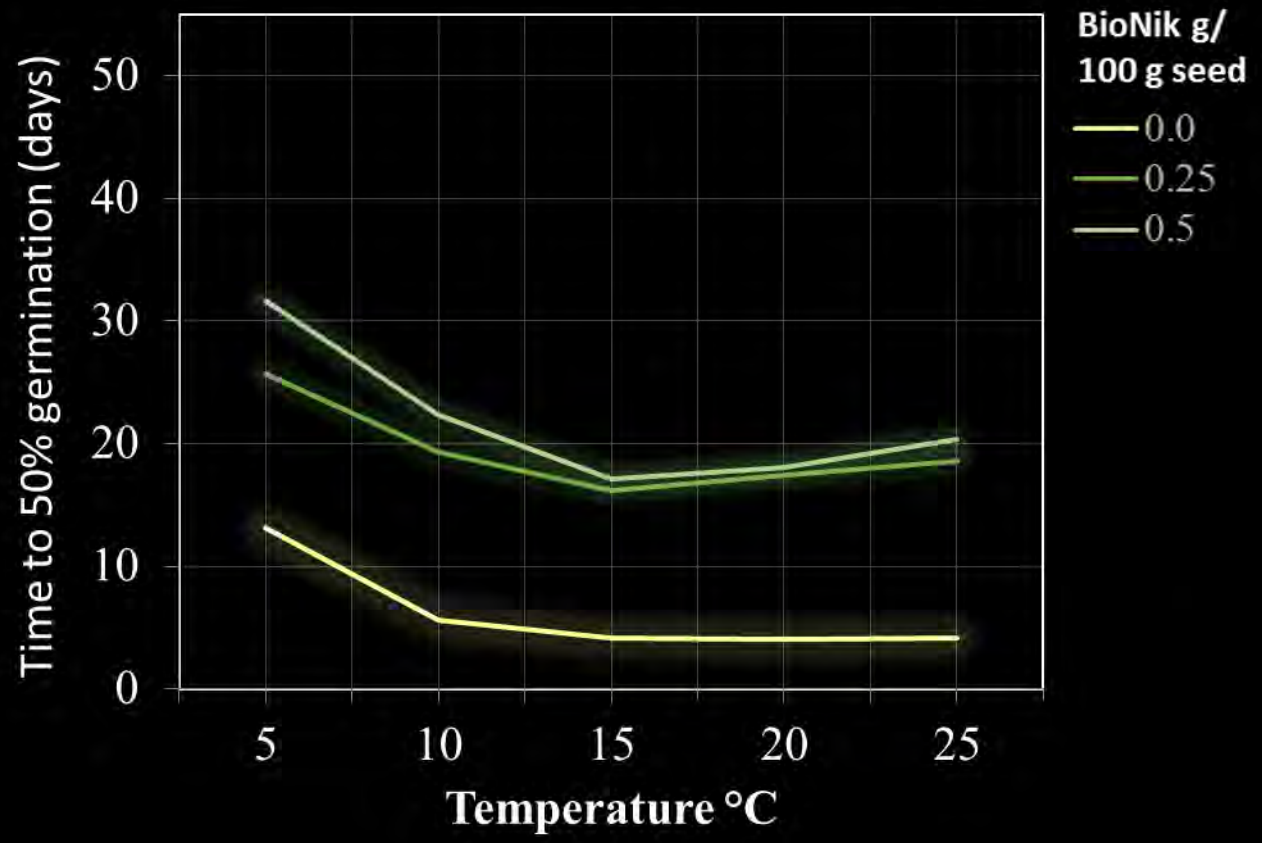
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B

Objective 1: ABA Influence on Germination

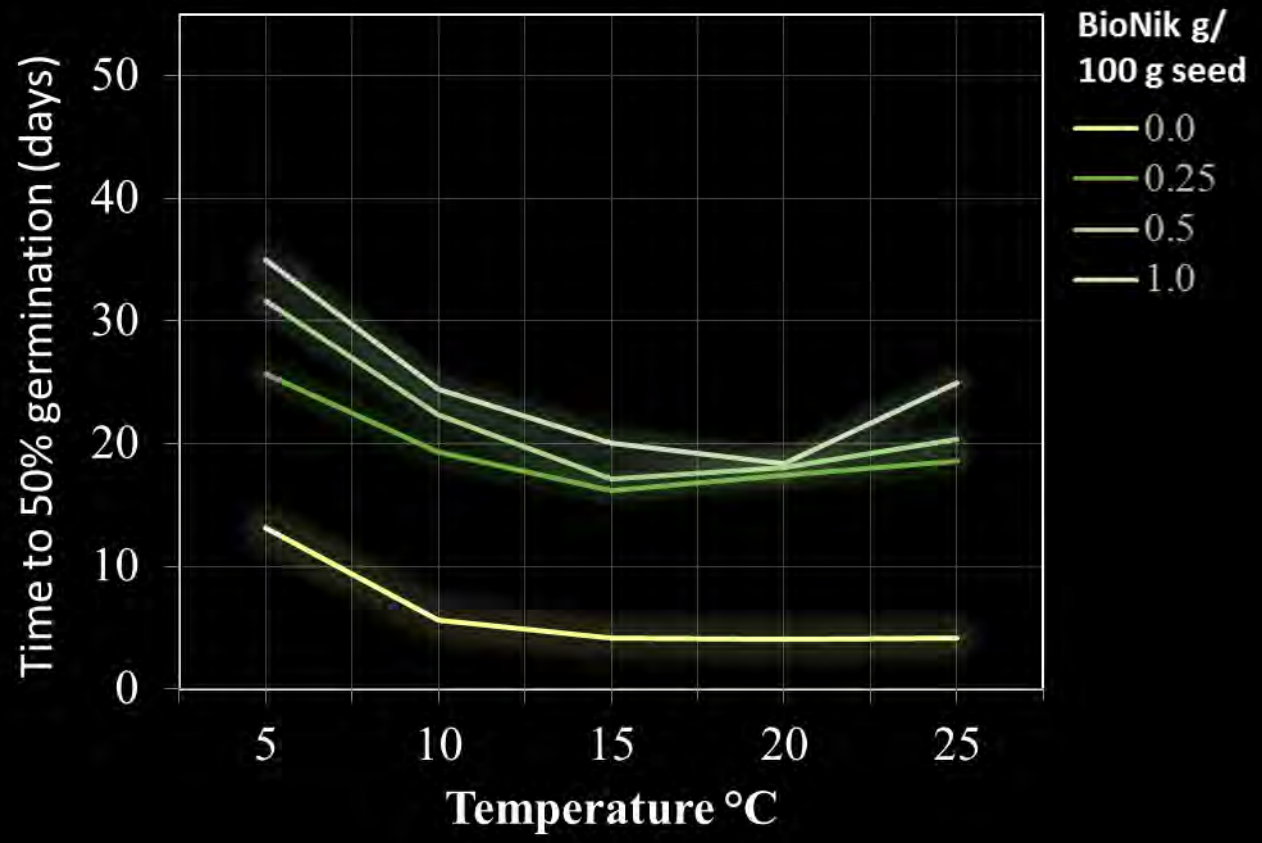
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC

Objective 1: ABA Influence on Germination

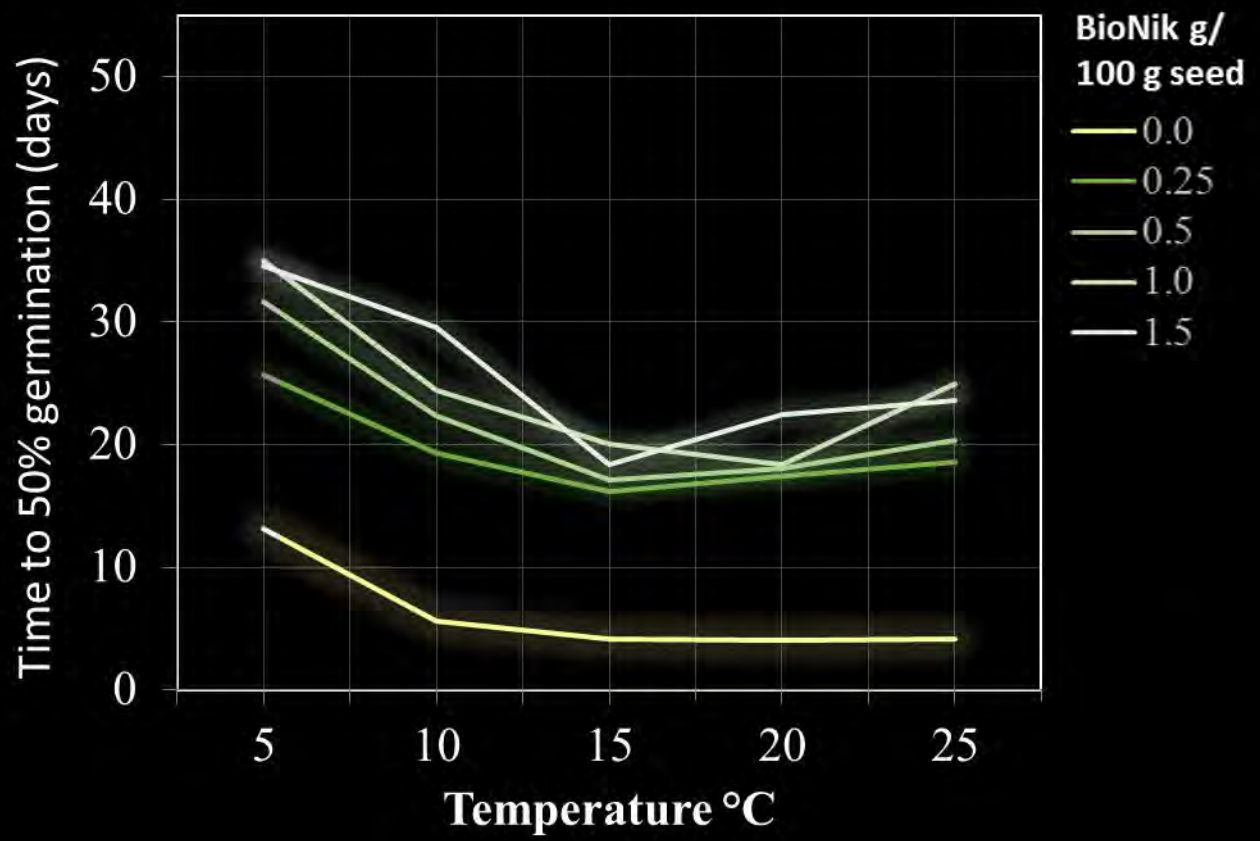
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC
1.0	BCD	CD	BC	B	BC

Objective 1: ABA Influence on Germination

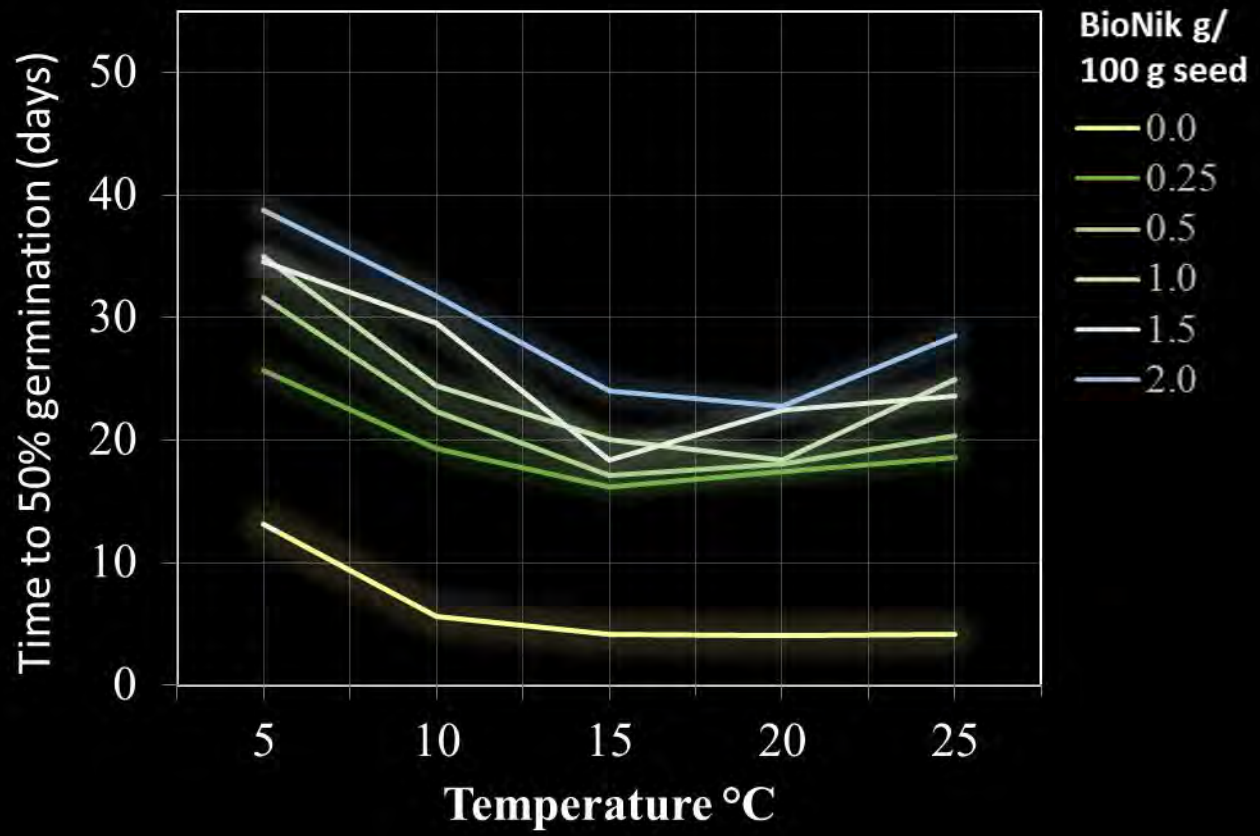
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC
1.0	BCD	CD	BC	B	BC
1.5	BCD	CDE	BCD	B	BC

Objective 1: ABA Influence on Germination

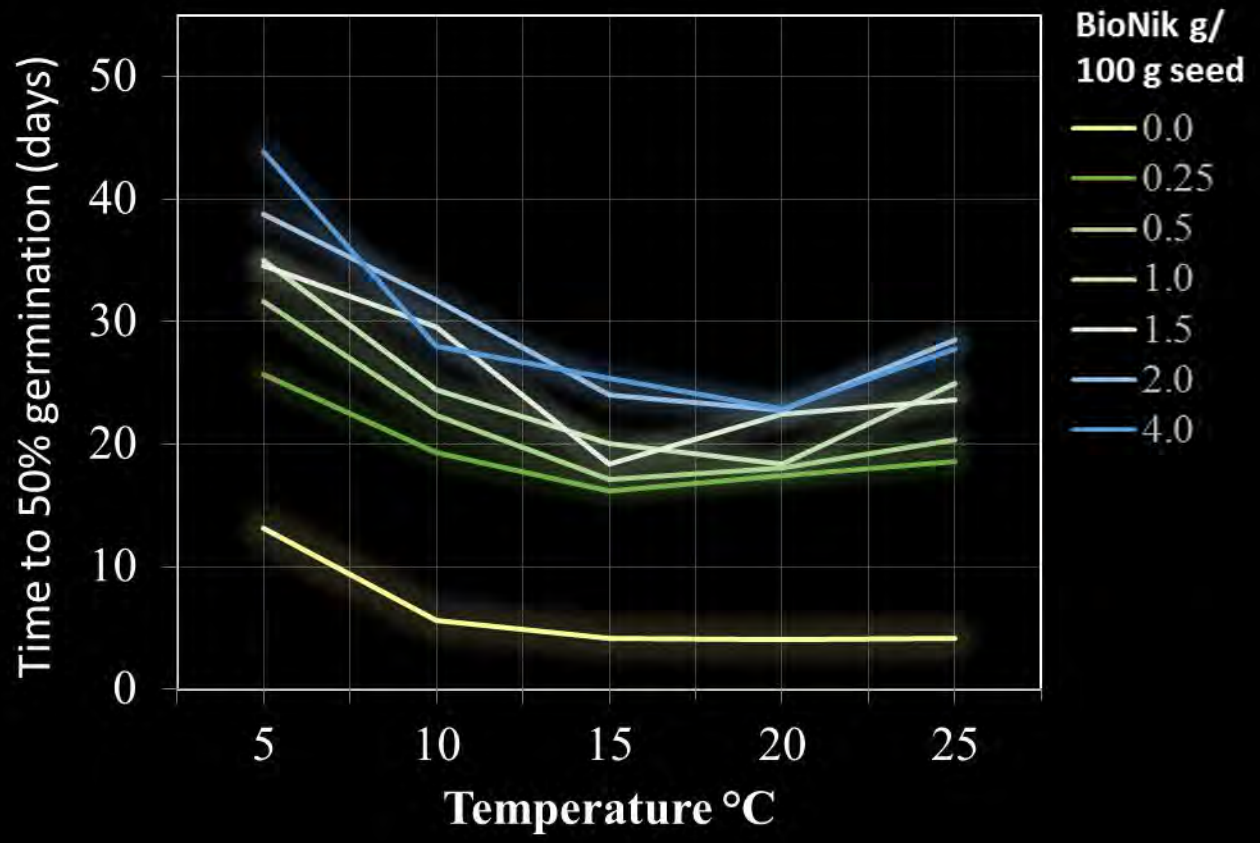
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC
1.0	BCD	CD	BC	B	BC
1.5	BCD	CDE	BCD	B	BC
2.0	CD	DE	CD	B	BC

Objective 1: ABA Influence on Germination

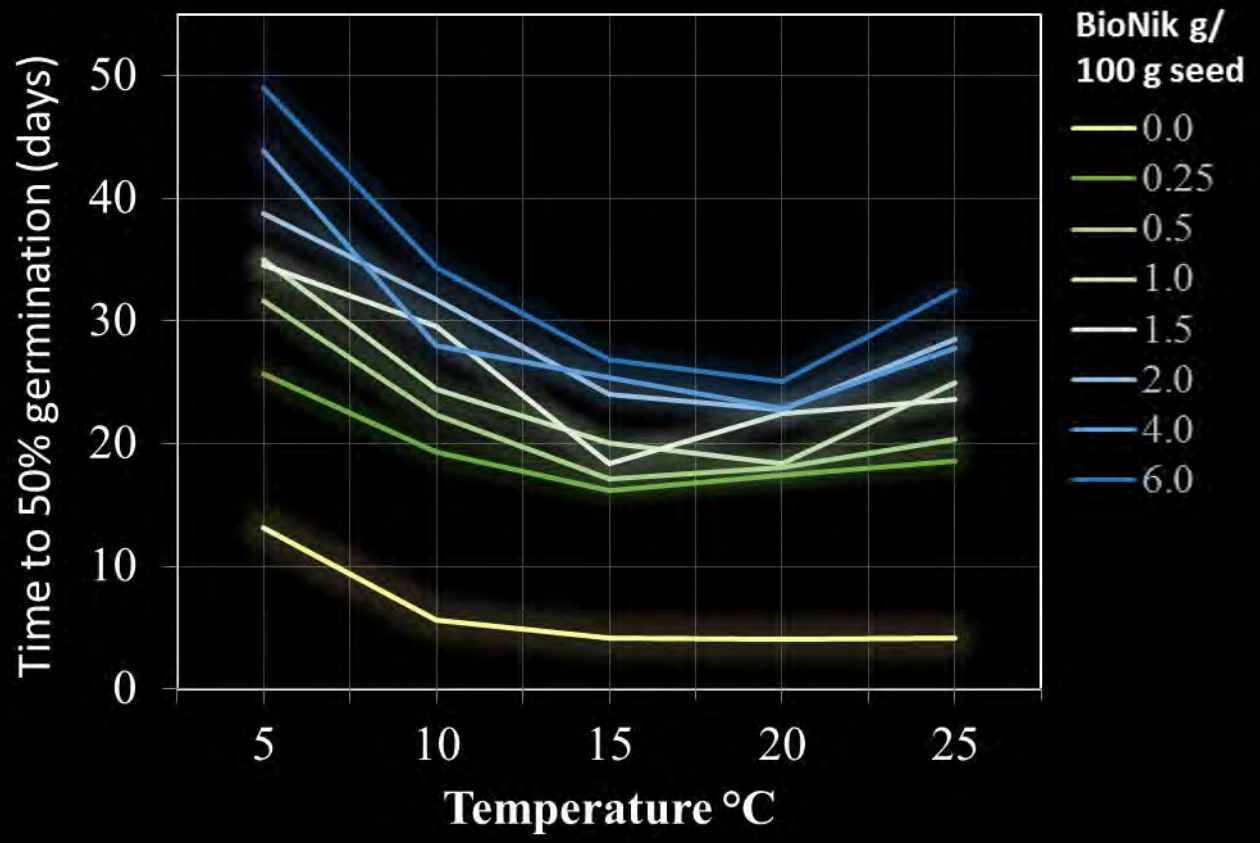
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC
1.0	BCD	CD	BC	B	BC
1.5	BCD	CDE	BCD	B	BC
2.0	CD	DE	CD	B	BC
4.0	CD	DE	D	B	BC

Objective 1: ABA Influence on Germination

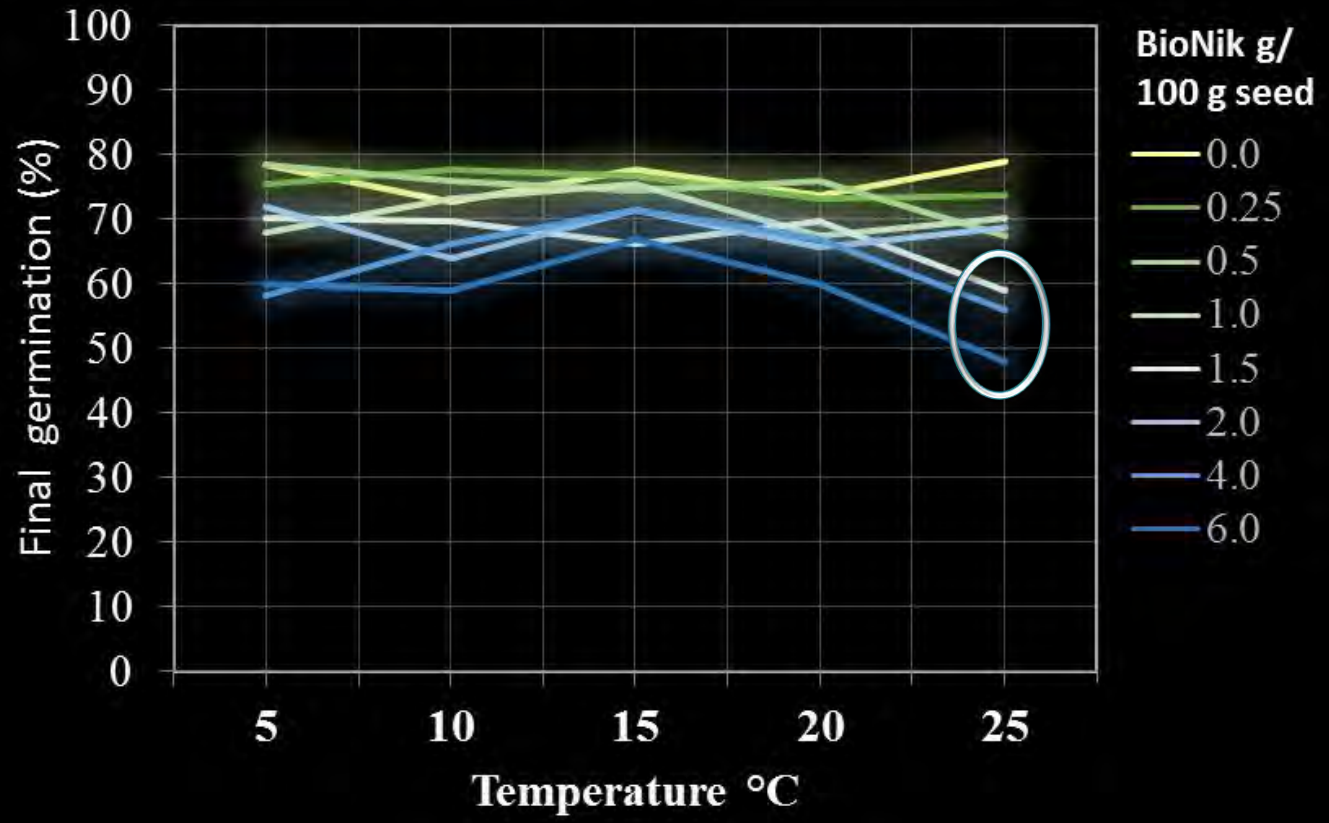
RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	BC	B	B	B	B
0.5	BC	BC	B	B	BC
1.0	BCD	CD	BC	B	BC
1.5	BCD	CDE	BCD	B	BC
2.0	CD	DE	CD	B	BC
4.0	CD	DE	D	B	BC
6.0	D	E	D	B	C

Objective 1: ABA Influence on Germination

RESULTS



BioNik g/ 100 g seed	5°C	10°C	15°C	20°C	25°C
0	A	A	A	A	A
0.25	A	A	A	A	AB
0.5	A	A	A	A	ABC
1.0	A	A	A	A	ABC
1.5	A	A	A	A	ABC
2.0	A	A	A	A	BCD
4.0	A	A	A	A	CD
6.0	A	A	A	A	D

Objective 2: Predicting Seed Germination Date

METHODS

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journal homepage: www.elsevier.com/locate/envexpbot

Predicting germination in semi-arid wildland seedbeds. I. Thermal germination models

Jennifer K. Rawlins[a], Bruce A. Roundy[a,*], Scott M. Davis[a], Dennis Egget[b]

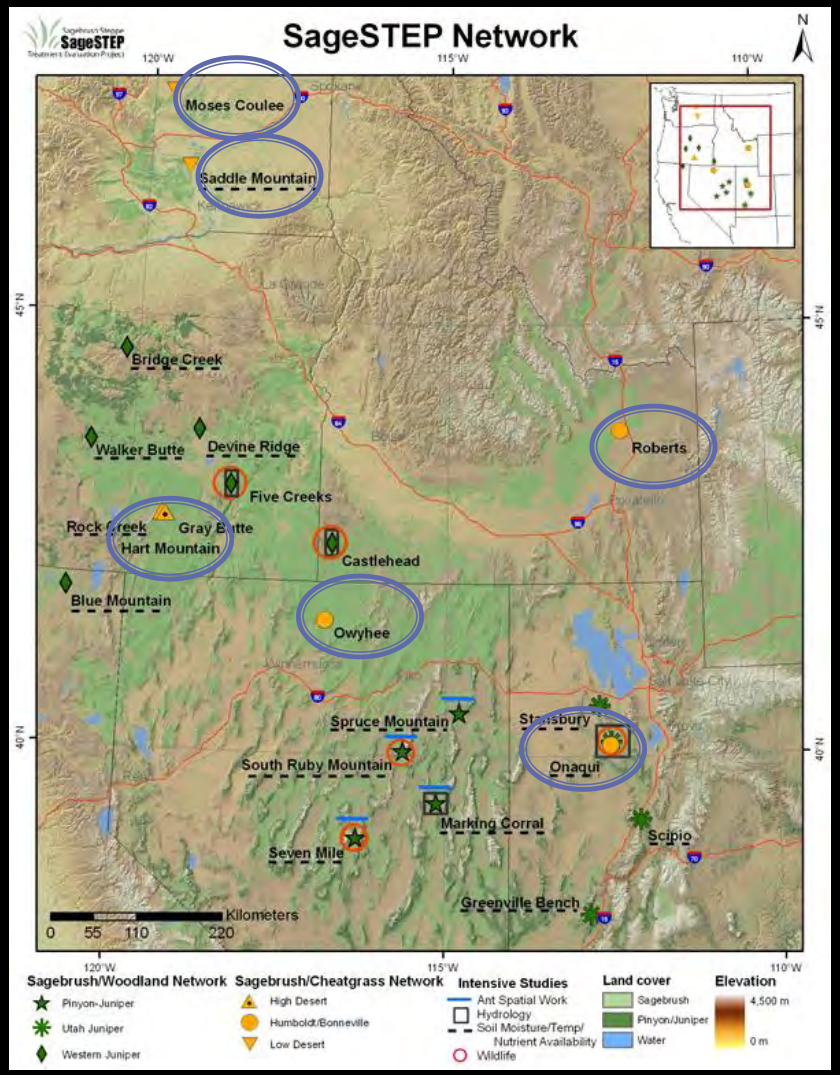
- Estimated seed germination timing in the field from historic field data according to Rawlins et al. 2012.

Objective 2: Predicting Seed Germination Date

METHODS

Study Sites

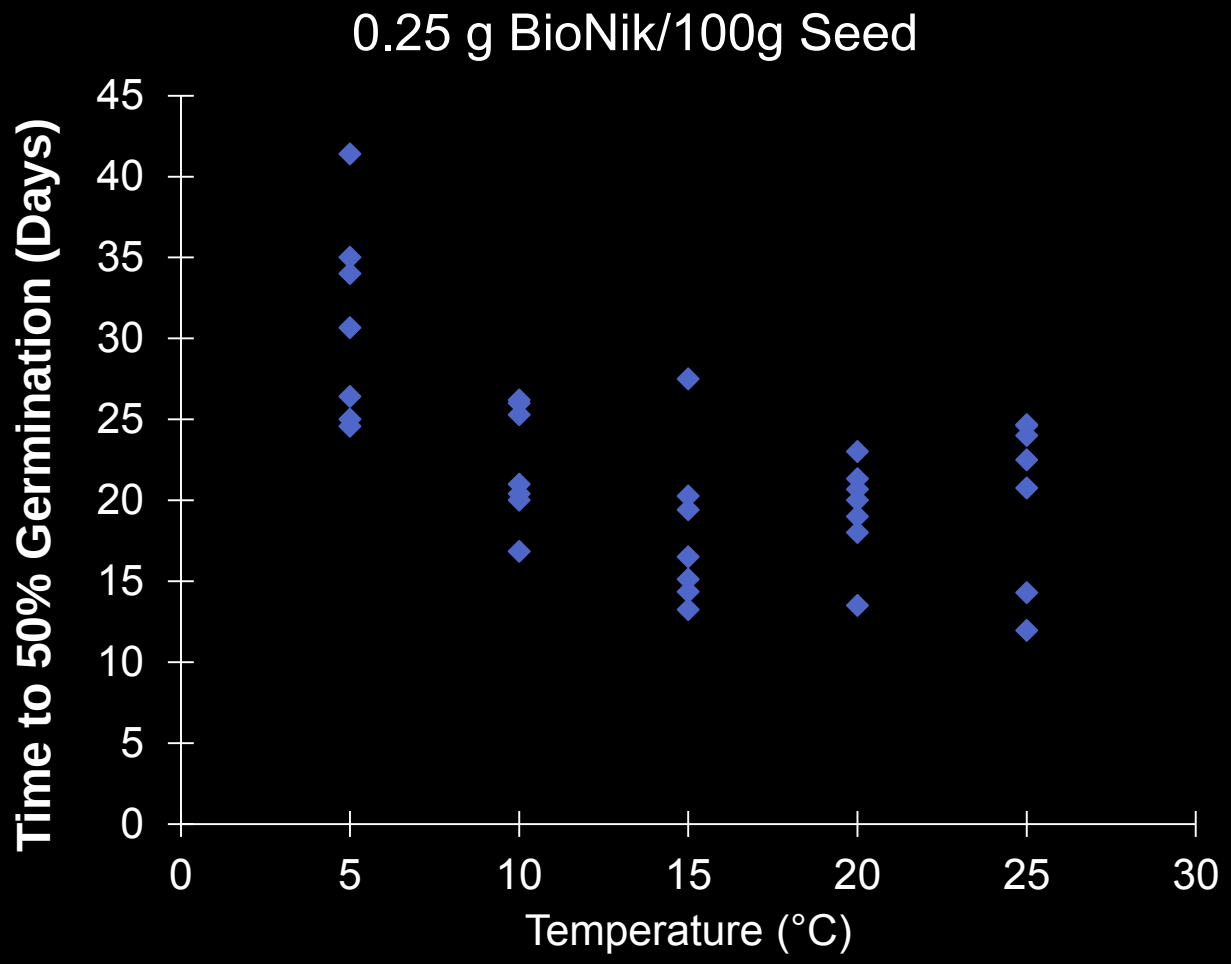
- Modeling was conducted on 6 Wyoming big sagebrush sites on four different years (2010-2014)
- We predicted the timing of seed germination using water potential (gypsum blocks) and soil temperature (thermocouples) data collected form the SageSTEP network



Objective 2: Predicting Seed Germination Date

METHODS

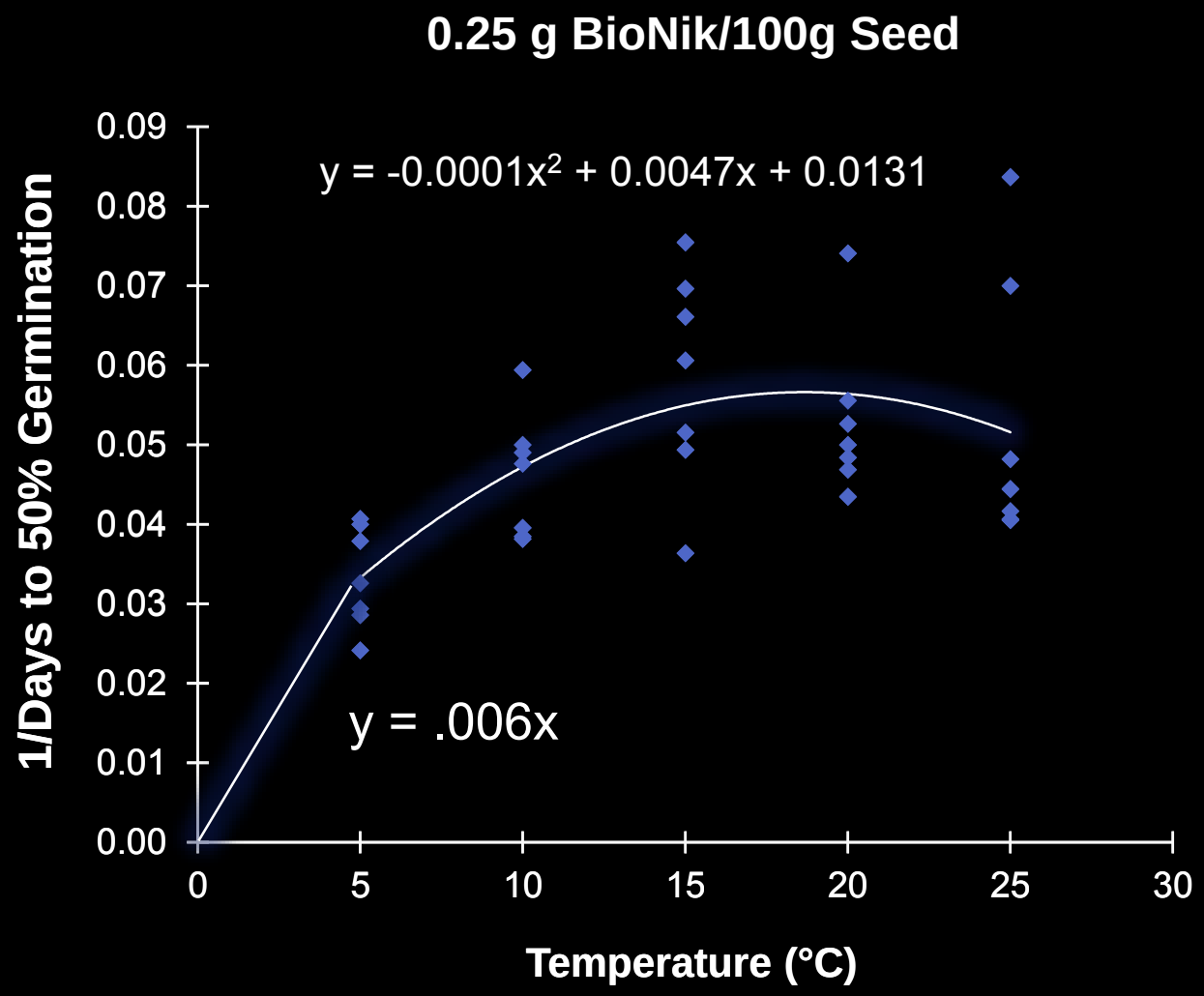
- Example



Objective 2: Predicting Seed Germination Date

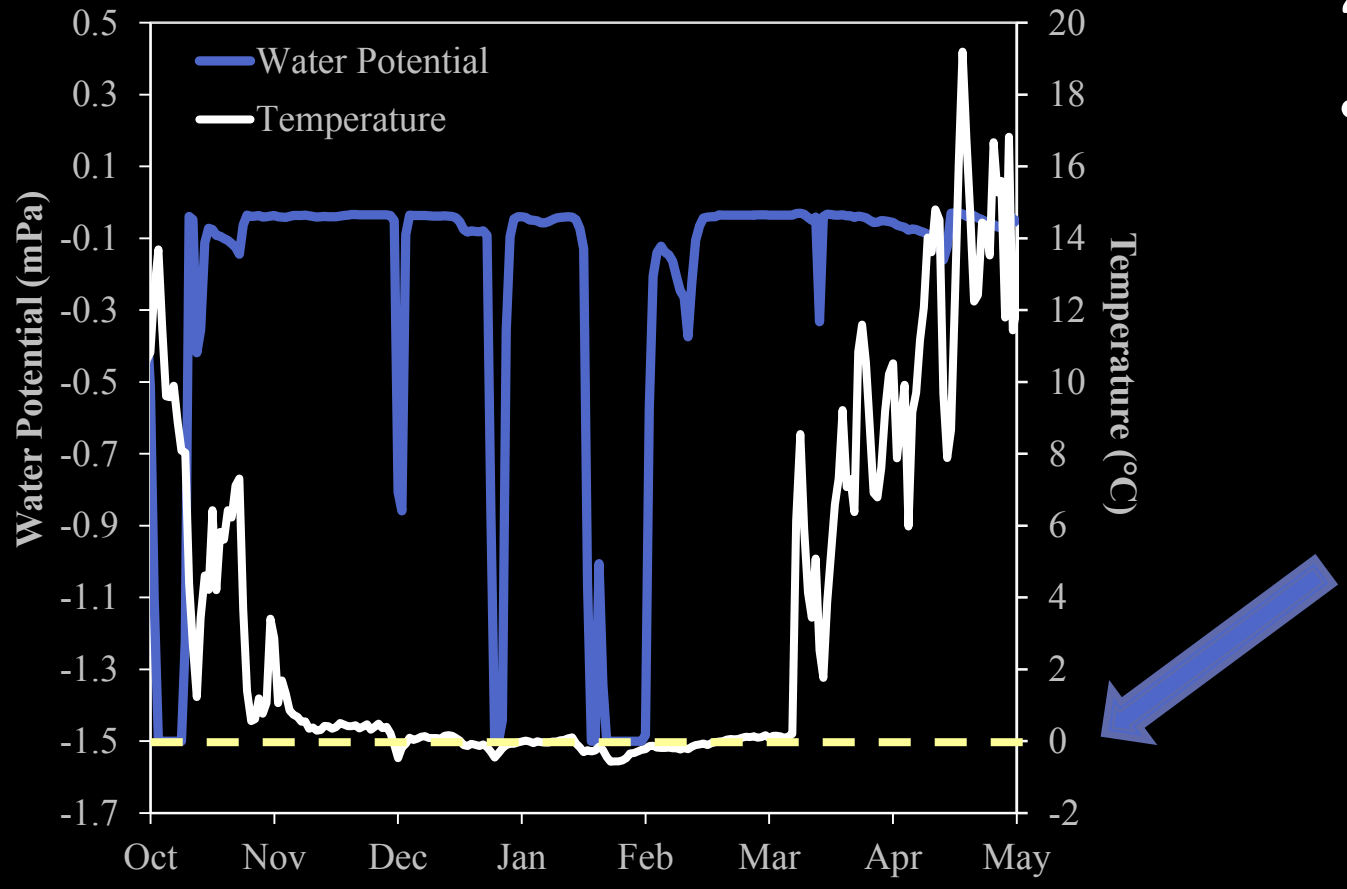
METHODS

- We took the inverse of the data
- Fit the data (polynomial)
- No data from 0 to 5 °C
- Linear extrapolation (Hardegree et al. 2013)



Objective 2: Predicting Seed Germination Date

METHODS



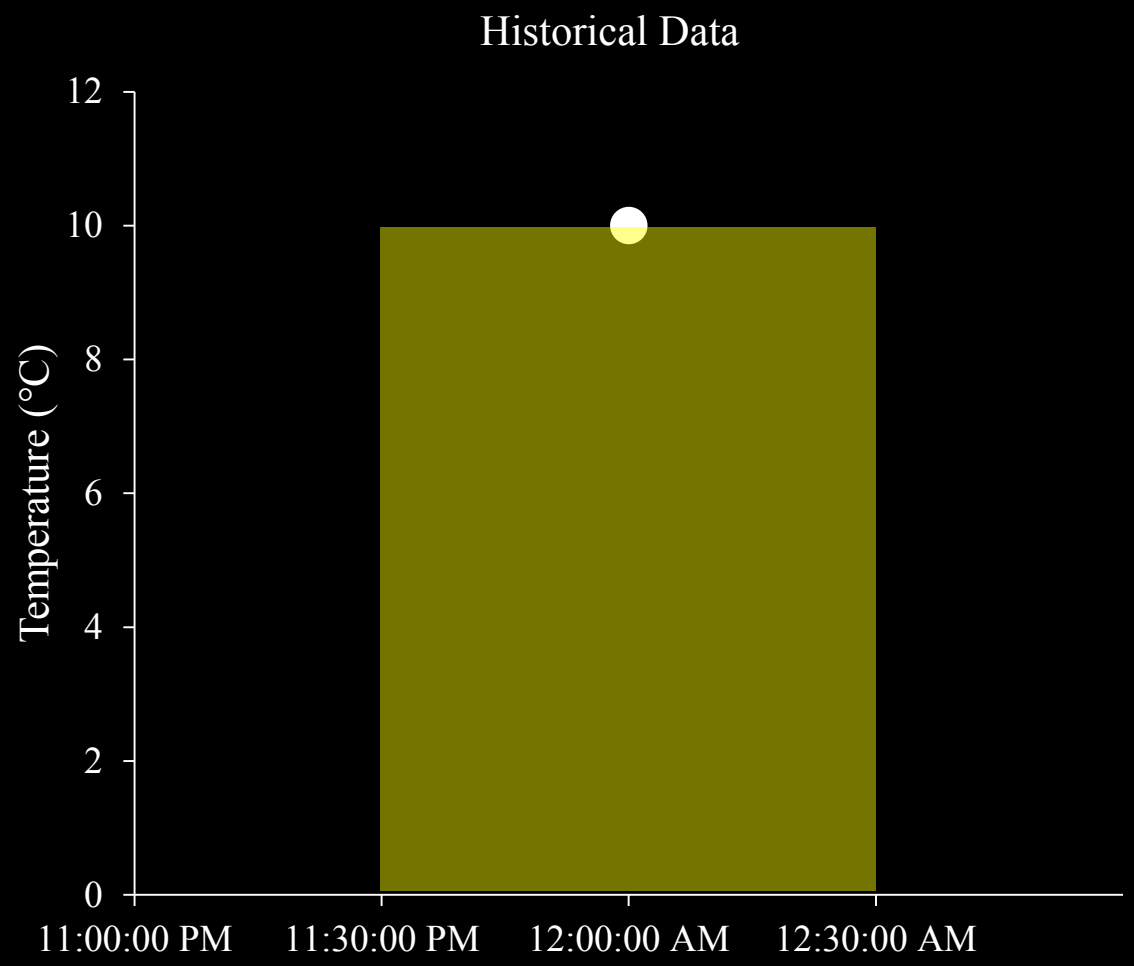
"On/Off" Switch

- Seeds start accumulating thermal time (i.e. progress towards germination) when water potential is $\geq -1.5\text{MPa}$ and soil temperature is > 0 °C

Objective 2: Predicting Seed Germination Date

METHODS

$$\frac{1\ hr * \frac{1\ Day}{24\ hrs}}{22.22\ Days} * 100 = 0.19\ \%$$



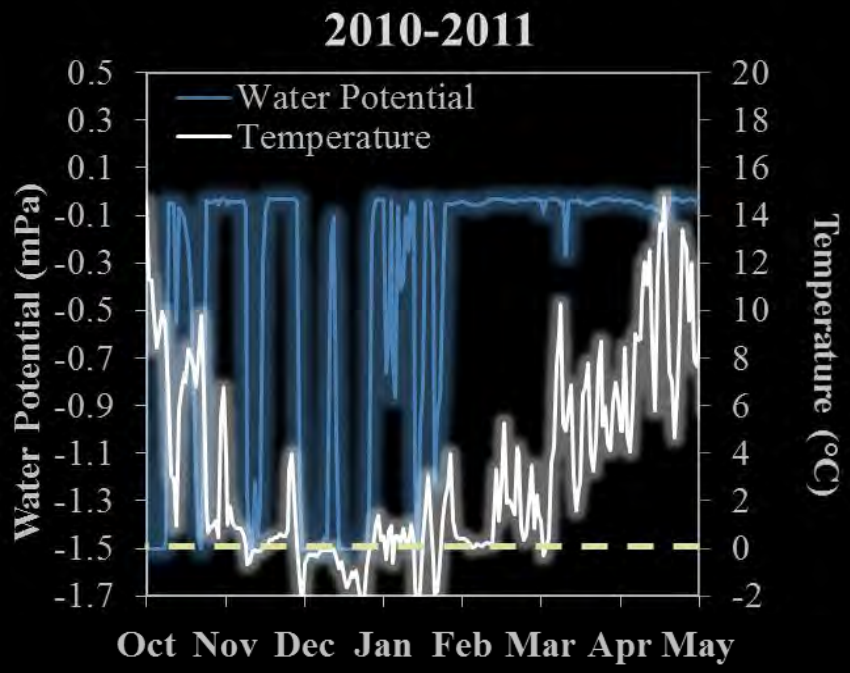
Objective 2: Predicting Seed Germination Date

METHODS

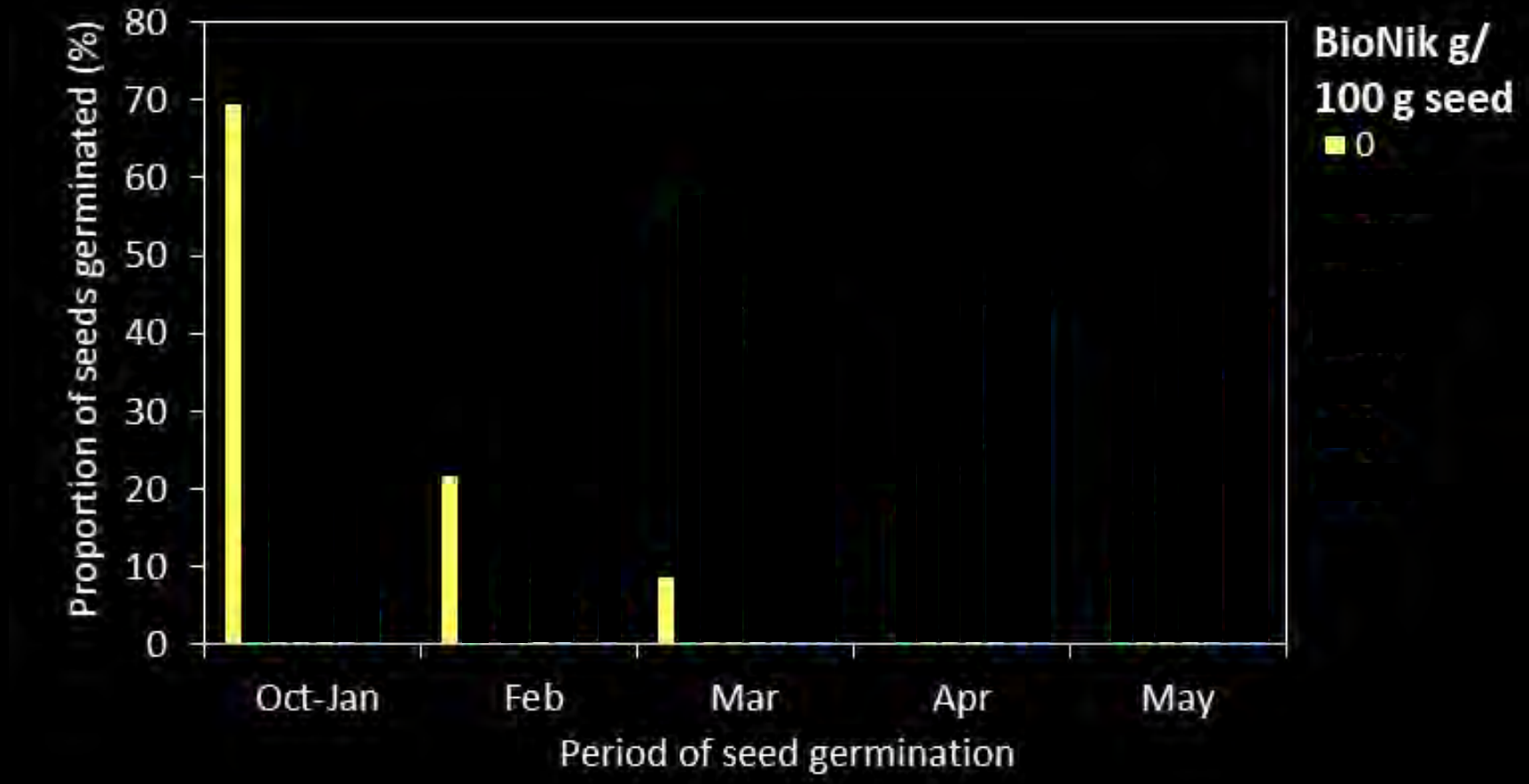
- Progress towards germination is summed until reaching 100%
- Repeated for each treatment to estimate time to 10-90% germination
- Lots of data! Excel VBA programing is used to speed up process

RESULTS

Hart Mountain



RESULTS


Proportion of seeds germinated (%)
80
70
60
50
40
30
20
10
0
Oct-Jan
Feb
Mar
Apr
May
Period of seed germination
BioNik g/ 100 g seed
0

Agglomeration of Wyoming big sagebrush seed

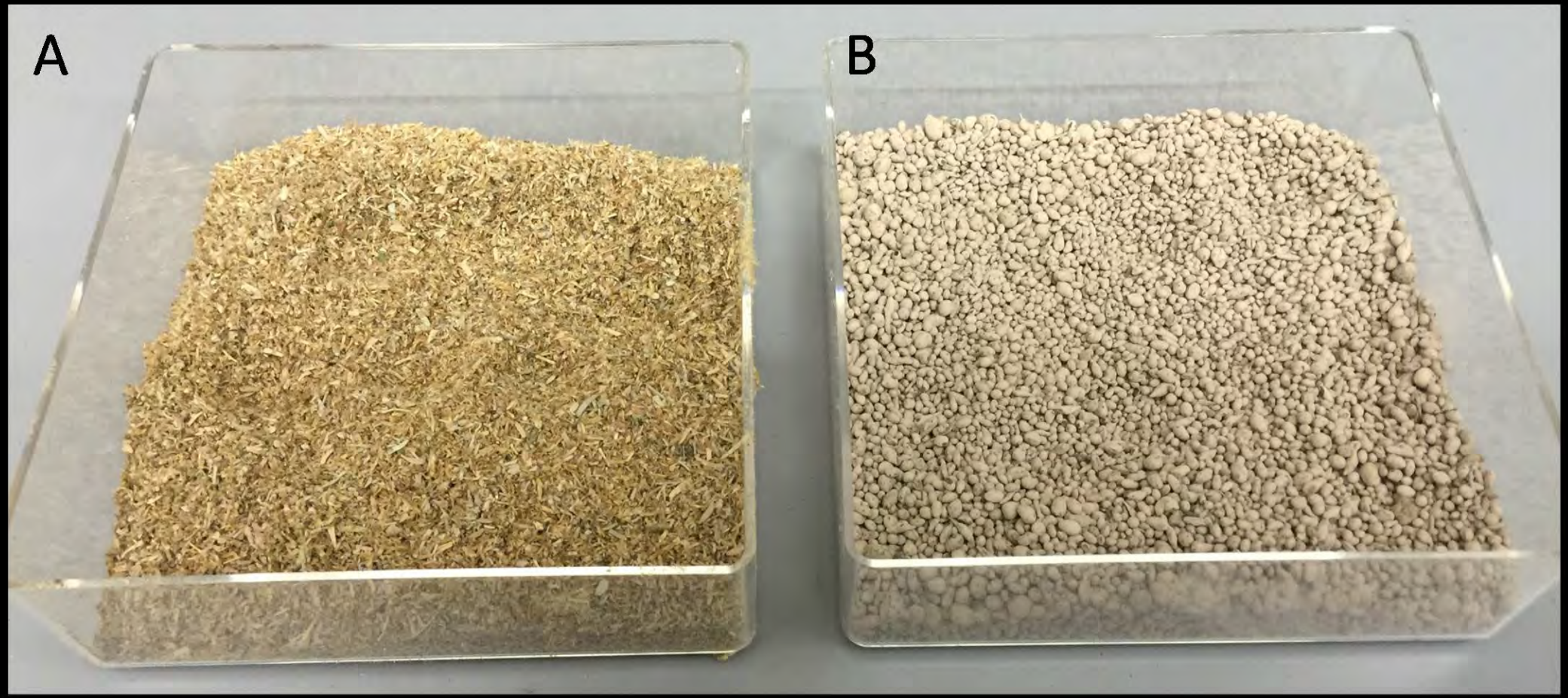
Step 1: Mixture of rock dust (Azomite®), compost, ARTRw seed

Step 2: Azomite®

US Provisional application #62/452,091

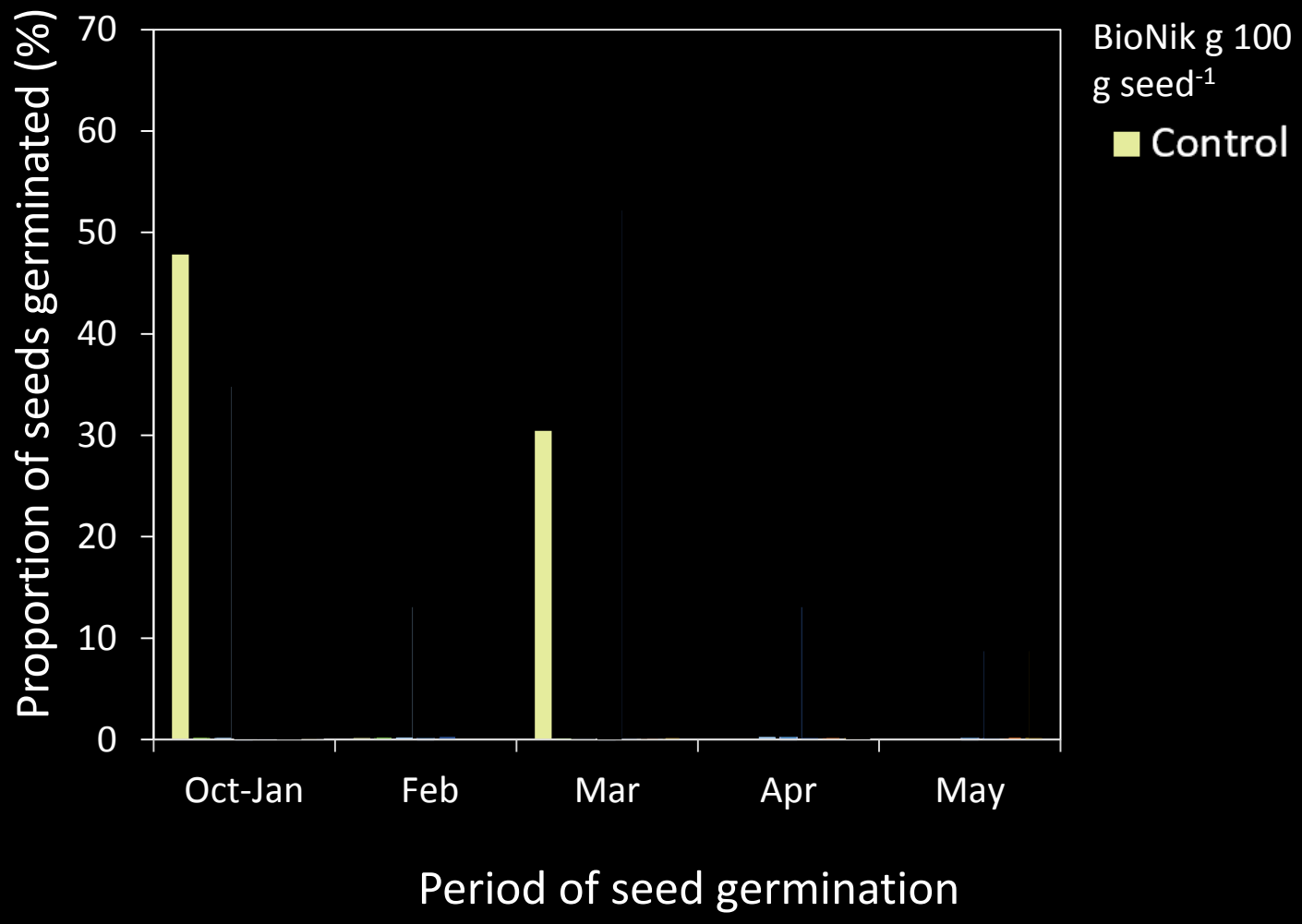
Agglomeration of Wyoming big sagebrush seed

Untreated **Agglomerated**

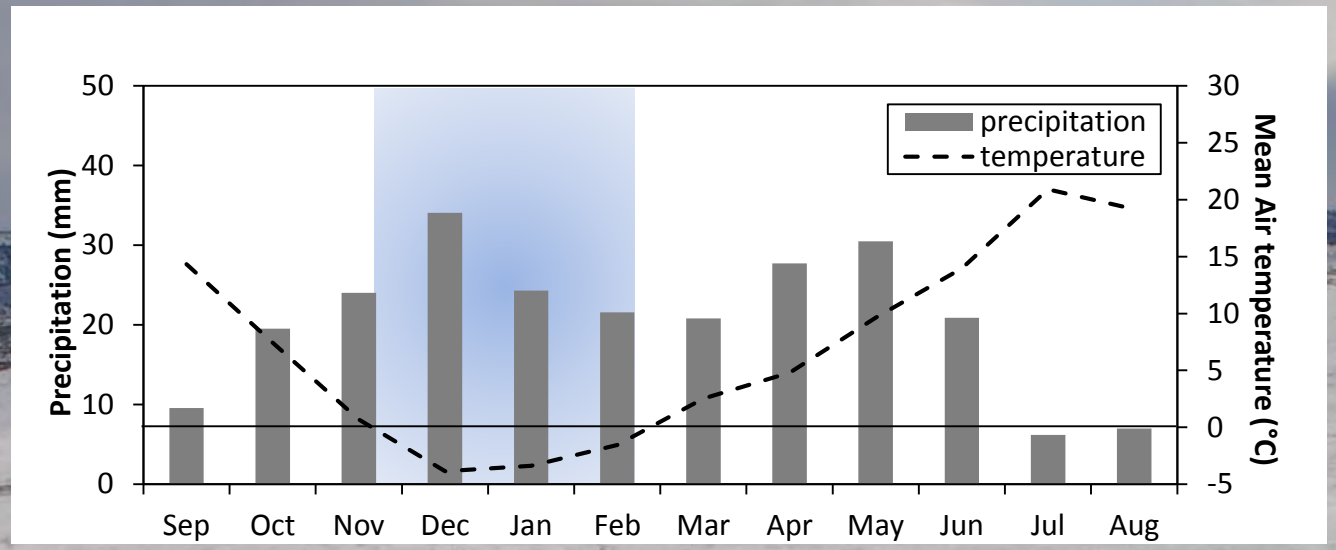


Agglomeration of Wyoming big sagebrush seed

RESULTS



ABA Seed Coating to Delay Seed Germination



Untreated seed

ABA coated seed

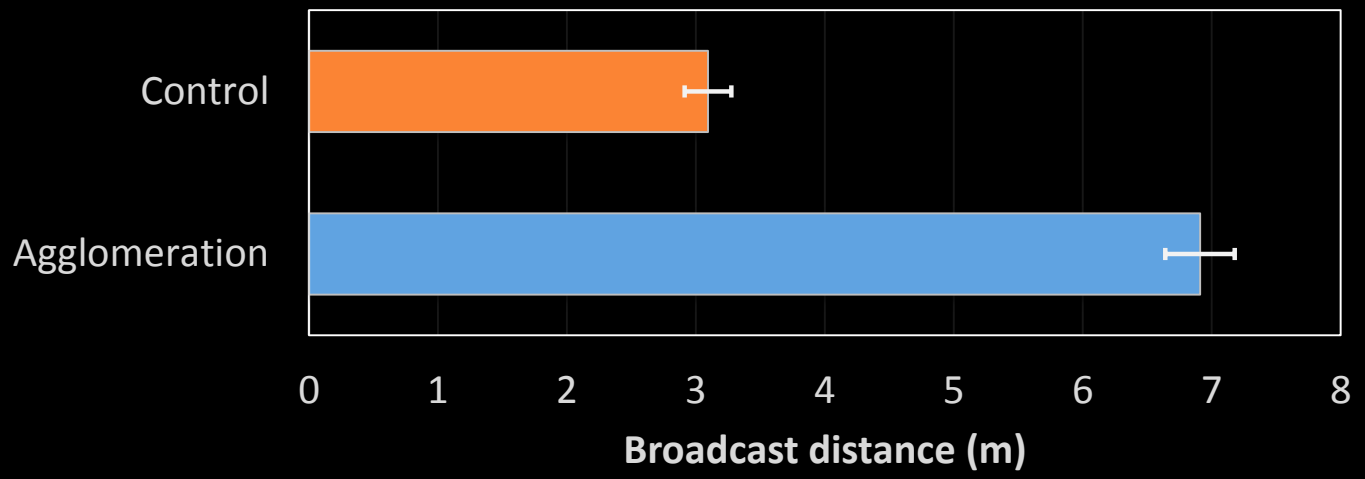
Future Research

- Field test thermal accumulation models
- Quantify how ABA treated seed influence plant establishment
- Determine if mixes of ABA treated seed can decrease the risk of seeding failure by having cohorts of seed germinating at different time intervals
- Conduct a cost-benefit analysis on the seed-coating treatments

Questions?

Agglomeration of Wyoming big sagebrush seed

Agglomeration of Wyoming big sagebrush seed



The preceding presentation was delivered at the

2017 National Native Seed Conference

Washington, D.C. February 13-16, 2017

This and additional presentations available at http://nativeseed.info

NATIVE SEED NETWORK

Institute for Applied Ecology