

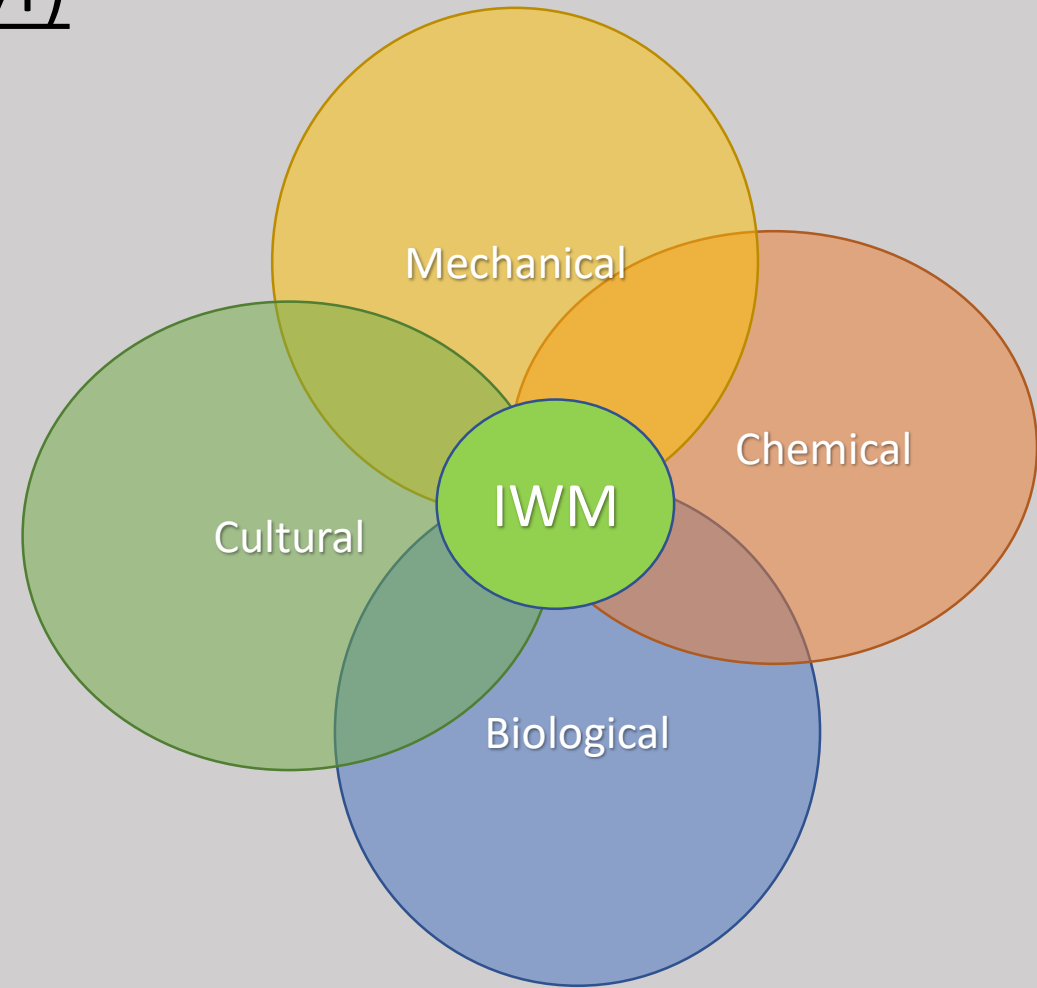
Maximizing the efficiency of invasive plant control with a phenology-based timing approach to management

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Integrated Weed Management (IWM)

- Weed management program using a combination of control methods
- Improved weed control
- Reduce costs
 - \$82 million/ year in CA
- Phenology based timing of control



Phenology and Invasion

- Plant phenology
 - Timing of a plant life cycle
- Competitive advantage
 - Rapid life cycle
 - Early germination and flowering
 - Long bloom



Phenology and Control

- Improve control methods
- Timing of disturbance
 - Season of fire
 - Annual grass → Annual forb
- Phenology based management
 - multiple species
 - Timing of control

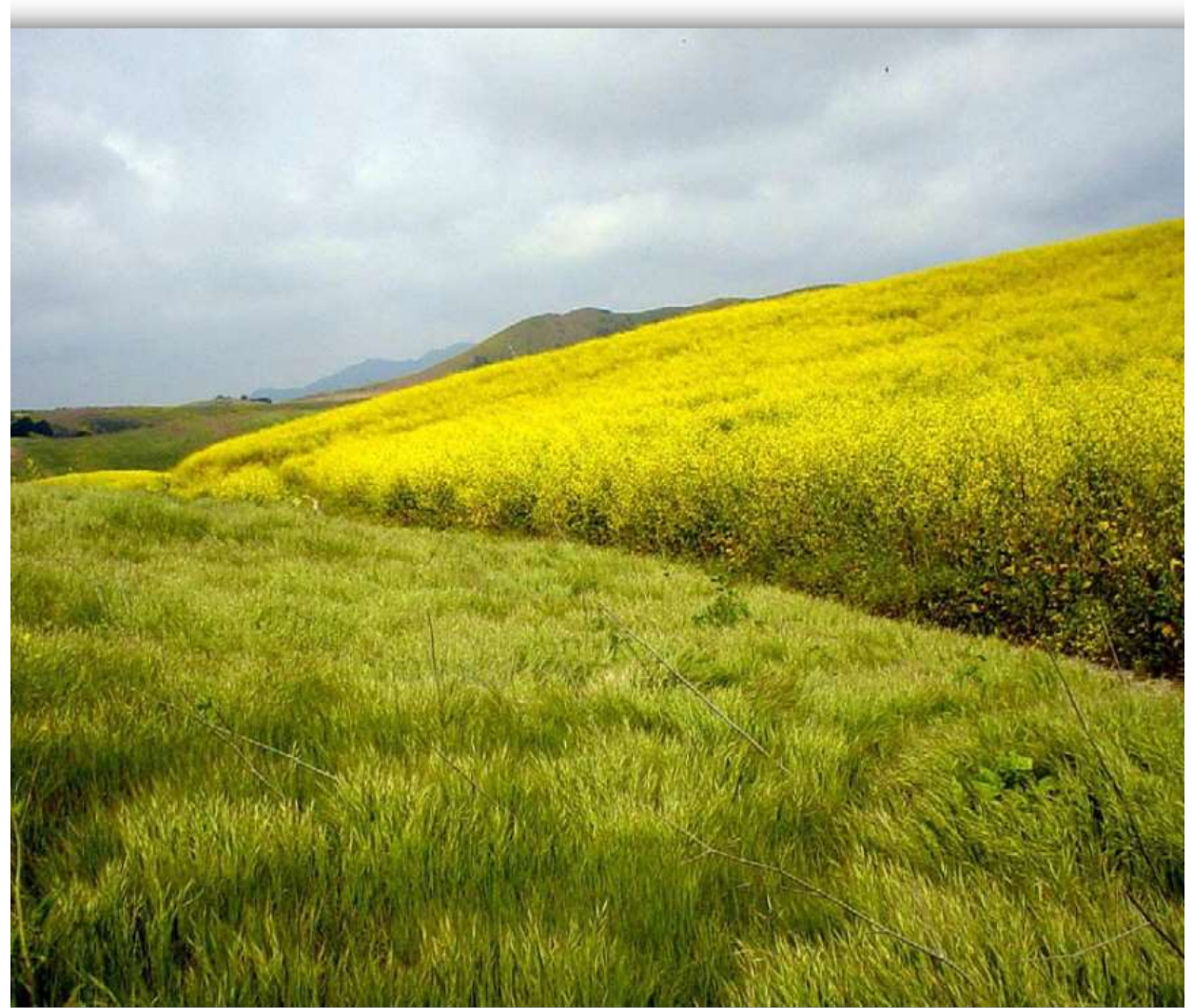
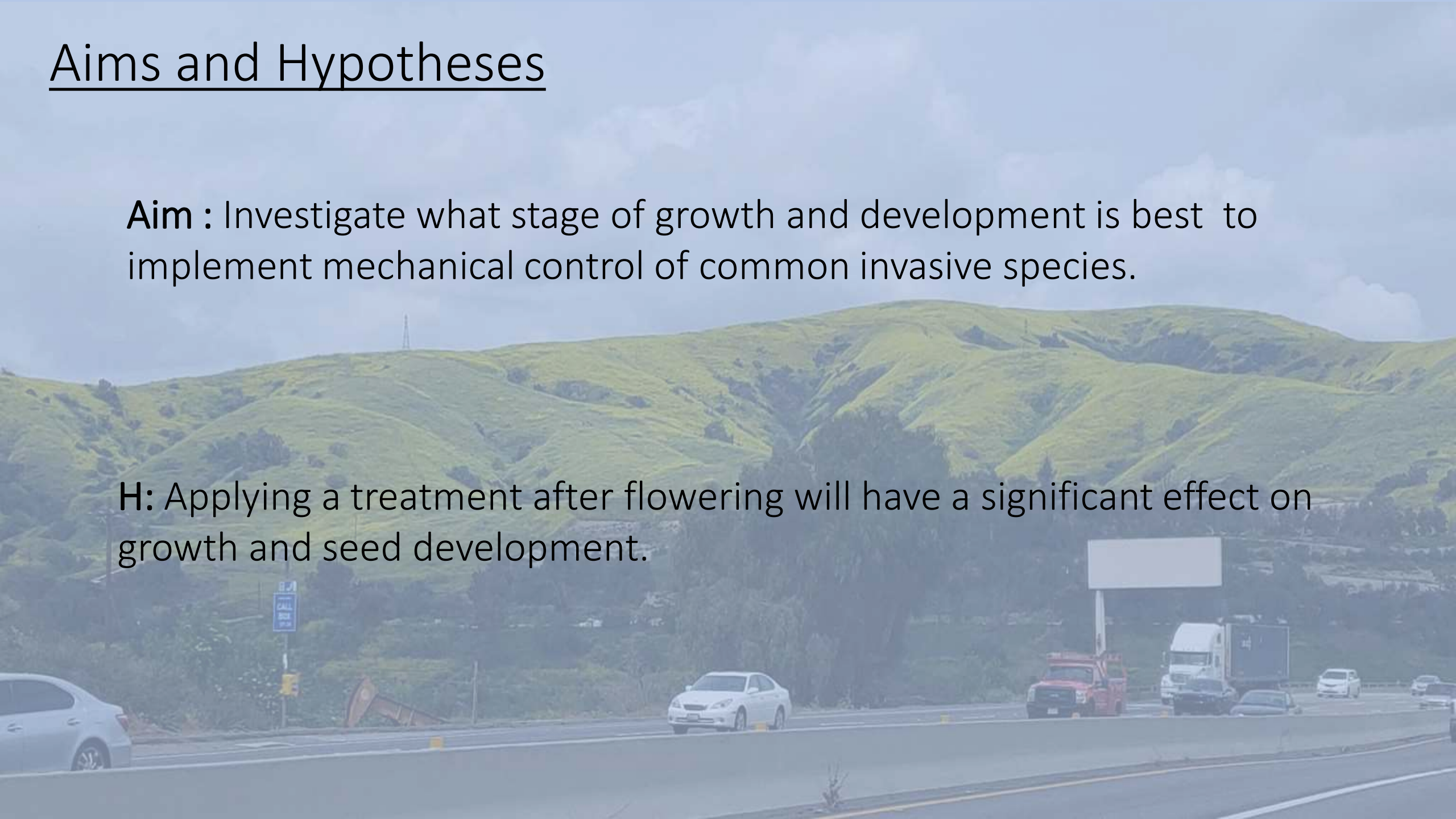


Photo credit: Moyes, et al. 2005, *Restoration Ecology*




Aims and Hypotheses

Aim : Investigate what stage of growth and development is best to implement mechanical control of common invasive species.

H: Applying a treatment after flowering will have a significant effect on growth and seed development.



Test Species

	Current Control Methods	Time of Growth	
<i>Bromus diandrus</i>	Prescribed burning Grazing (early application) Cultural Chemical	Winter (early)	
<i>Brassica nigra</i>	Mechanical Grazing Chemical	Winter – Spring (mid)	
<i>Centaurea melitensis</i>	Prescribed burning Mechanical Grazing (early application) Chemical Biological	Winter (late spring)	

Methods: Study Sites

California State
Polytechnic
University, Pomona



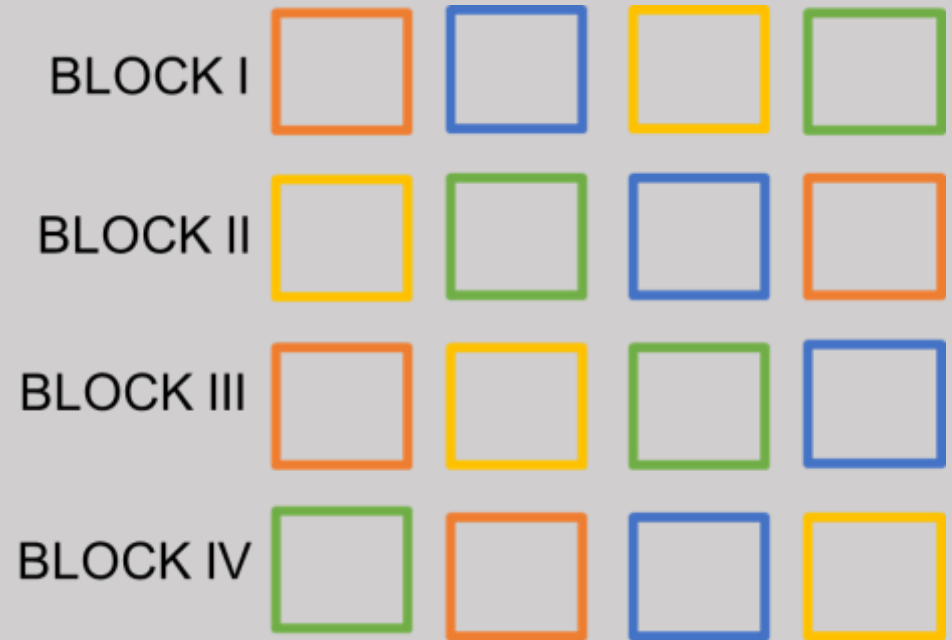
Methods: Field Experiment

- Design

- Randomized Block Design
- 16 plots / species x 3 species = 48 plots
- 4 Cutting Treatments, 4 replicates
- 2 growing seasons

- Measurements of regrowth

- Height (*B. nigra* & *C. melitensis*)
- Biomass (All spp.)
- Seed production (All spp.)
- Percent Cover (*B. diandrus*)



Methods: Greenhouse Experiment

- Design

- 2 x 4 factorial design
- (2) Watering treatments: Wet (30% VWC) or Dry (15% VWC)
- (4) Cutting Treatments: Uncut control, Early, Flower, and Late
- 96 pots, 32 each species, 16 per watering treatment

- Measurements of regrowth

- Height (*B. nigra* & *C. melitensis*)
- Biomass (All spp.)
- Seed production (All spp.)



Methods: Debris Experiment

- Purpose:
 - Observe seed germination within debris material from each cutting treatment.
- Design
 - (4) Cutting Treatments: Uncut control, Early, Flower, and Late
 - 3 spp. x 4 treatments x 3 reps = 36 flats
- Measurements
 - Germination twice/week (All spp.)



B. diandrus Early Stage



B. nigra Late Stage



Methods: Phenology Transect

- Purpose
 - Document growth and identify time of year for management
- Design
 - 25 m permanent transect
 - Phenological Stages
 - Non-reproductive
 - Budding
 - Flower
 - Seed
 - Soil moisture
 - Abundance data collected weekly



Results: *Bromus diandrus*

Flower or Late treatment

- Field Experiment

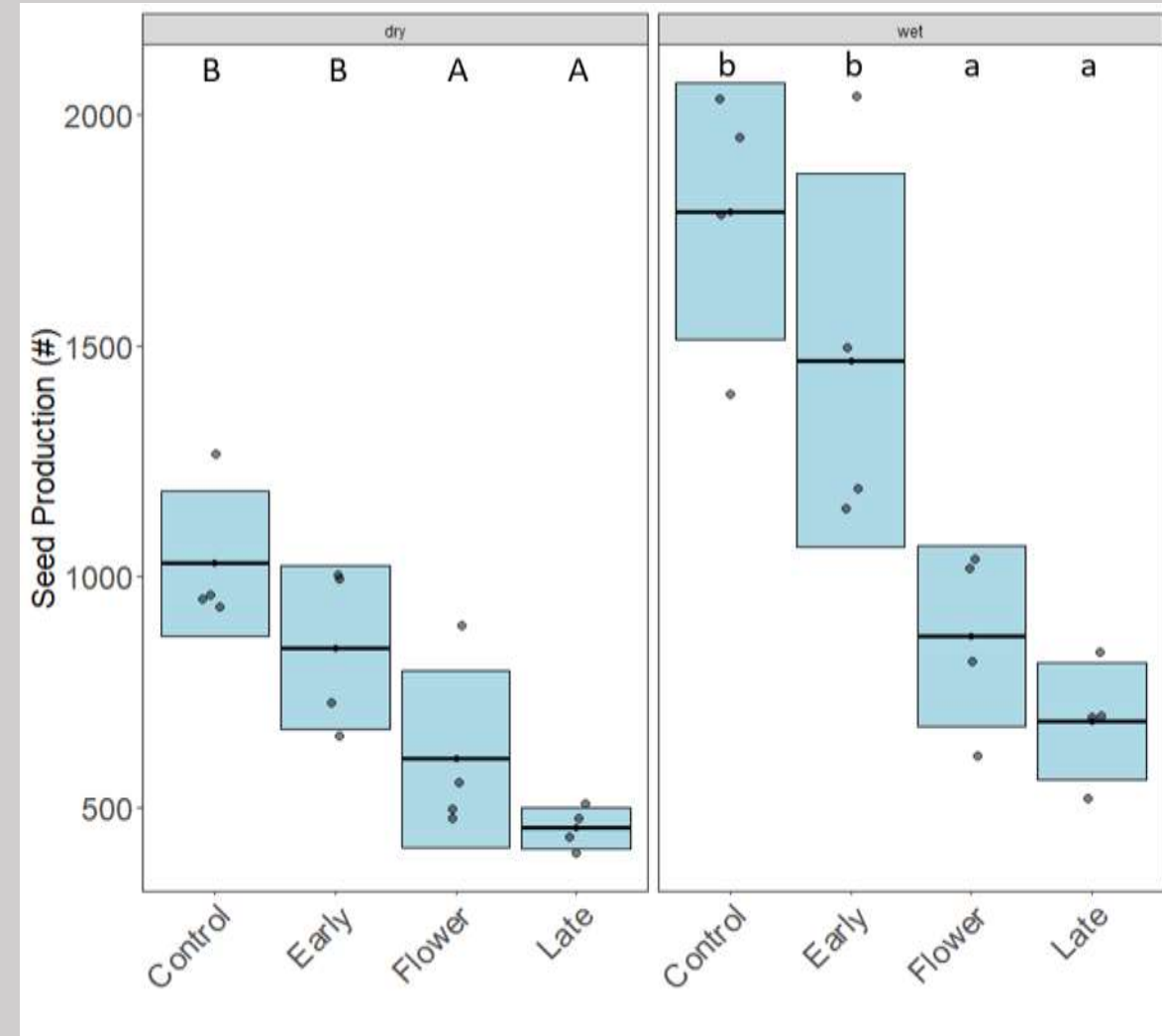
- **Cutting:** Significant difference in biomass, seed production and percent cover between control and cut plots.

- Debris Experiment

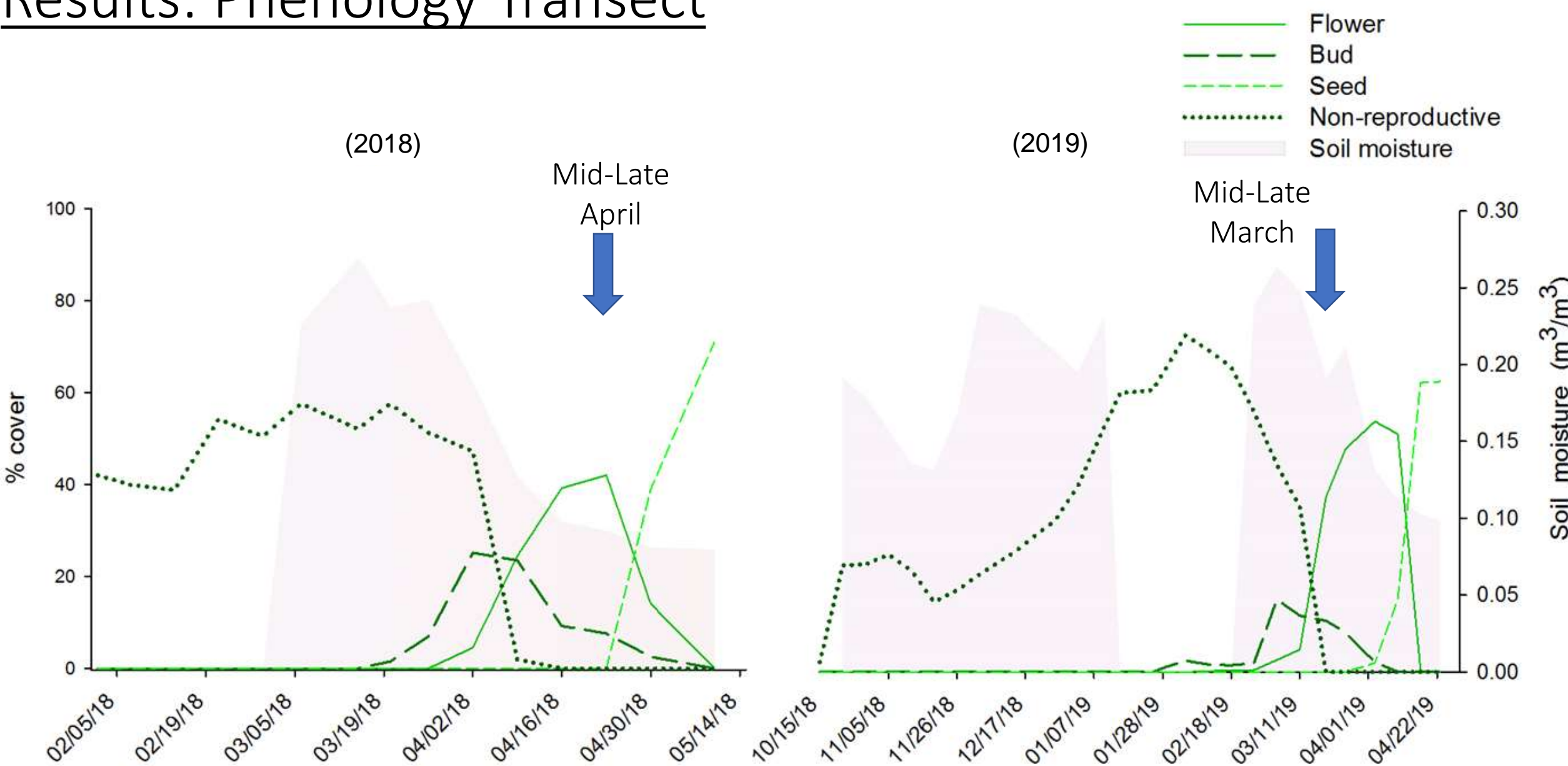
- No significant difference among cutting treatments.

- Greenhouse Experiment

- Significant difference in seed produced in Flower and Late pots, greater in wet soil.
- Difference in biomass between control and cutting treatments in wet and dry soil.



Results: Phenology Transect



Results: *Brassica nigra*

- Field Experiment

- **Cutting:** Successful at all stages. Significant increase in biomass, seed production and height from 2018 to 2019.

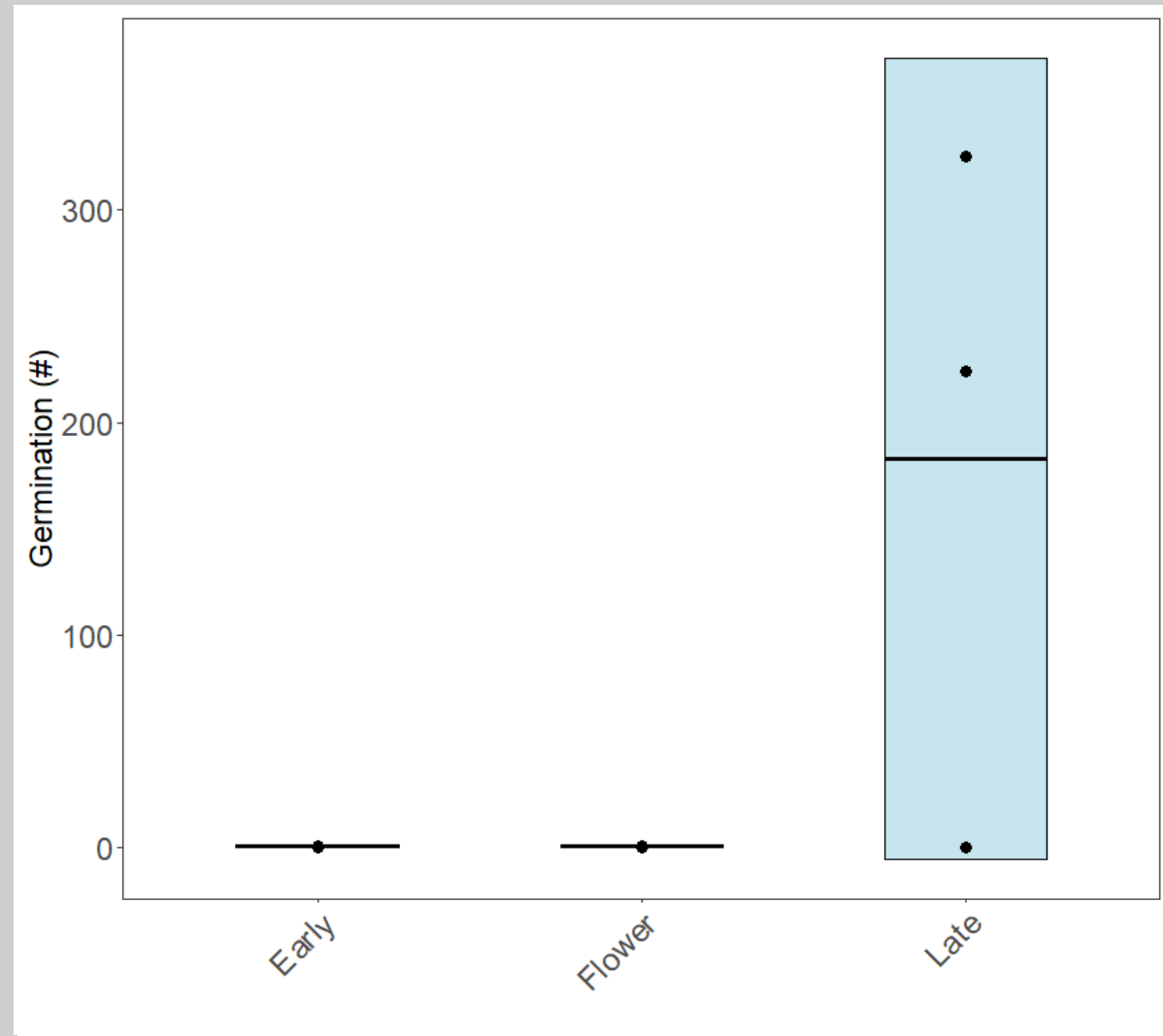
- Debris Experiment

- No significant difference among treatments.
- Least germination in Early and Flowering debris compared to Late.

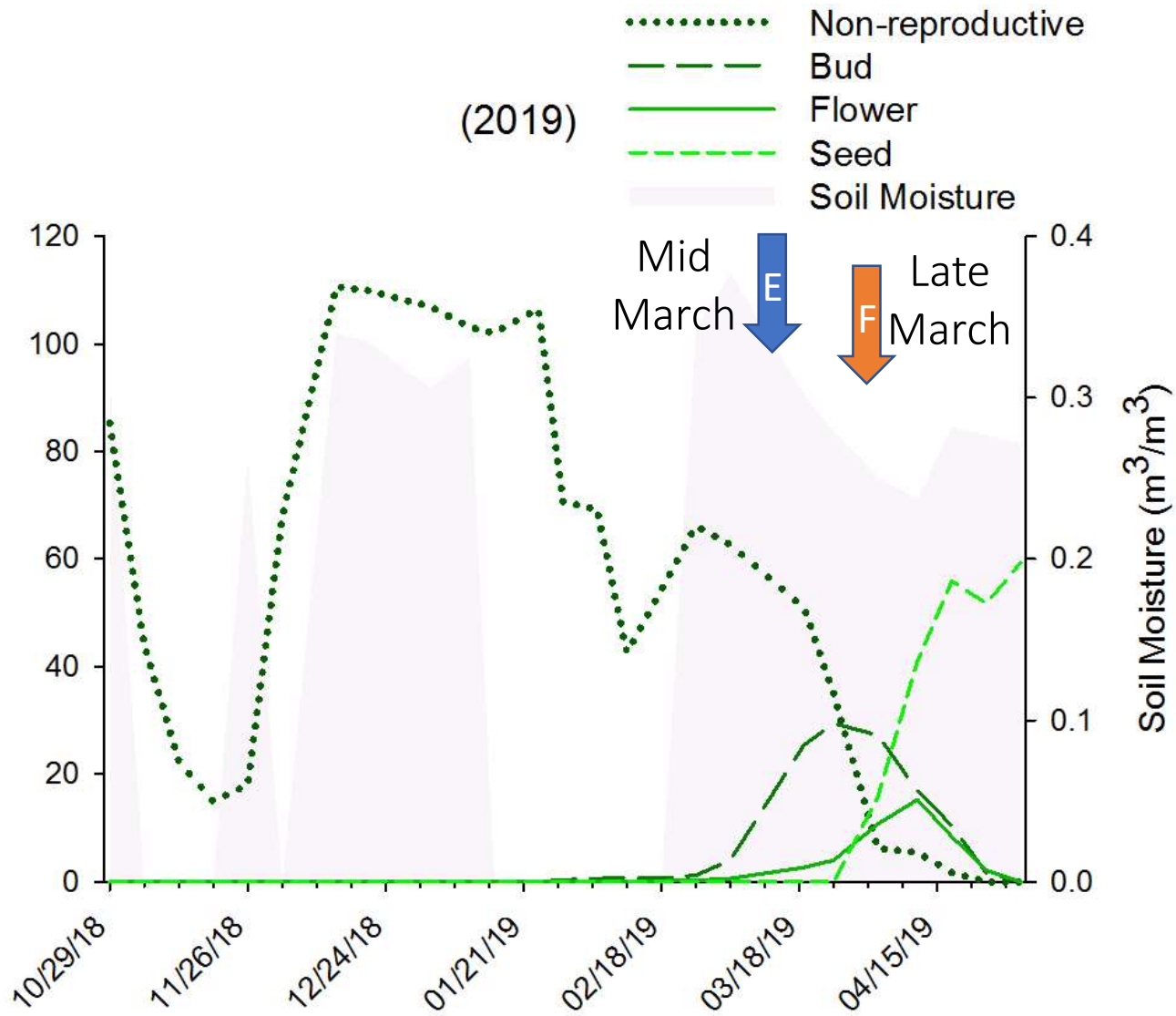
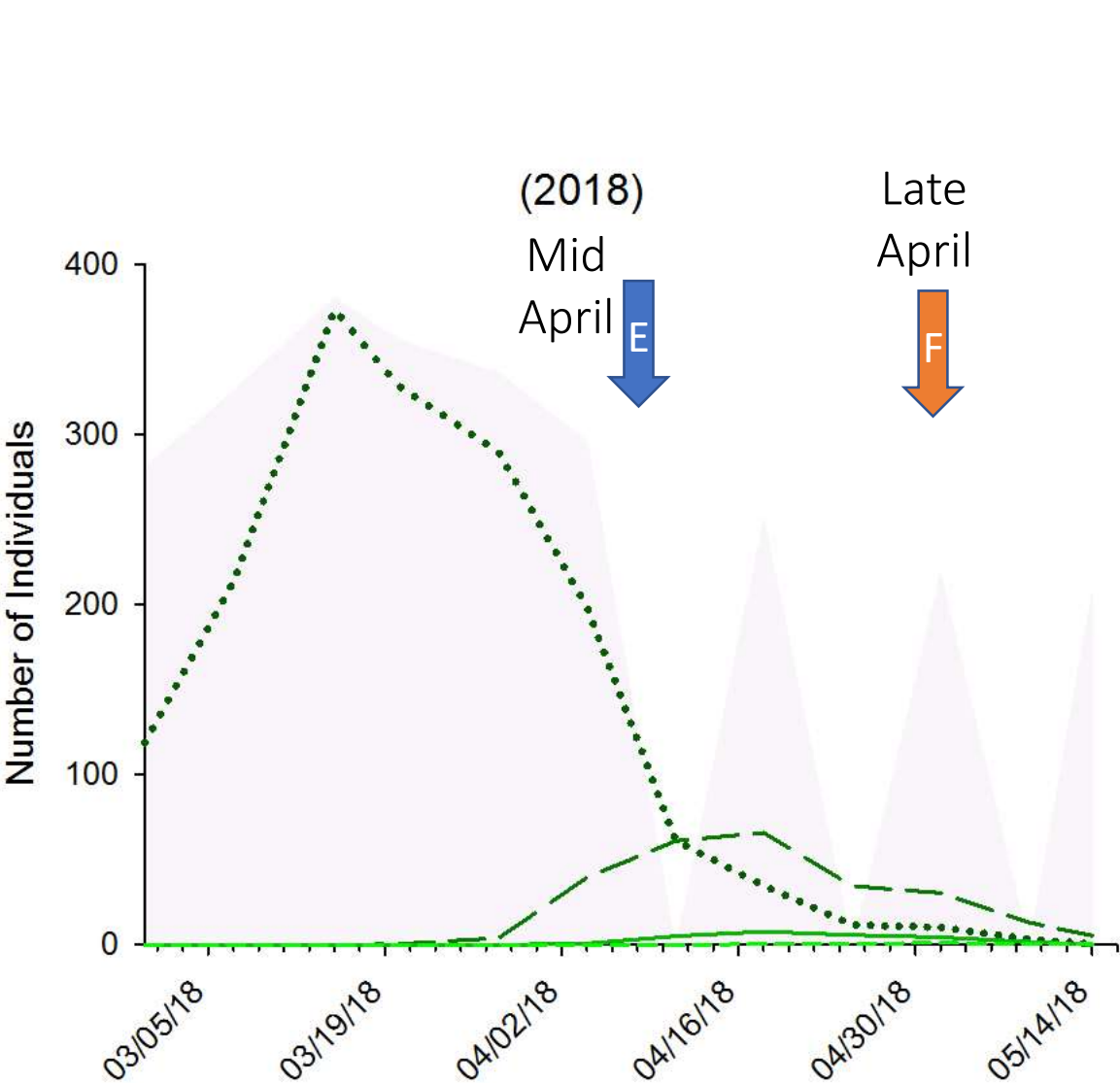
- Greenhouse Experiment

- Cutting successful at all stages despite wet or dry soil.
- Biomass significantly greater in wet soil.
- Height and seed production not affected by soil moisture.

Early or Flower treatment



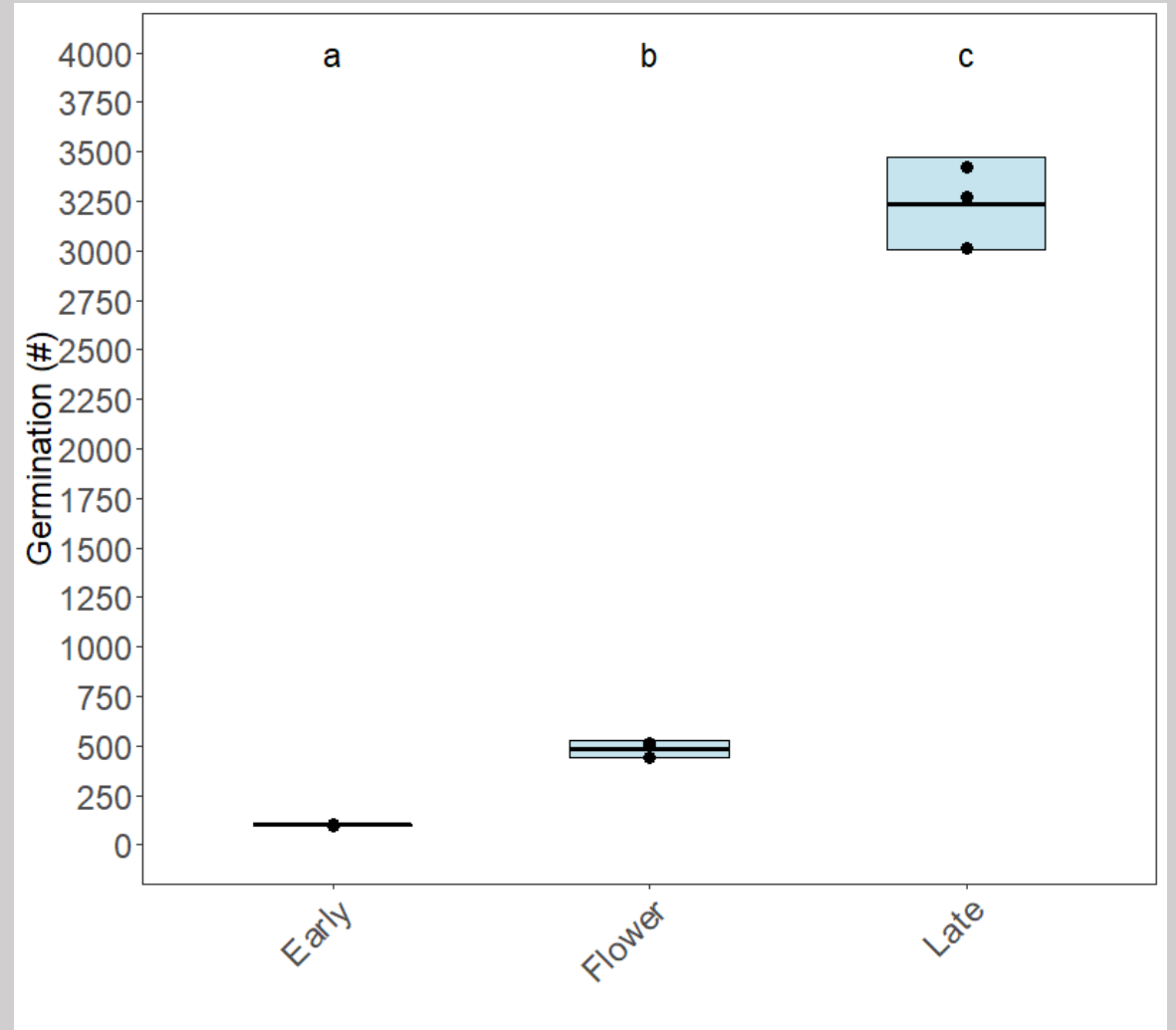
Results: Phenology Transect



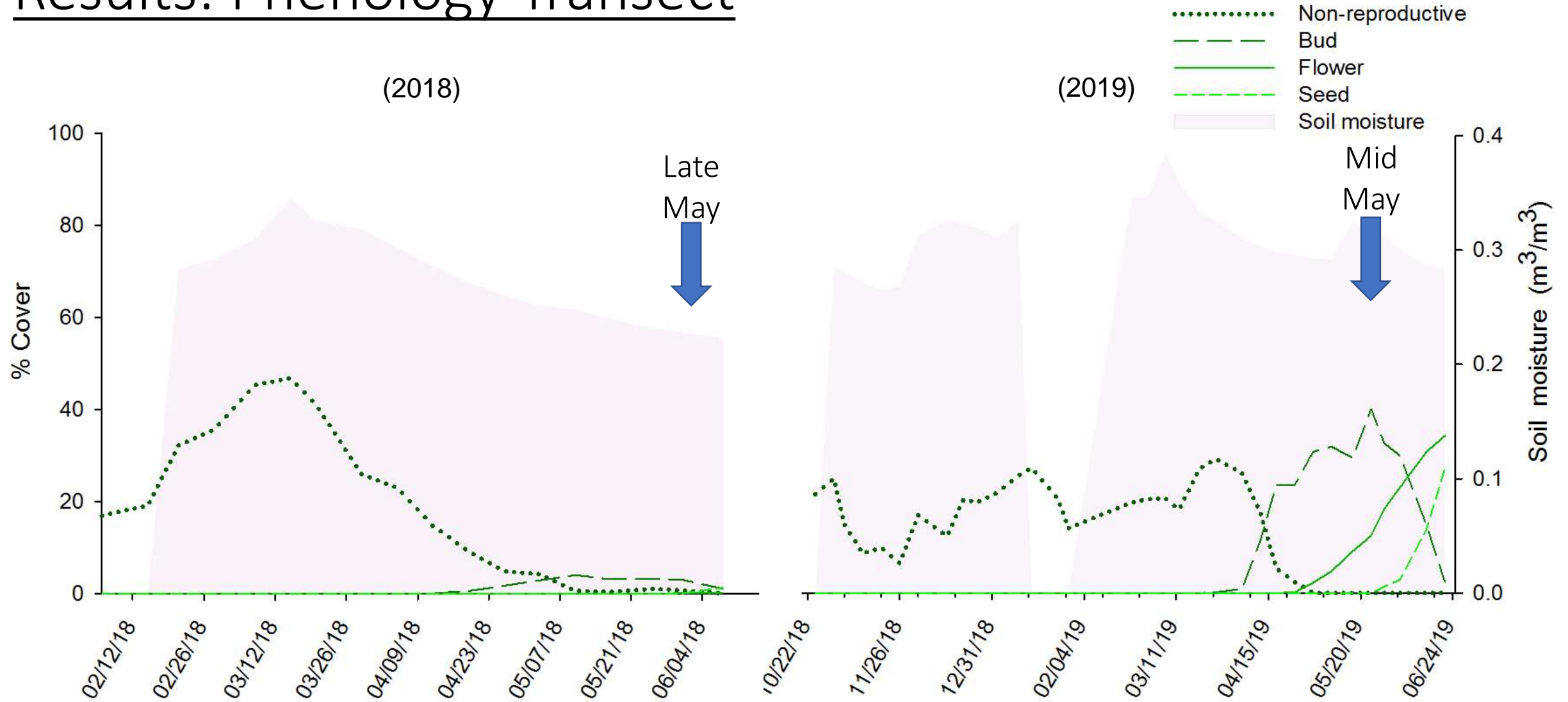
Results: *Centaurea melitensis*

- Field Experiment
 - **Cutting**: Difference in seed production, biomass, and height.
- Debris Experiment
 - Difference in debris among all cutting treatments .
- Greenhouse Experiment
 - Cutting Successful during Flower and Late treatments.
 - Reduction in height, seed production, and biomass, not significant.
 - Height, biomass, and seed production not affected by soil moisture.

Flower treatment



Results: Phenology Transect



Significance

- Provide an effective form of mechanical control for the restoration and agriculture community.
- Help reduce the reliance on one control method.
- Provide additional tools in the creation of an efficient Integrated Weed Management (IWM) program.



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