Competitive intensity among and between seedlings

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2017 National Native Seed Conference
Plant interactions

• Objective 2.3 of the National Native seed strategy that calls for research on plant establishment, species interactions, and ecological interactions
  • Explore interactions among native and between native and non-native plants
Restoration in the arid west

• Restoration efforts are plagued by substantial seedling failure due to environmental factors and competition from aggressive species
  • Dry, disturbed, fire prone
  • Low productivity, high competition

• Hinders creating diverse plant assemblages
  • Diversity benefits, ecosystem services, & wildlife support
Plant seedlings

- Vulnerable life stage to abiotic and biotic stressors (Moles & Westoby 2003)

  - Soil resources
  - Light availability
  - Temperature
  - Water avail

  - Pathogens
  - Herbivores
  - Adult & seedling competitors

- Competition imposed on seedlings is more detrimental than among adults (Weigelt et al. 2002, Spasojevic et al. 2014)

- Population dynamics may govern whether competition between individuals of the same species differ from those of different species
Negative density dependence

• Individuals of the same species share more similar resource needs [etc.] than individuals of differing species

• Expected to cause competition among individuals of the same species to be more intense than between individuals of different species

• This sounds bad, but…
Stabilizing niche mechanisms

• Promotes diversity (Chesson 2000, 2008)
• Reduce overabundance
• Help buffer small populations from extinction
  • intense within species competition is alleviated due to low numbers
Species 1

Species 2

Less intense

Species 5

Less intense
Negative density dependence

• Negative density dependences
• More facilitation between individuals of the same species
• Contributes to overabundance and dominances
• Detrimental to diversity
Restoration & plant interactions

• High diversity in restoration is often a goal
  • Plant-plant interactions can play a major role in the establishment of species & maintaining diversity

• We need to know more about the within- and between species interaction dynamics to inform seed mix design
Das Study (German for “the Study”):

• Objective
  • Determine if the interaction strength differs among individuals of the same species compared to competition between species
Das Study

• Species used:
  • Considered as high priority species for restoration in the Colorado Plateau
  • Species
    • *Helianthus annuus* (common sunflower) $ 
    • *Linum lewisii* (native blue flax) $ 
    • *Linum perenne* (blue) $ 
    • *Pascopyrum smithii* (western wheatgrass) $ 
  • Accessions purchased or wild collected
    • Stored in the Dixon National Tallgrass Prairie Seed Bank
Das Study

- Sand in containers
- Growth chamber
- Seven weeks
- Three treatment groups
Interaction dynamics

• Data
  • above- and belowground mass

• root mass fraction (RMF) \( \frac{\text{Root mass}}{\text{Total mass}} \)

• Effect size calculation \( \ln\left( \frac{\text{RMF of experimental group}}{\text{RMF of control group}} \right) \)
Roots & Interactions

• Roots
  • Important for resource acquisition
  • Soil biota associations
  • Non-resource based communications.
    • Important interface for interactions (e.g. Acciaressi & Guiamet 2010, Foxx & Kramer in prep)
      • Most intense interactions occur between roots (Kiær et al. 2013)
Interaction dynamics

Effect size comparison
$p = 0.037$
Interaction dynamics

• Four of seven combinations competed more intensely with individuals of the same species than of other species
  • *Helianthus annuus* & *Linum lewisii*

• Two species competed more intensely with individuals of different species
  • *Pascopyrum smithii* & *Linum perenne*
    • *P. smithii* can become dominant where introduced and *L. perenne* can also become abundant
    • *L. perenne* is non-native, used in restoration, and can become abundant
  • Varies by population?
  • These dynamics may limit diversity via competitive exclusion of different species
  • Seed mix design consideration
Future Work

• Elucidate how intraspecific variation and plastic responses can change the competitive relationships between individuals of the same and different species using native and invasive species
  • Mechanistic understanding of how dominant and invasive species negatively impact plant establishment and coexistence
Acknowledgements
Andrea Kramer, PhD
Amy Iler, PhD
Stuart Wagenius, PhD
Florian Fort, PhD
Kramer-Havens Lab group
Community Ecology Lab group
PBC PhD Fellowship
Colorado Plateau Native Plant Program
Bureau of Land Management

Thank you!

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The preceding presentation was delivered at the

**2017 National Native Seed Conference**
Washington, D.C. February 13-16, 2017

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