National Park Service
U.S. Department of the Interior

Lake Mead National Recreation Area

2005-NPS-532

Threats research and monitoring on the invasive species Sahara mustard (*Brassica tournefortii*)

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Project Overview

Goals

1. Increase the knowledge of biology and ecology of Sahara mustard plant populations in southern Nevada

2. Increase the knowledge of effective control and management of Sahara mustard in southern Nevada

Project Overview

Objectives

1. To conduct experiments to test the effects of hand pulling and herbicide treatment methods on seed viability (Hypotheses #1 and #2)

2. To conduct experiments to test genetic variability of various plant sizes of Sahara mustard (Hypothesis #3)

Project Overview

Objectives

3. To conduct experiments to test the effects of light on seed germination (Hypothesis #4)

4. To conduct experiments to determine the mating system of Sahara mustard plants (Hypothesis #5)

5. To conduct experiments to test Sahara mustard seed viability in the soil seed bank (Hypothesis #6)

Hypotheses

Hypothesis 1: Unripened seed pods from Sahara mustard plants will continue to ripen in the field once pulled and will become viable – Implemented in conjunction with University of Nevada Las Vegas.

Hypothesis 2: Sahara mustard seeds remain viable after host plant is sprayed with herbicide.

Hypothesis 3: There is genetic variation between small and large Sahara mustard plants.

Hypotheses

Hypothesis 4: Sahara mustard seed germination is inhibited by light.

Hypothesis 5: Sahara mustard is not capable of self-fertilization

Hypothesis 6: Sahara mustard seeds are short-lived in the soil seed bank – Implemented in conjunction with University of Nevada Las Vegas.

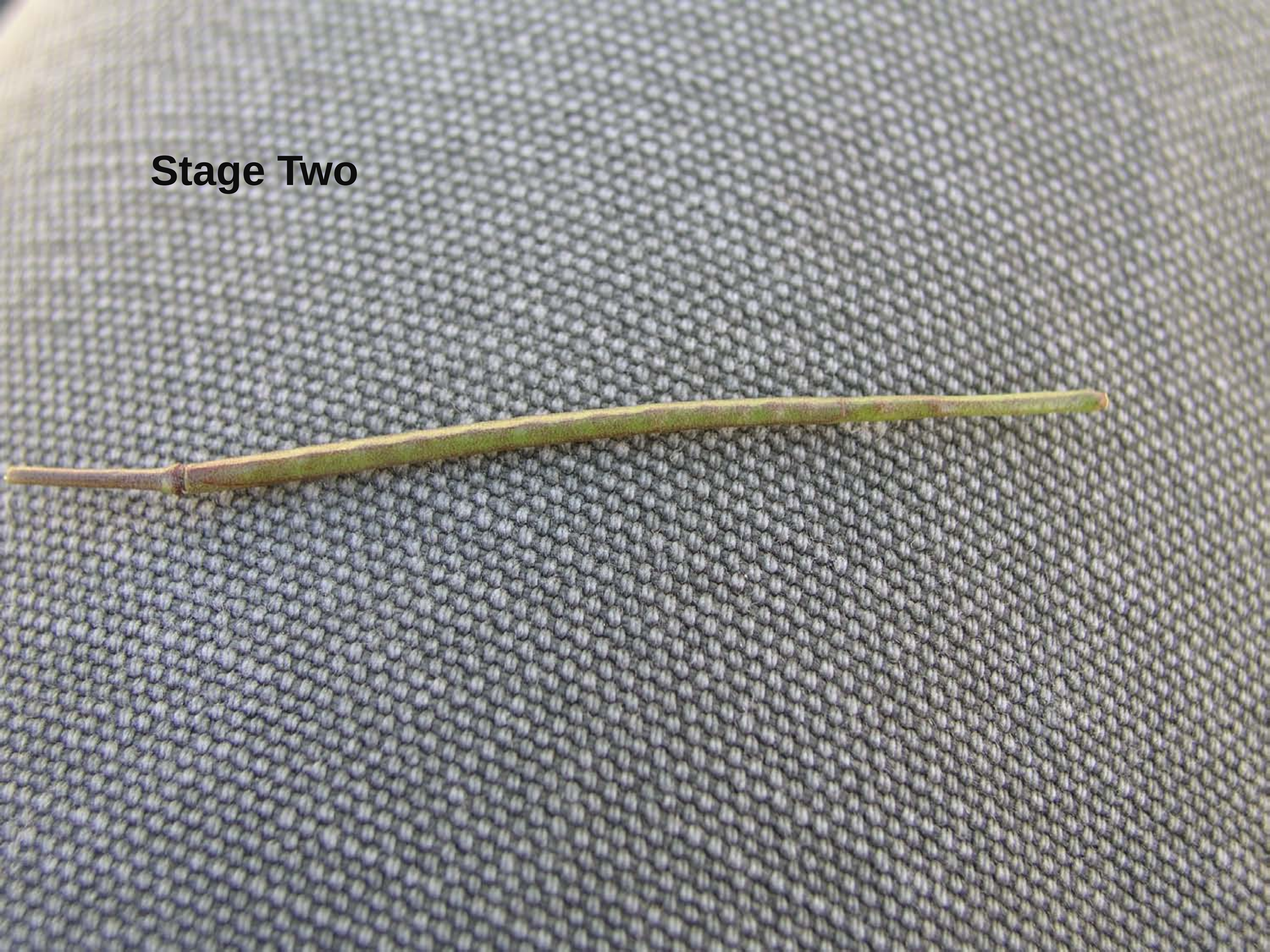
Developmental stages

Stage One – Undeveloped - seeds with only liquid endosperm without visible embryos; small and pliable seed pods

Stage Two – Developing - seeds with partially developed embryos in liquid endosperm; somewhat firm but still pliable seed pods

Stage Three – Developed - seeds are firm and have fully developed embryo with green cotyledons that fill the seed coat; hard seed pods


Stage One


Stage Two


Stage Three

Hypothesis #1

Unripened seed pods from Sahara mustard plants will continue to ripen in the field once pulled and will become viable

Methods

One hundred plants were randomly selected in a heavily-infested area (Boxcar Cove)

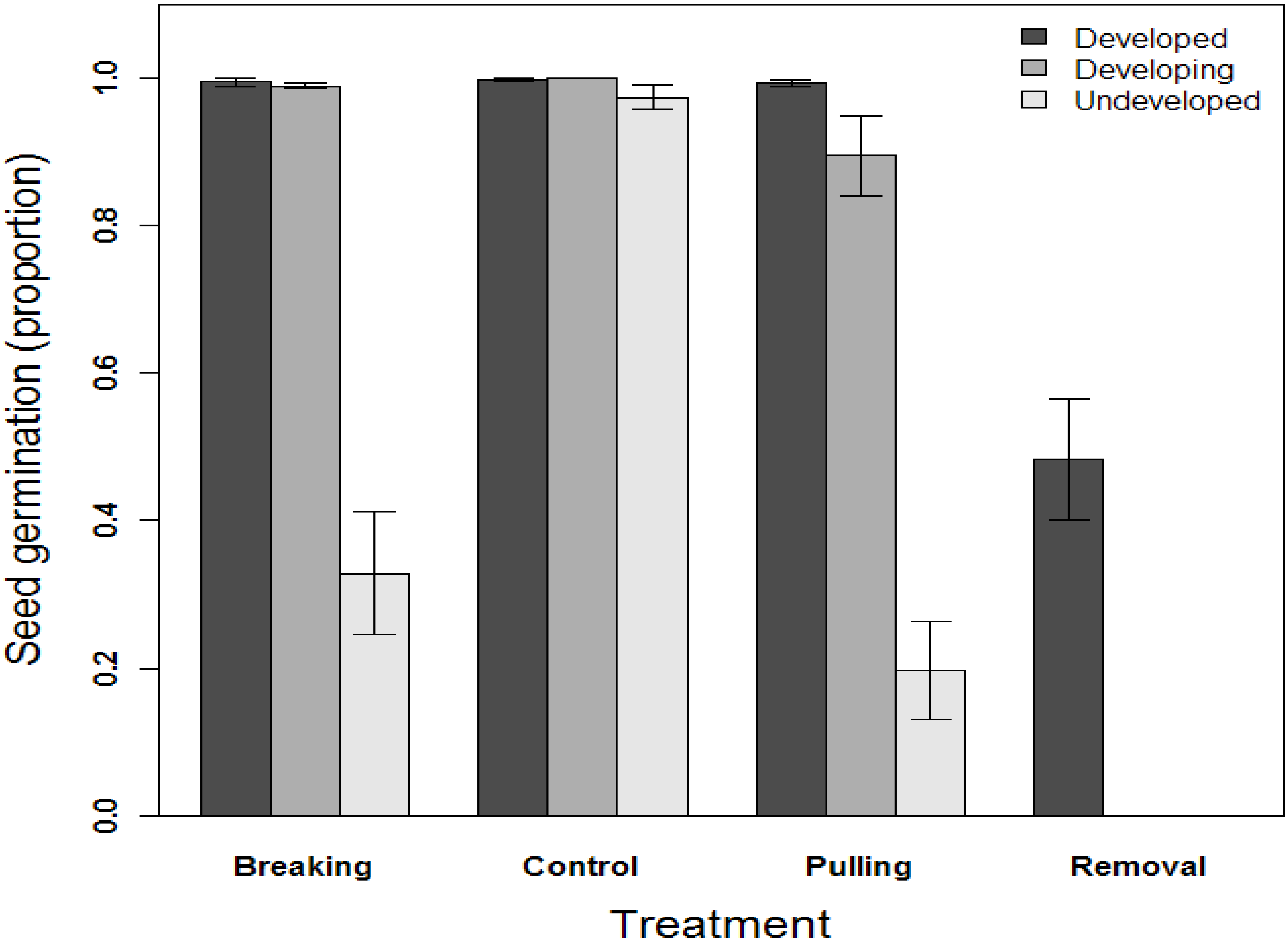
Plants were labeled to follow plant and silique growth over time

Treatments (pull, break, silique removal, and control) were assigned randomly

Methods cont.

Siliques were collected approx. 2 weeks after treatment application

Viability testing by germination



Developed
Developing
Undeveloped
Seed germination (proportion)
0.0
0.2
0.4
0.6
0.8
1.0
Breaking
Control
Pulling
Removal
Treatment

Results and Progress to date

Breaking off and pulling up had no appreciable effect on developed and developing seeds (Stage Three and Stage Two)

Breaking allowed 35%, and pulling allowed 20% of undeveloped seeds (Stage One) to mature to viability

Silique removal reduced developed seed viability to 50%, and developing and undeveloped seed to 0%

Final reports are in preparation

Hypothesis #2
Sahara mustard seeds remain viable after host plant is sprayed with herbicide.

Methods
Siliques were randomly selected from three developmental stages (undeveloped, developing, and developed)

Three herbicides (Glyphosate, Metsulfuron methyl, and 2,4-D) and control treatments were applied

Siliques were collected after plant die off occurred

Viability testing by germination

Sahara mustard sprayed with Glyphosate

Results and Progress to date

All three treatment methods reduced germination to 0-1% across all three developmental stages

Final reports in preparation

Hypothesis #3
There is genetic variation between small and large Sahara mustard plants.

Methods
Twenty plants were randomly chosen from each of three size classes (small, medium, and large)

Developed siliques were collected and counted from each plant, then seeds separated from siliques

Five seeds from each parent plant were randomly chosen for grow out for size class comparison

Results and Progress to date

Repeated attempts at grow out were unsuccessful and this Hypothesis was terminated

The largest plant measured supported 6,794 siliques, with an average of 25 seeds each, for a total of 169,850 seeds

17 plants supported 1000 or more siliques per plant

Hypothesis #4
Sahara mustard seed germination is inhibited by light.

Methods
25 seeds per petri dish with filter paper and 4 ml distilled water

Three temperature treatments: 15°C / 9°C; 20°C / 12°C; and 25°C / 15°C

Each temperature treatment received two photoperiod treatments: 24 hours dark; 12 hours light and 12 hours dark

Seeds from 2008, 2009, and 2010 were tested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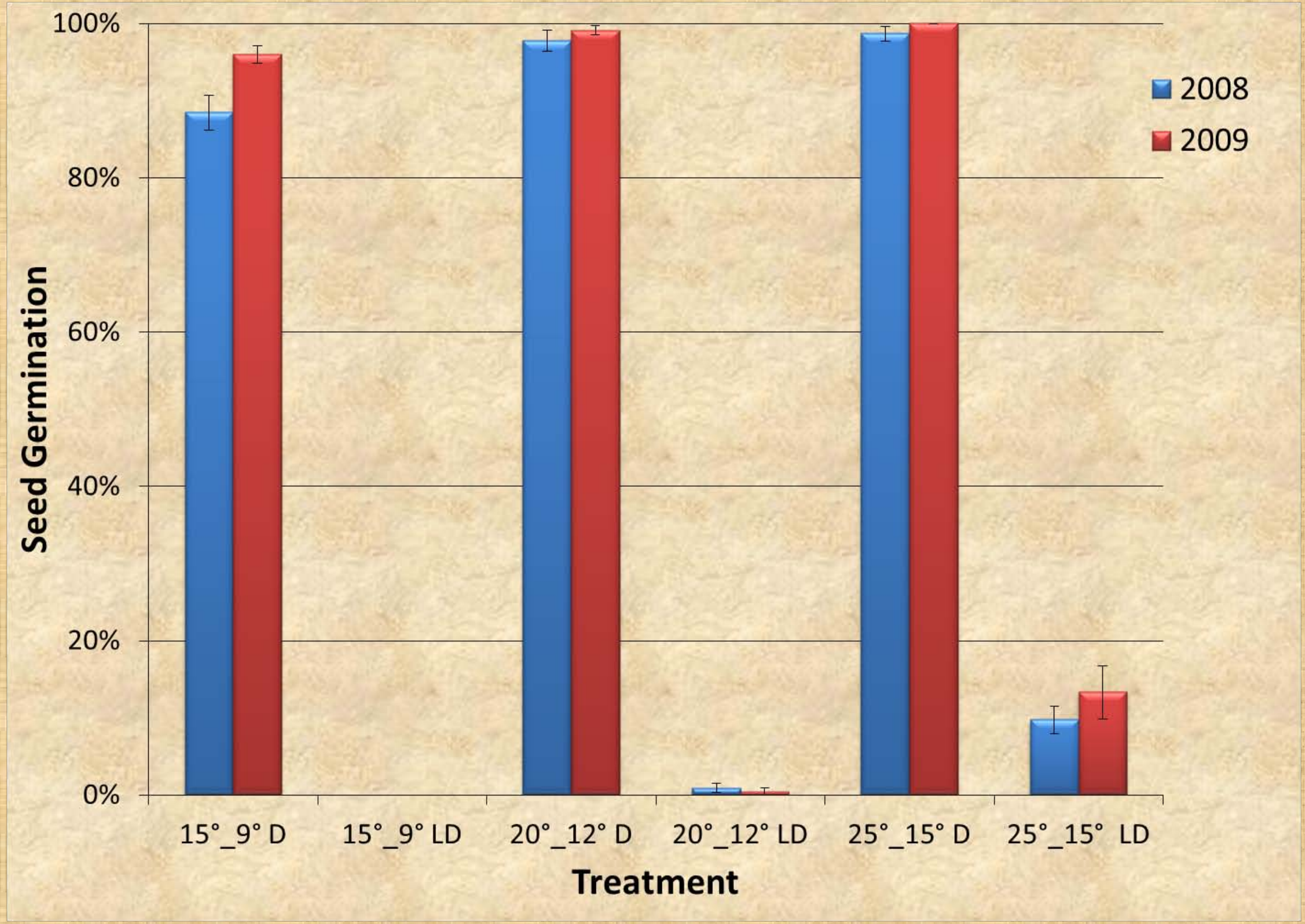
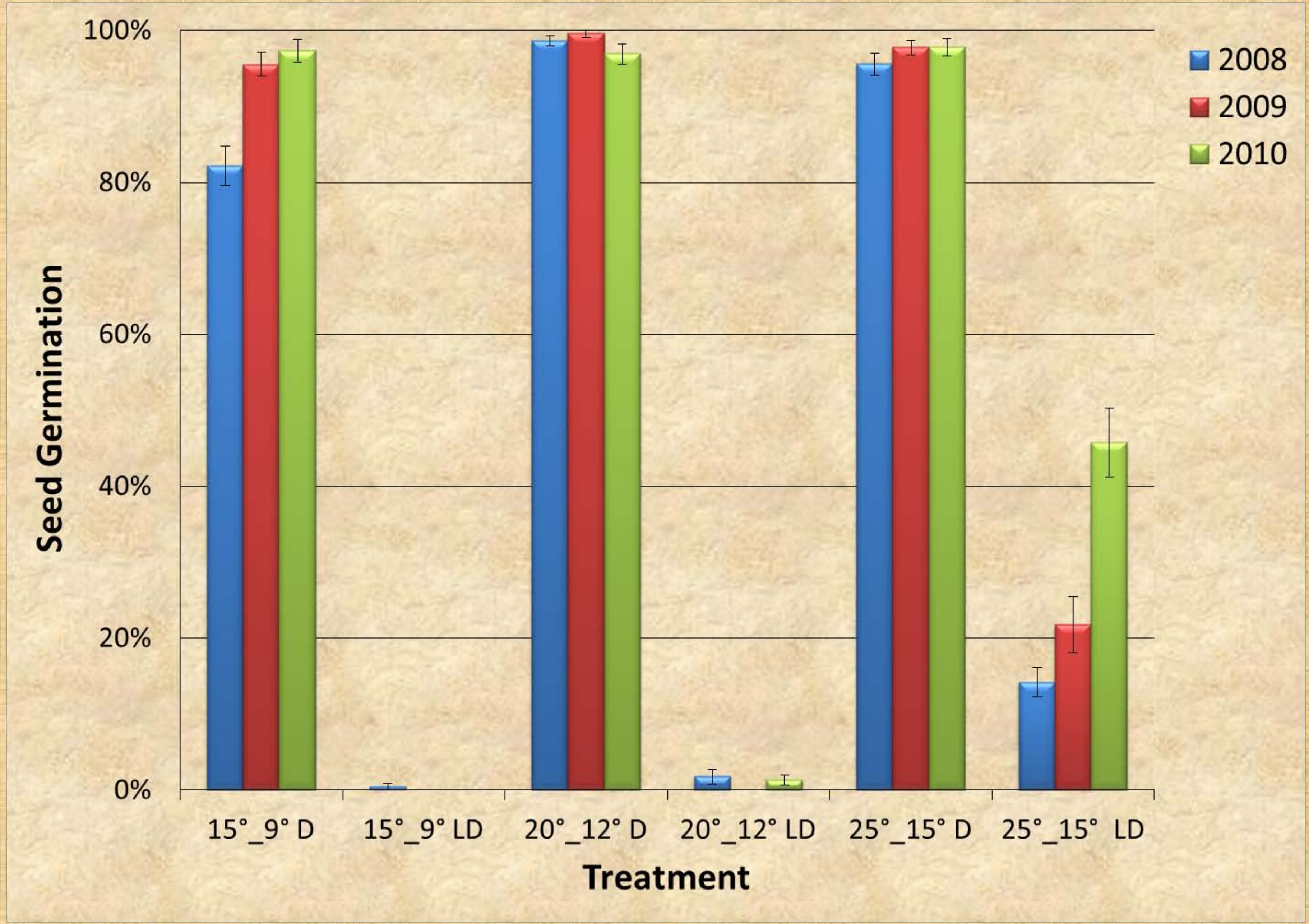


Seeds were germinated between April 1, 2010 and June 4, 2010



Seeds were germinated between October 21, 2010 and February 15, 2011

Results and Progress to date

Profound differences in germination between dark and light/dark treatments

Warmer temperatures tolerated more light

Final reports are in preparation

Hypothesis #5
Sahara mustard is not capable of self-fertilization

Methods
Sixty plants will be grown to bolting stage, isolated (tented) and randomly chosen for treatments

- Twenty will be tented as only treatment – control
- Twenty will be tented and each pollinated with its own flowers
- Twenty will be tented and each pollinated with a different donor plant

Seeds from these plants will be counted and germinated to determine viability

Results and Progress to date

Repeated attempts at grow out were unsuccessful and this Hypothesis was terminated

Hypothesis #6
Sahara mustard seeds are short-lived in the soil seed bank

Methods
Eight plots were located in sandy and gypsum soils

Randomly placed quadrats were randomly assigned burial times (6, 12, 18, 21 months)

Within these quadrats locations were randomly assigned burial depths (2, 5, or 15 cm)

Rodent-proof packets of 100 seeds were buried at assigned depths

Hypothesis #6
Sahara mustard seeds are short-lived in the soil seed bank

Methods cont.
At each designated interval, packets were removed and seeds tested for viability

Any seedlings are also counted and removed

Results and Progress to date

After 6 months almost 100% of the seeds germinated at 2 cm, 5 cm, and 15 cm.

After 12 months almost 100% of the seeds germinated at 5 cm and 15 cm. There was more variability at 2 cm, but germination was never more than 70%.

The last burial excavation is scheduled to take place in November

Data analysis and final reports will be completed December 1

Conclusions (preliminary)

Hand or manual methods are most effective and efficient before seed pods begin to develop

If manual methods are used after seed pods begin to develop plants must be removed from site

The three herbicides tested are equally effective at any green stage after seed pods begin to develop

One-time treatments will not deplete the soil seed bank – may require 8 – 10 years before all seeds are germinated out

Conclusions (preliminary)

Loose soils (sand) may retain viable seeds longer than stable soils

Soil disturbance may enhance germination as well as seed longevity by covering exposed seed

Astragalus geyerii

Sahara mustard with phacelia seedlings

Next steps

Explore methods of shredding large plants to leave biomass and nutrients on site

Explore methods of removing the “hanging” seed bank (dry, standing plants) without further dispersing seeds

Explore the effects of heat and age on viability of seeds in hanging seed bank

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All photos by the National Park Service and University of Nevada Las Vegas

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