The role of seedbank composition and biotic function in vulnerable erosive agroecosystems

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MRP Inter-Institutional
Post-Graduate Competition

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The James Hutton Institute

Science connecting land and people

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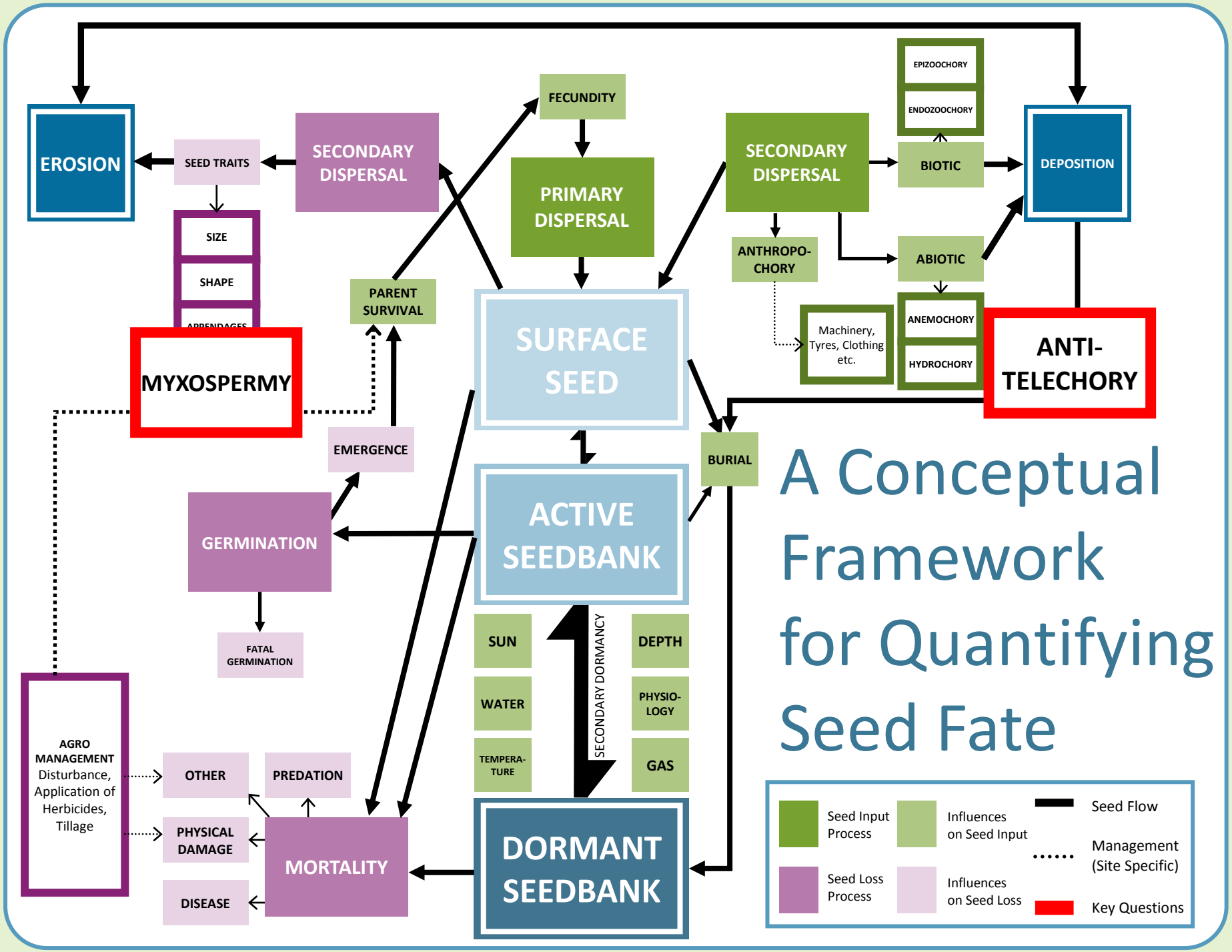
Why Arable Weeds Matter…

- Provide important ecosystem services within simplified agroecosystems
  - Pollination: UK £690m, worldwide £120b
- Vital buffer against short-term disturbance events
- Influenced by cultivation practices
- Effective indicators of farmland biodiversity

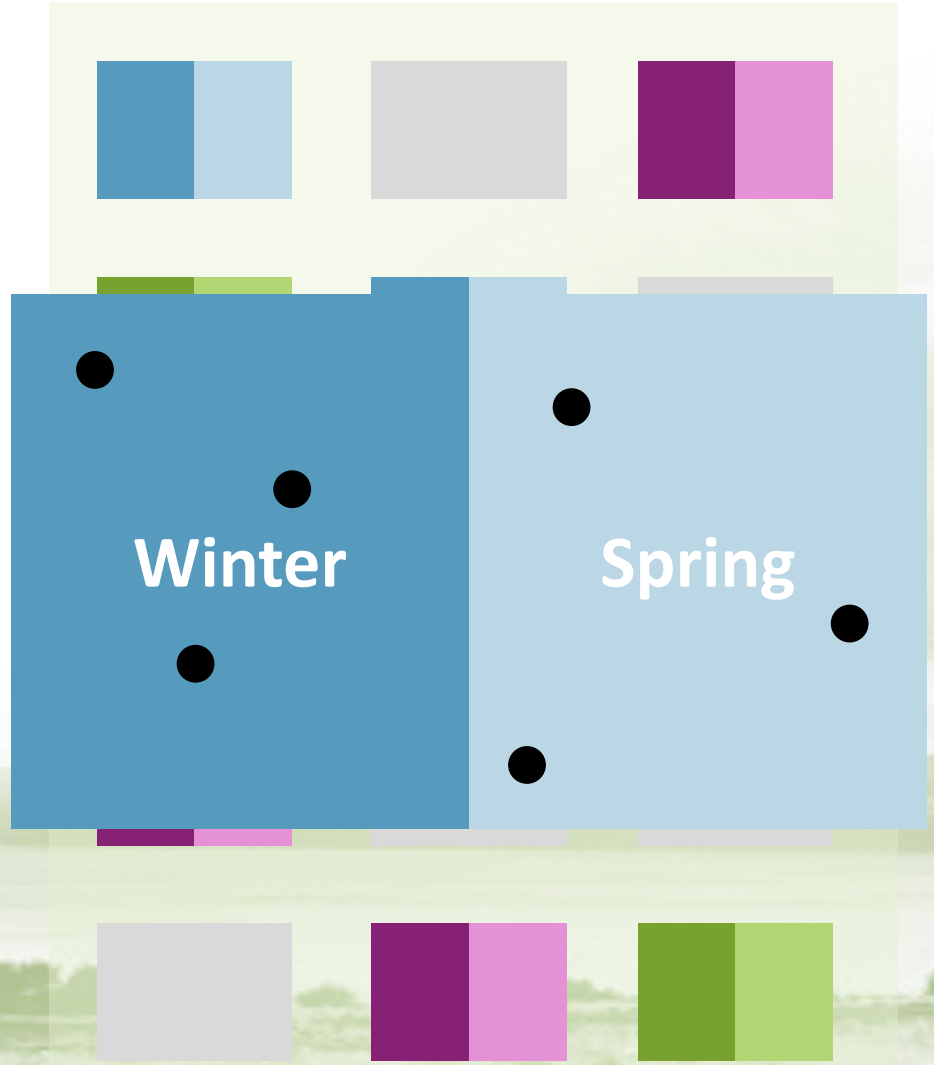


Research Aims:

- Quantify the influence of erosion on seedbank diversity and function
- **Investigate role of the weed seedbank influencing physico-chemical behaviour of agricultural soils**
- Improve understanding of seed fate to inform sustainable weed management

Seedbanks and Management

- Assessing the importance of tillage practices on seedbank composition and distribution
  - 12 year barley field trial
  - 3 management treatments
    - **No till**, minimum till, **conventional**, compaction, **deep plough**
  - Barley crop type
    - Crop-weed associations from seasonal tillage
  - Seed viability with depth
    - 4 depth intervals:
      - 0-4, 4-8, 8-16, 16-32 cm



Methodology

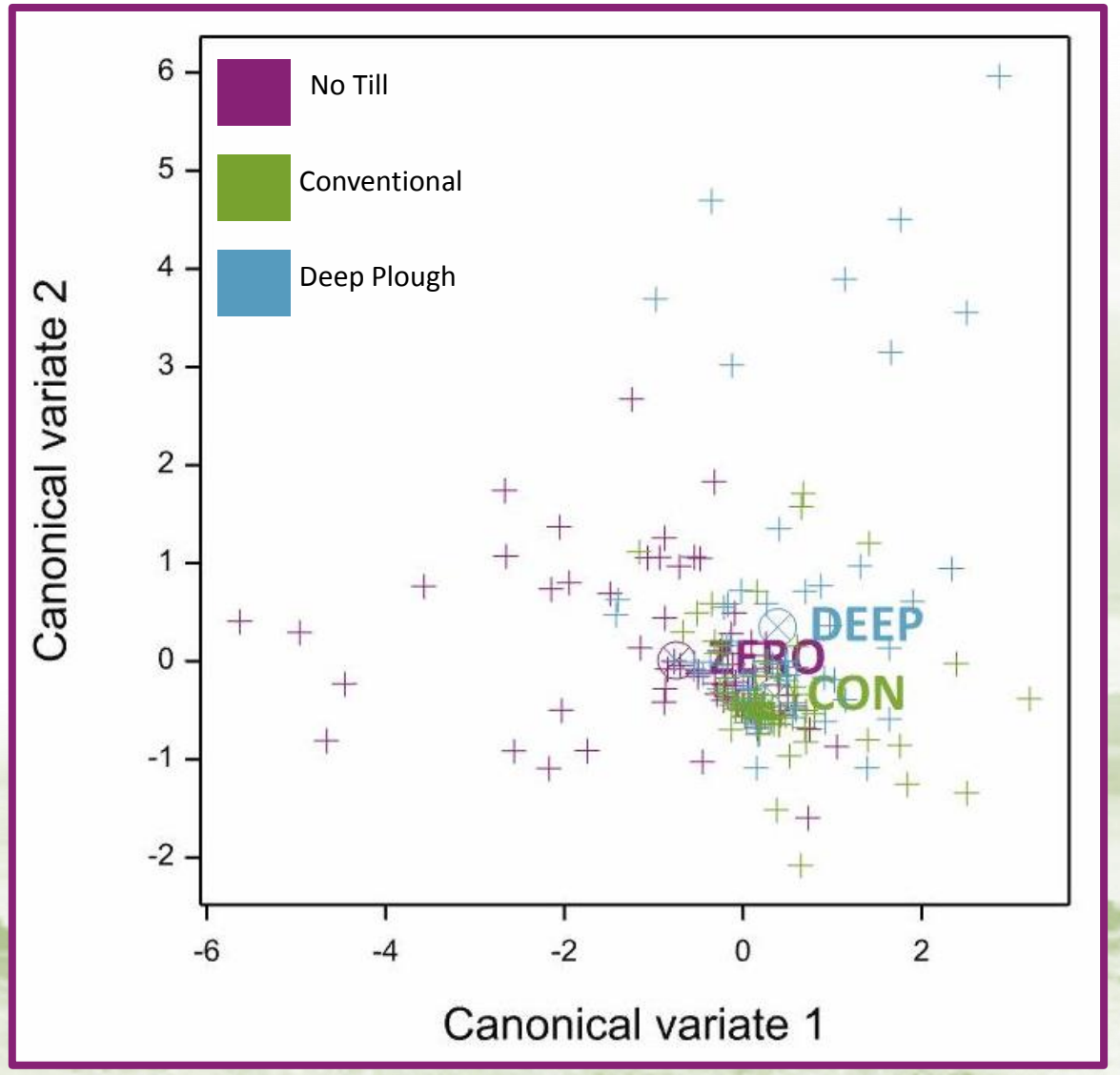
Seed Emergence

- Determines germinability under glasshouse conditions
- Count seedlings over 3 x 6-8 week periods
- Cold stratification between periods 1 + 2

Treatment Effect: Composition, Diversity & Distribution

- 38 species, 16 functional groups
- **Management impacting abundance and distribution**
  - Highest diversity in deep plough
  - Diversity increases with depth in no till
- Year 2…
  - No till treatment has been ploughed (Oct 2015)

Why do we care?

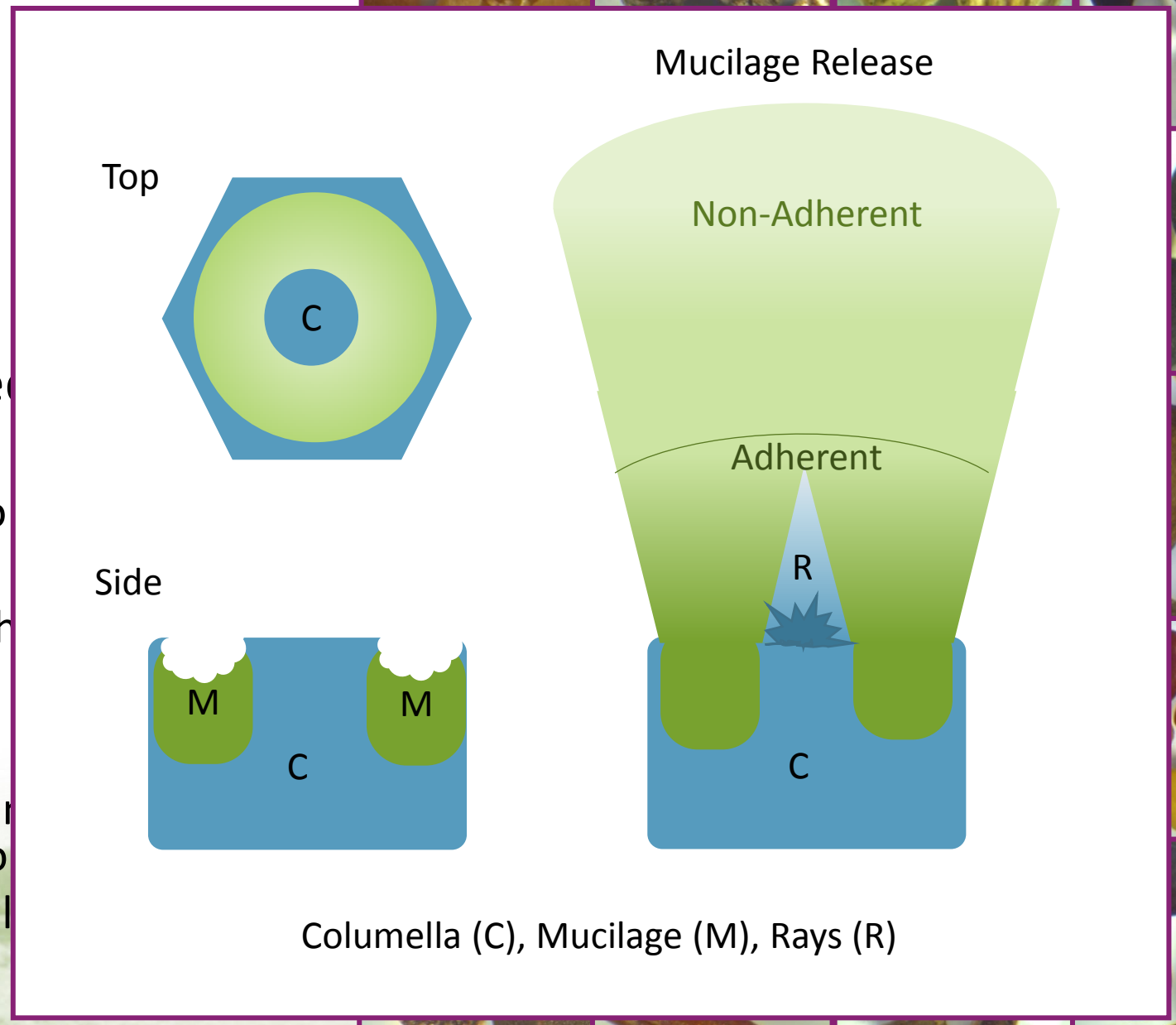


Soil Properties and Seed Characteristics

- Role of the weed seedbank influencing physico-chemical behaviour of agricultural soils
- Beneficial bi-products of seedbanks
- Differential mobility capacity depends on seed morphology
- Causes selective erosion of seeds
  - Seed size, shape, presence of appendages and **myxospermy**

Myxospermy

- Secretion of mucilage
  - “Gluing” seeds to the ground
  - **ANTITELECHORY**
- Quantitative studies are limite species
  - Physical alteration to soil due to nature
  - Stabilising soil structure and enh retention
- The unknowns…
  - Capability of specific species/co assemblages to prevent transpo
  - Existence of a mucilage threshol soil properties are altered



Myxospermy: Experimental Progress

Arabidopsis thaliana

Mouse-ear Cress

Capsella bursa-pastoris

Shepard's Purse

Euphorbia helioscopia

Sun Spurge

Plantago major

Broadleaf Plantain

Senecio vulgaris

Common Groundsel

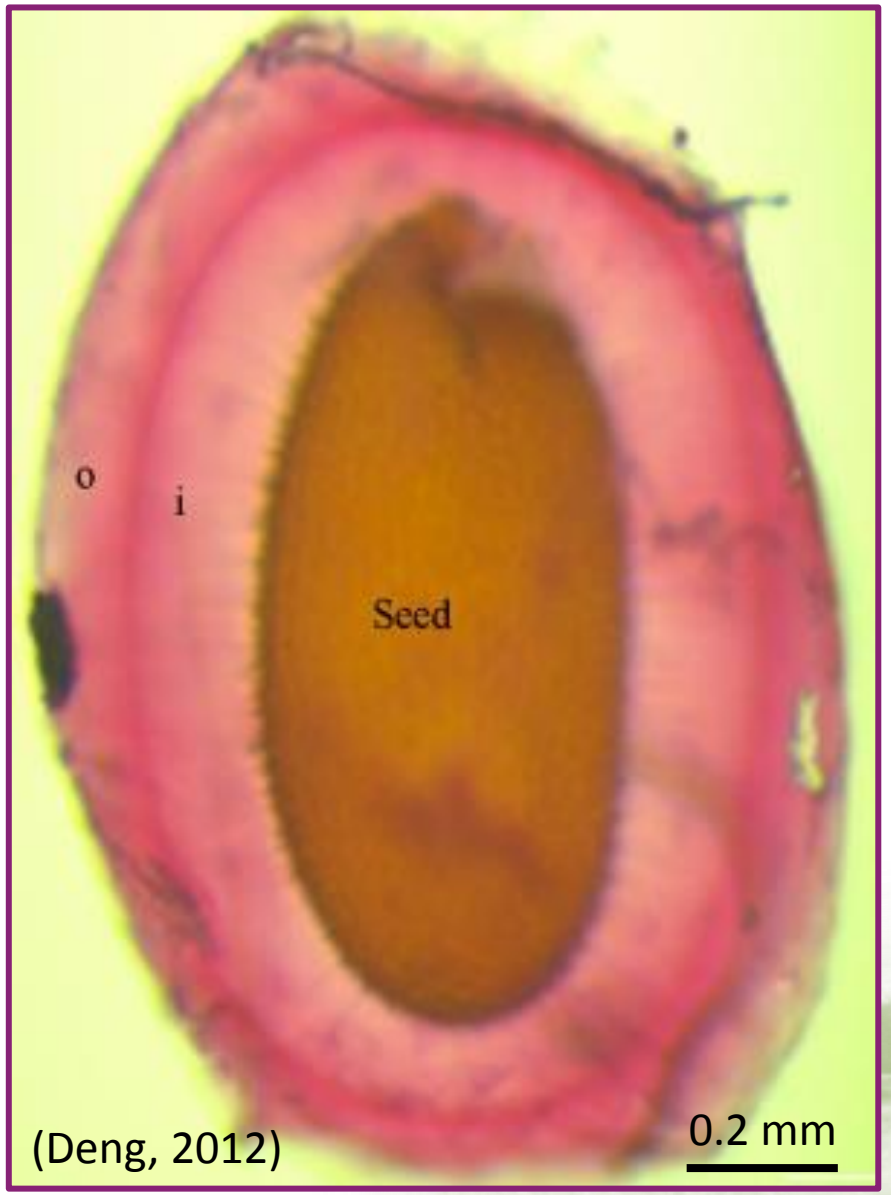
Urtica Urens

Annual Nettle

Veronica arvensis

Corn Speedwell

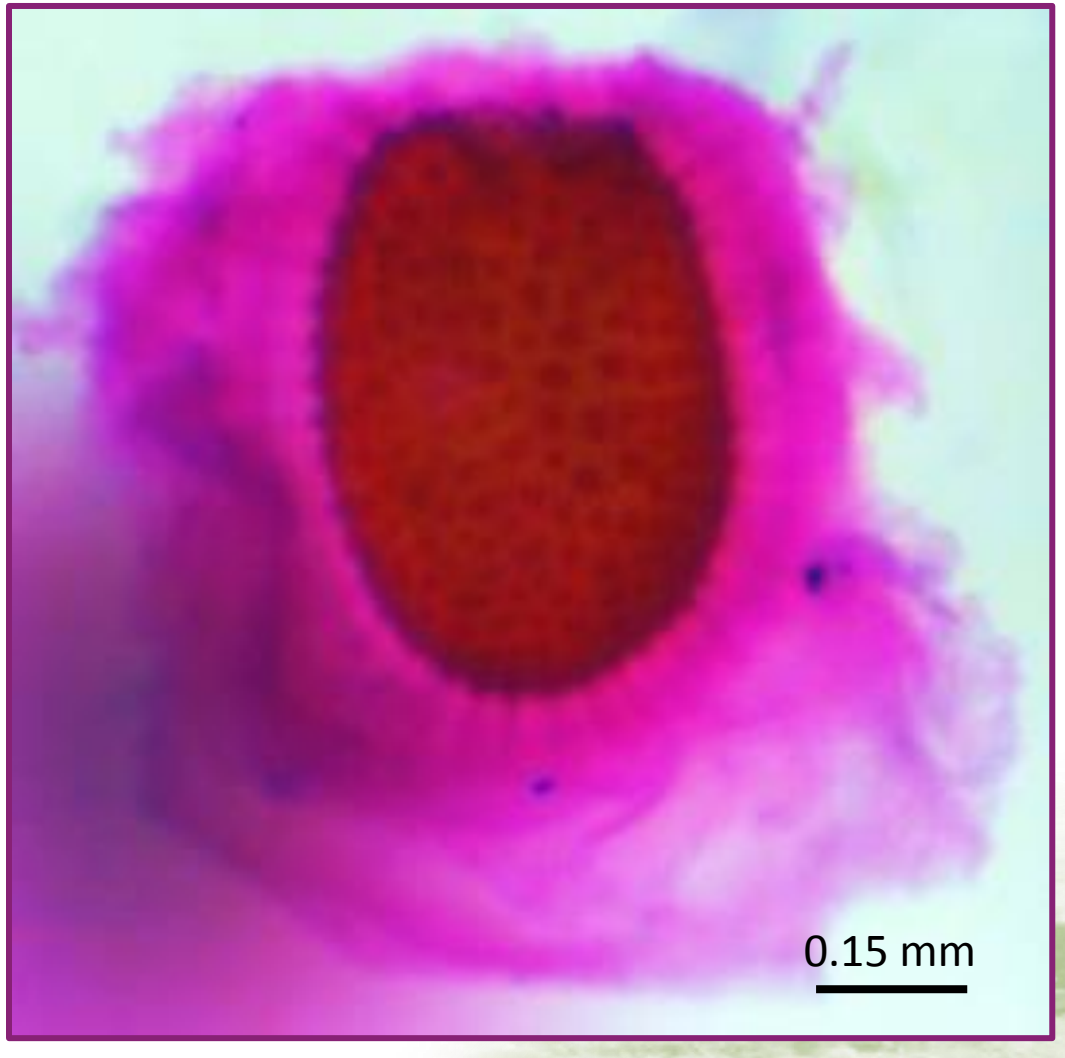
Capsella bursa-pastoris

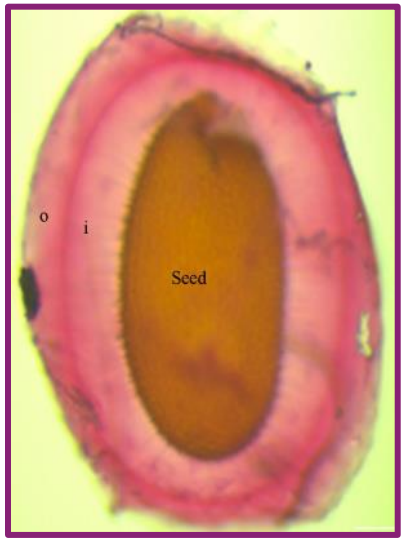


(Deng, 2012)

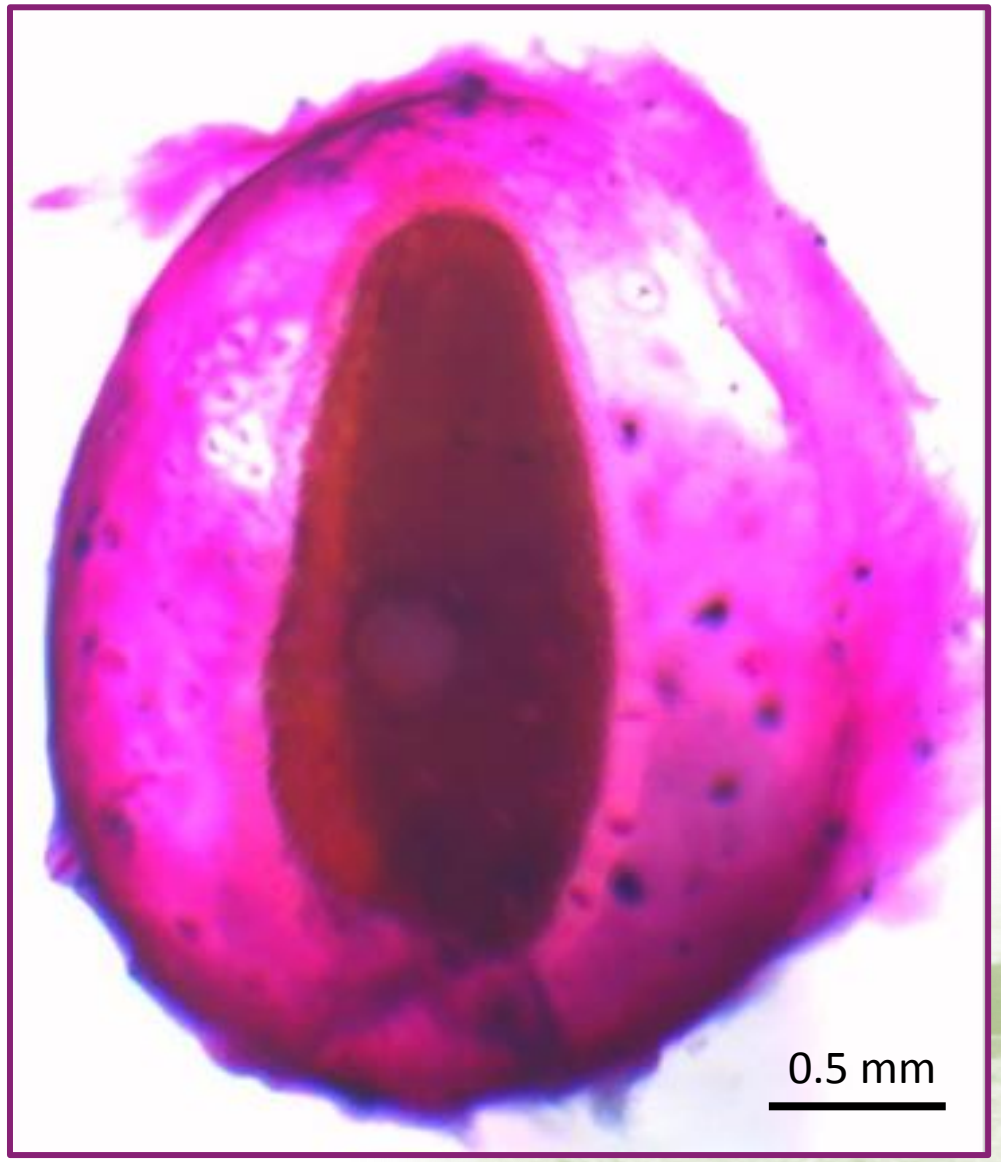
- Outer layer – Pectin (non-adherent to seed)
- Inner layer – Cellulose (adherent to seed)

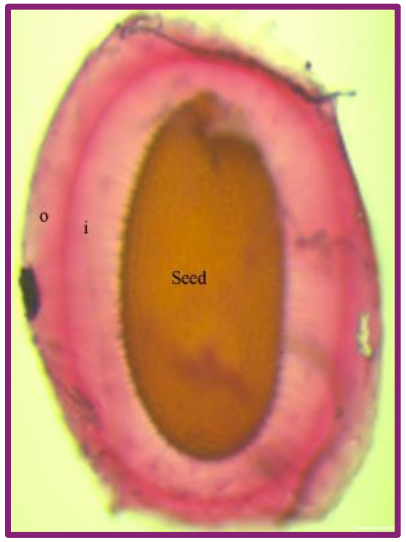
Arabidopsis thaliana

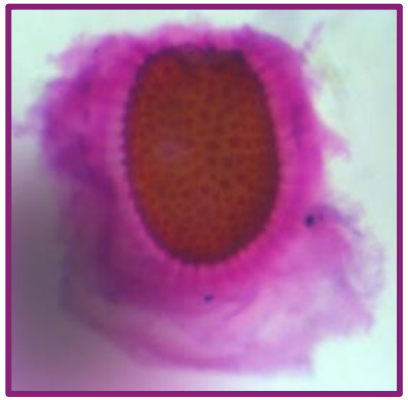




Plantago major







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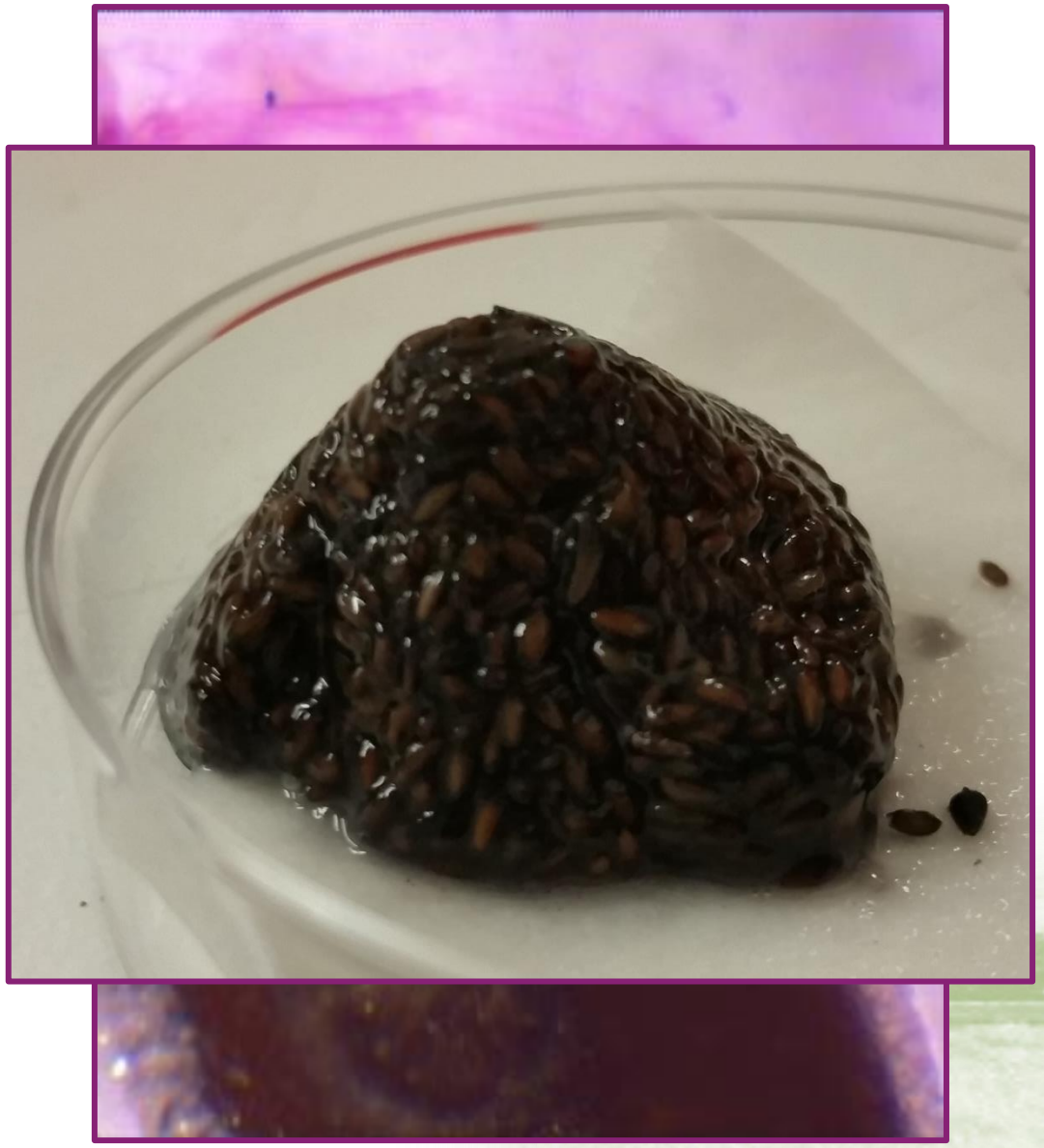
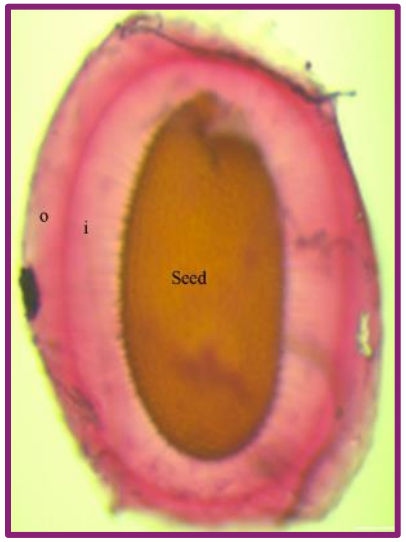
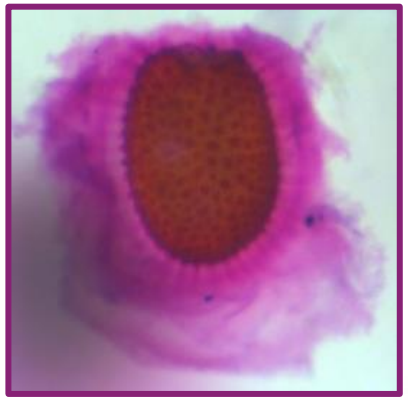
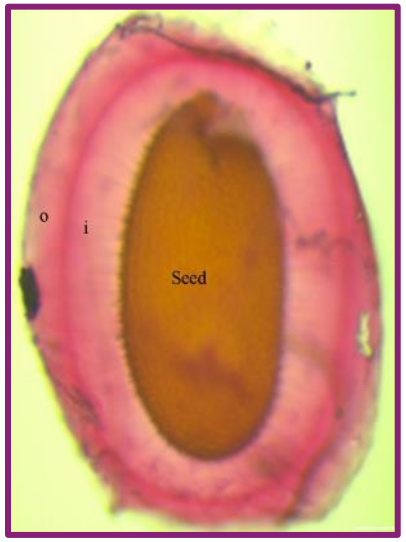
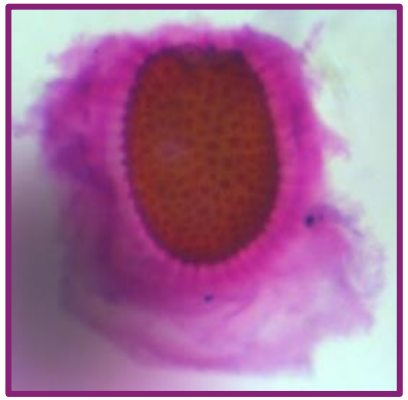




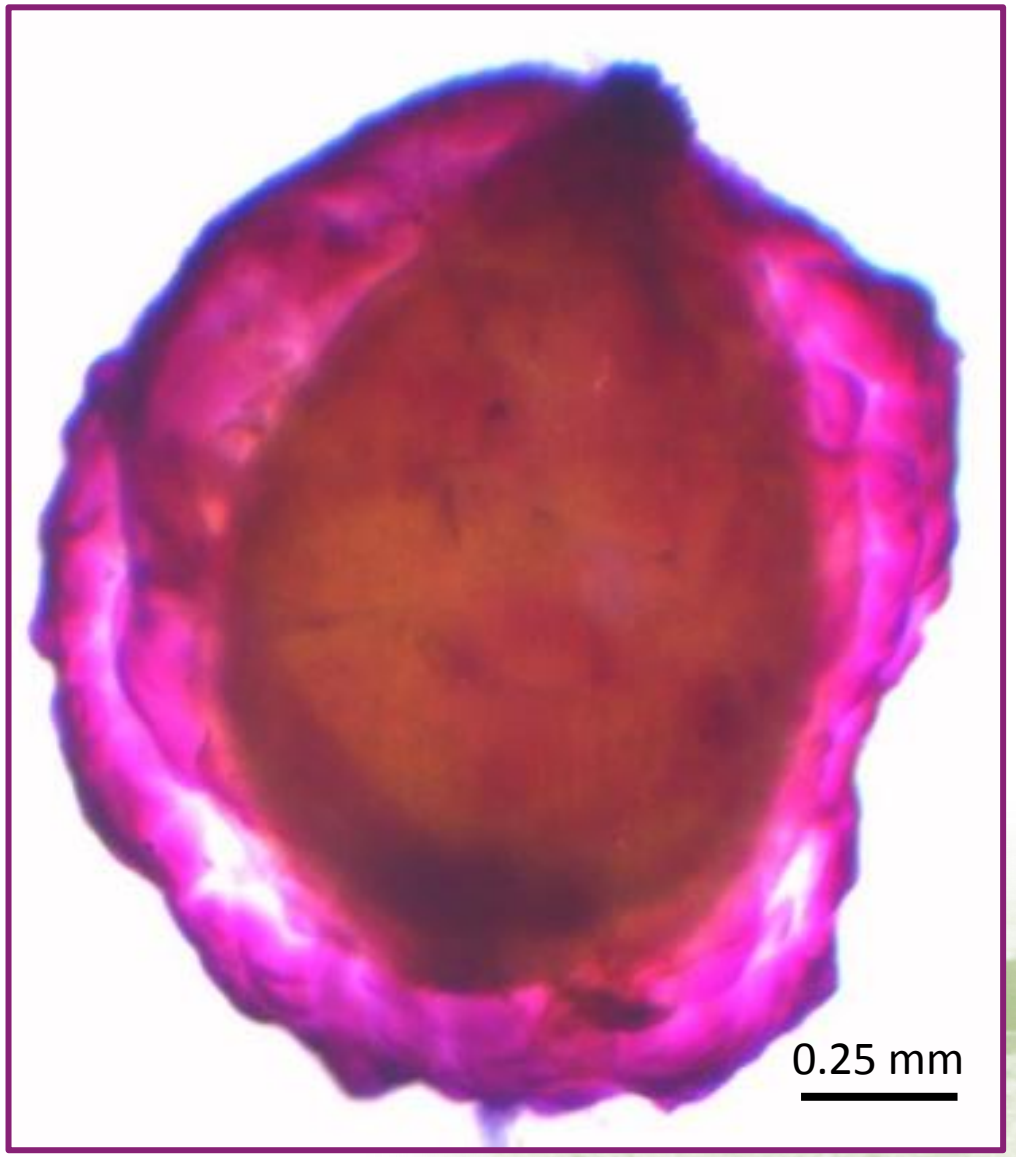


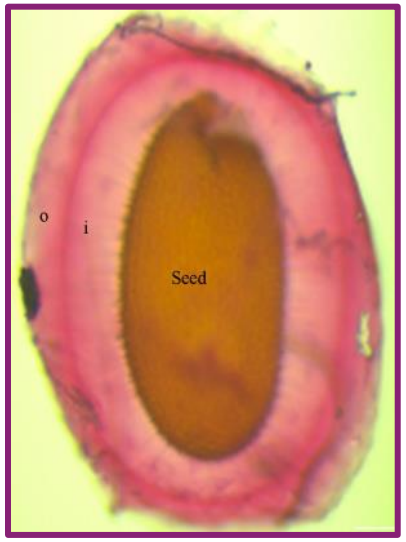
Veronica arvensis

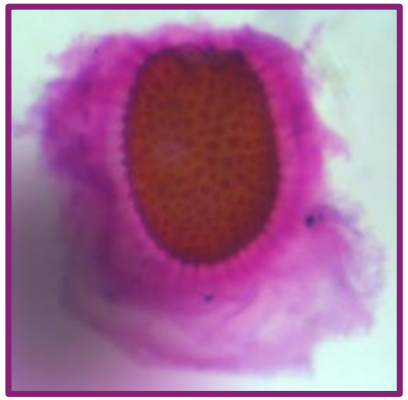


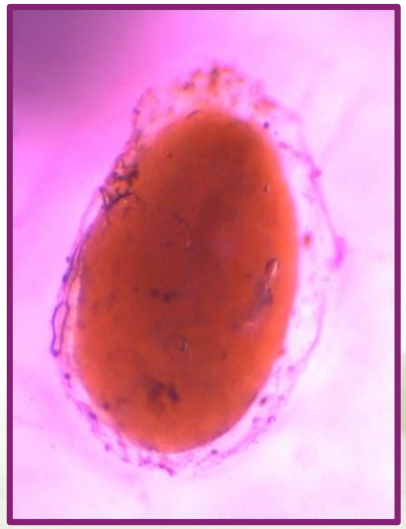


Urtica urens

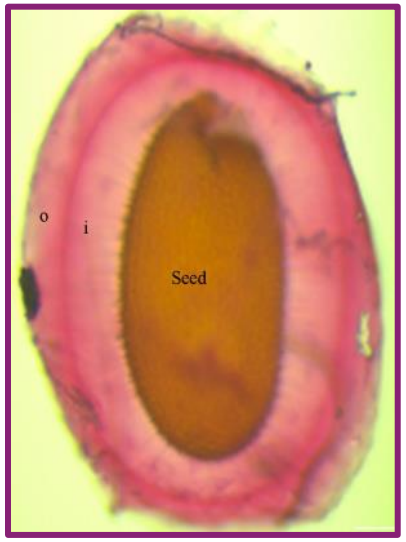


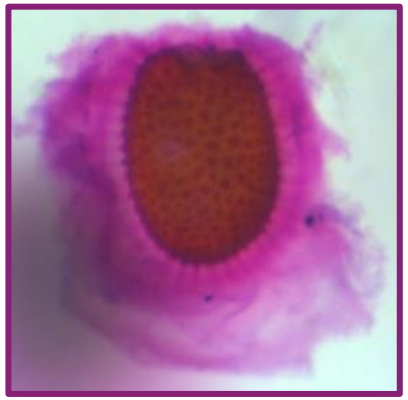


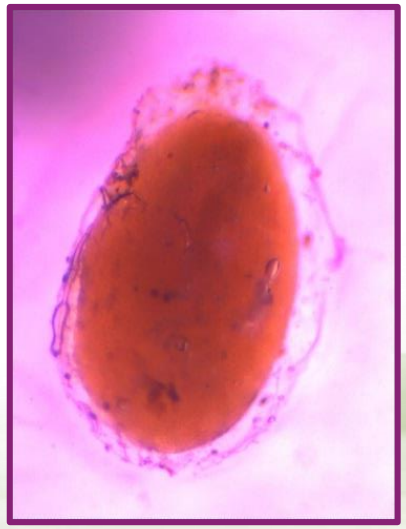


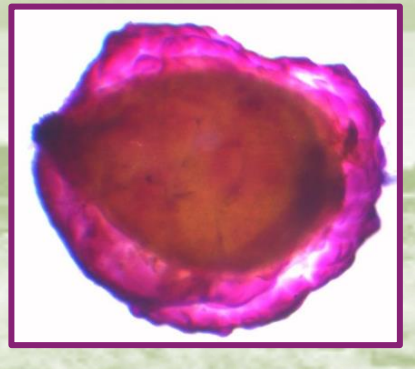


Senecio vulgaris









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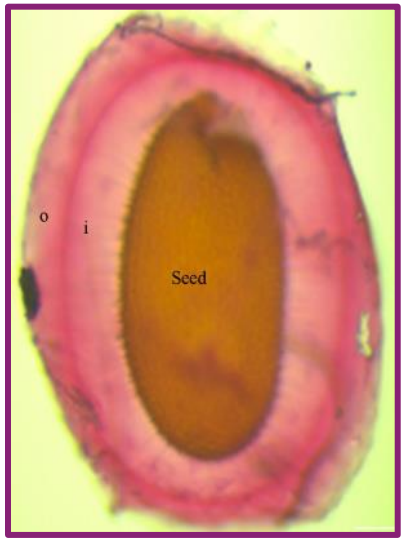
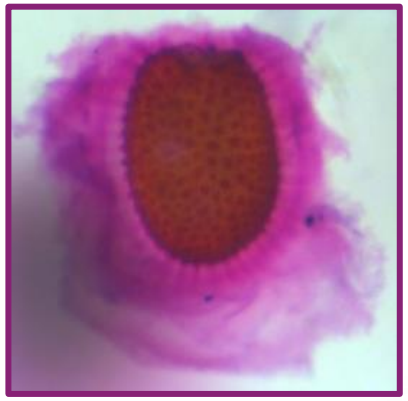
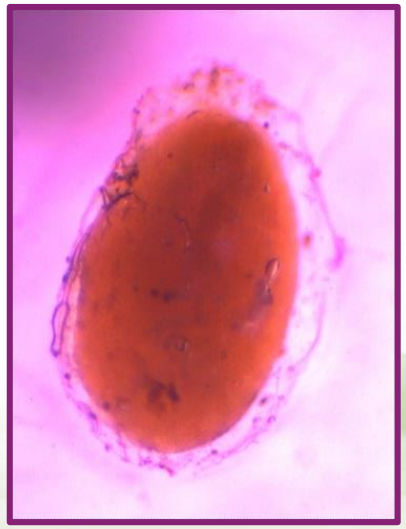
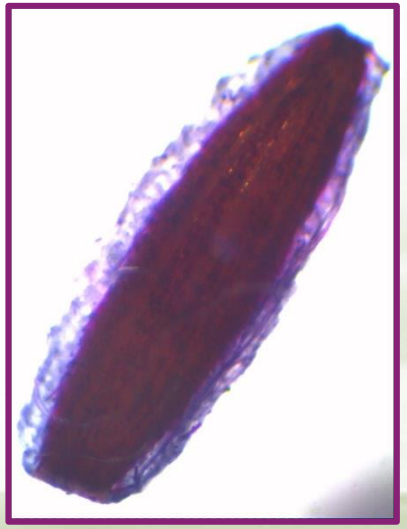
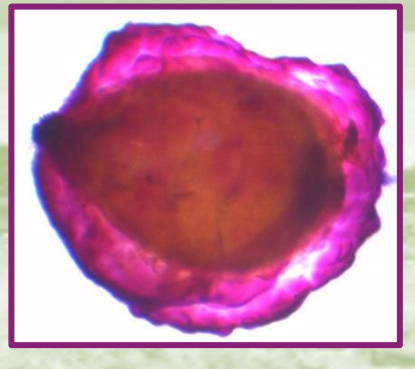


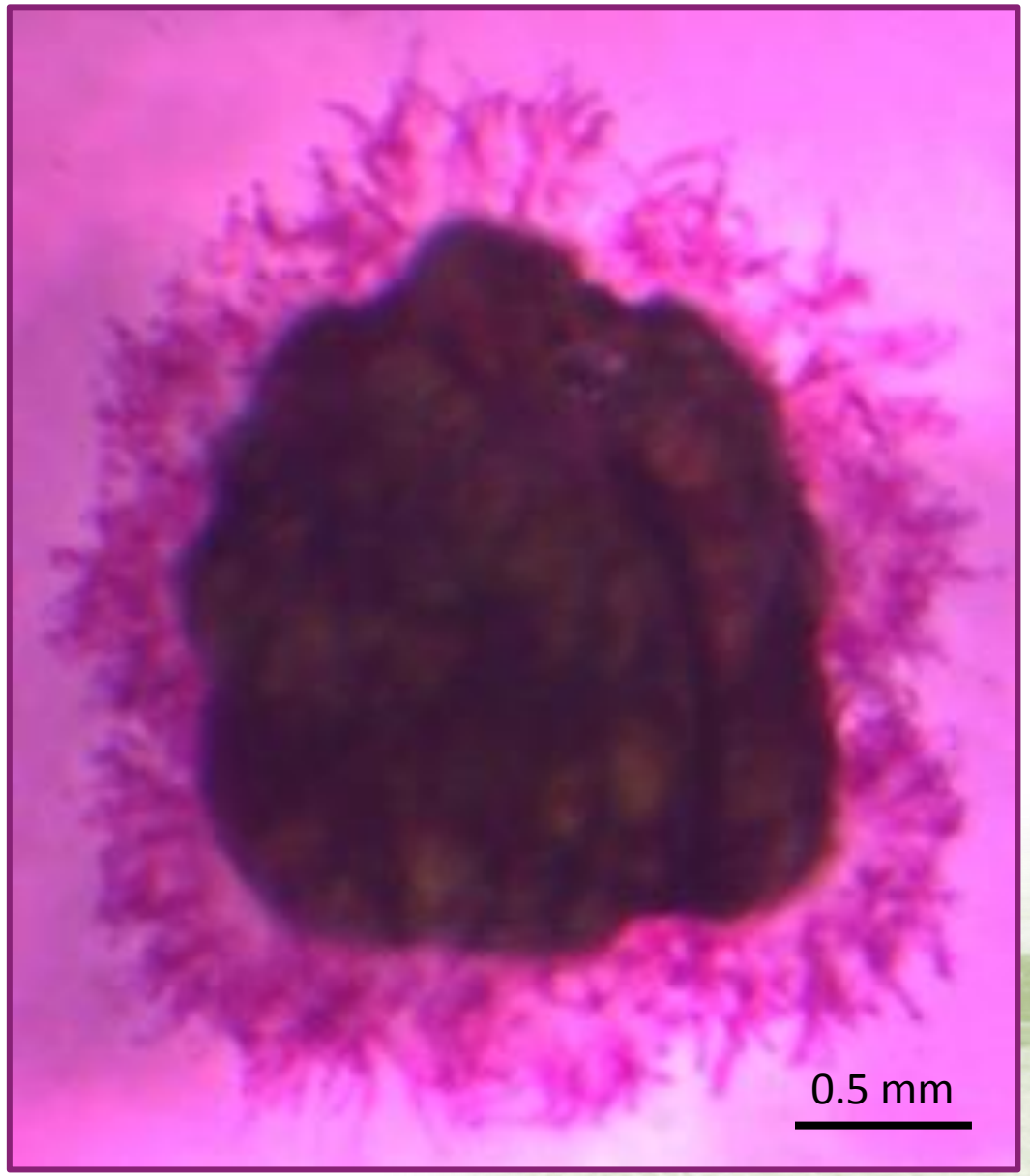


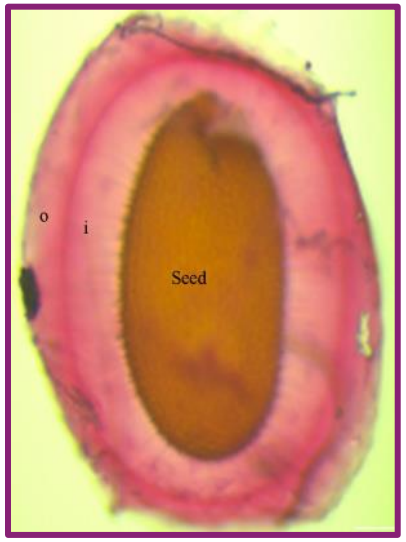


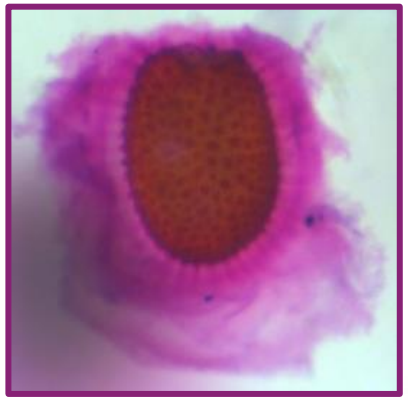


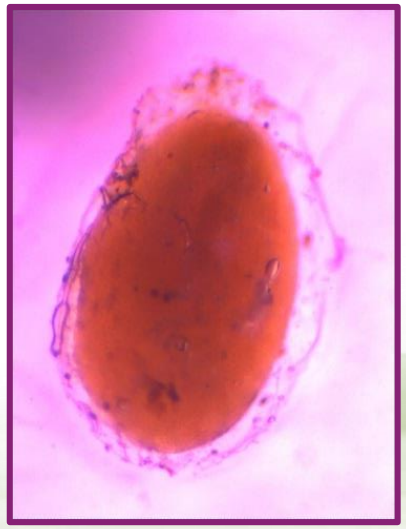


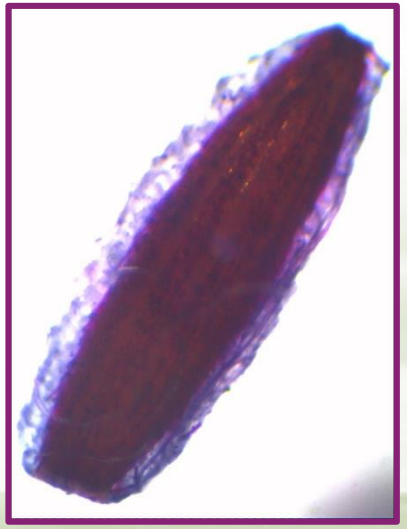
Euphorbia helioscopia

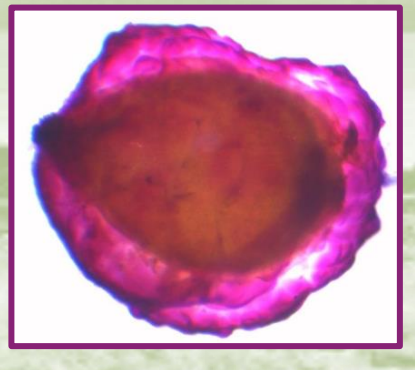












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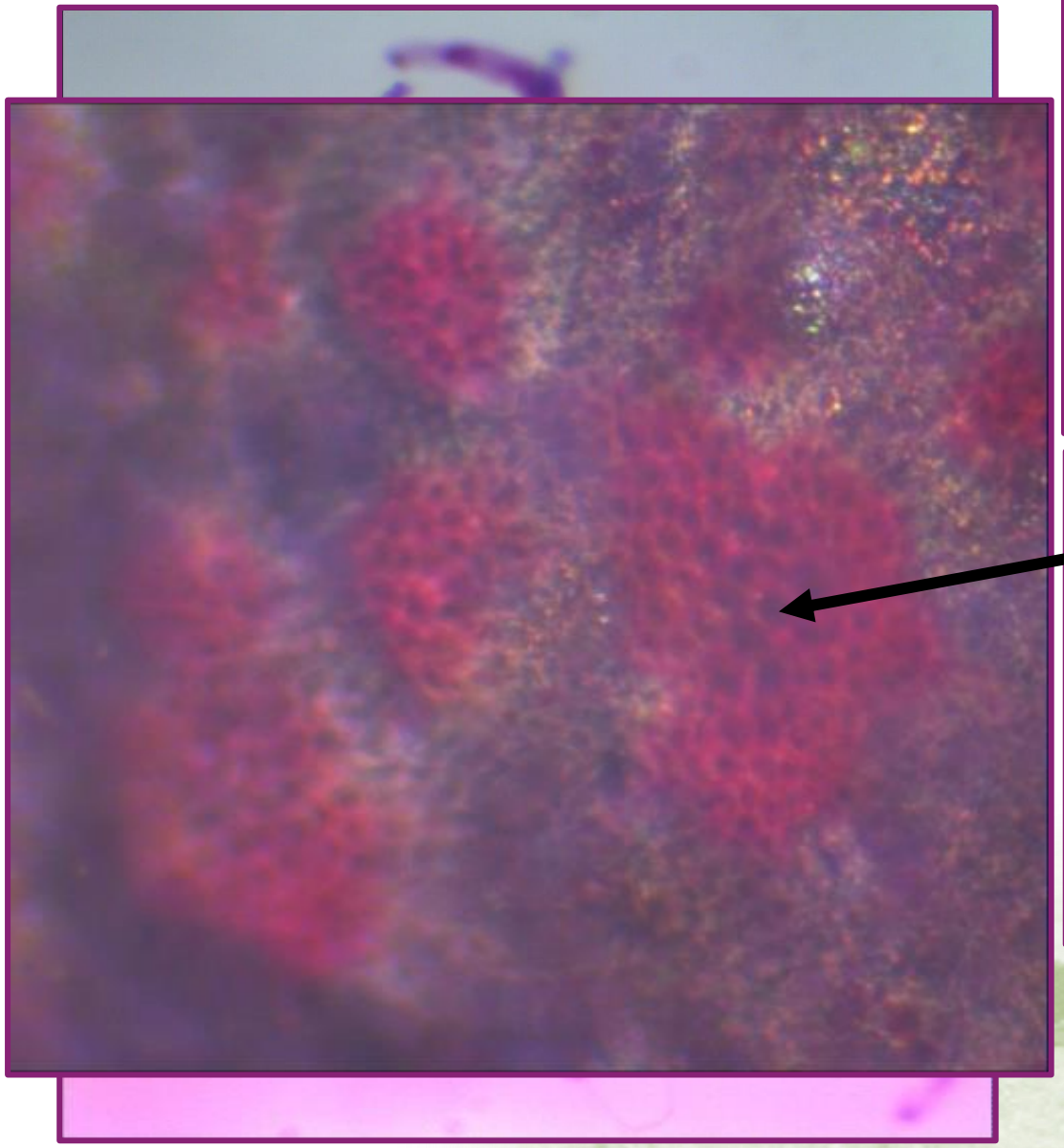
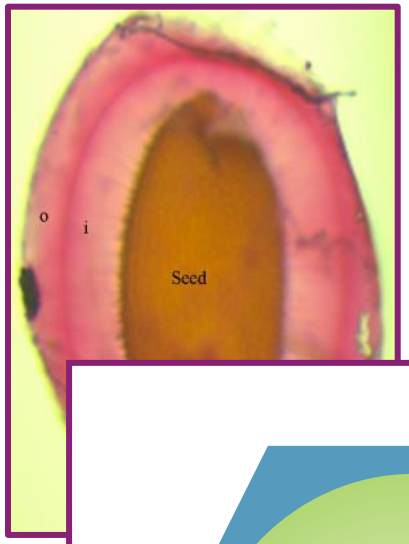
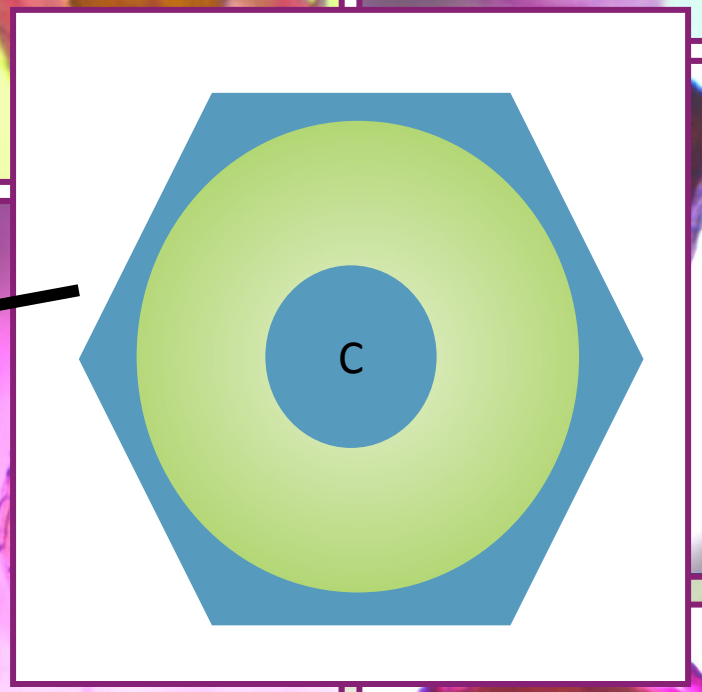
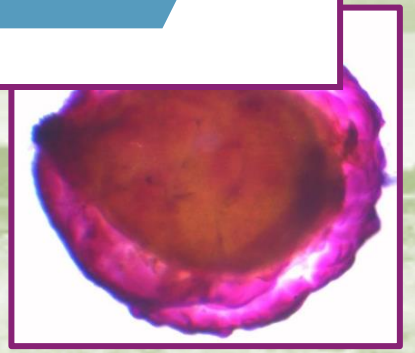
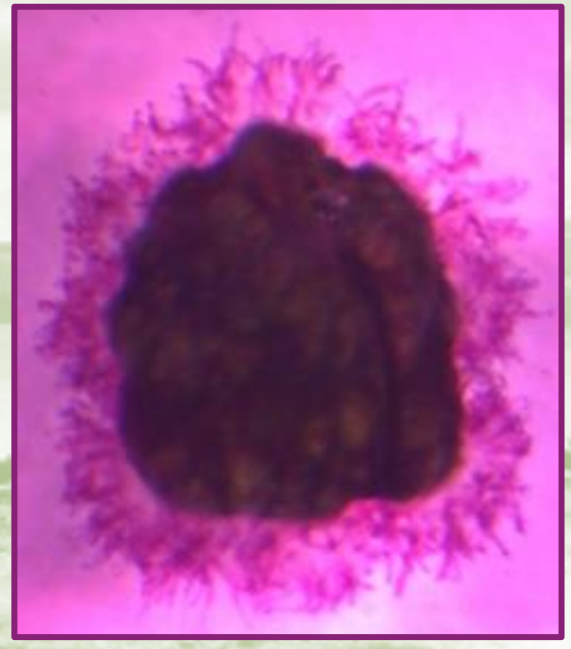


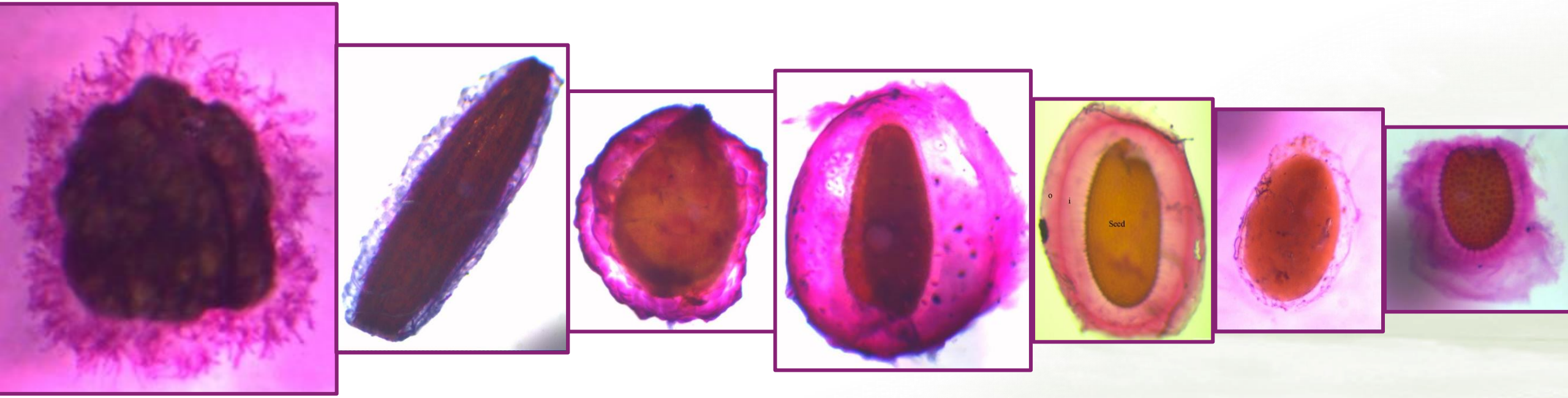








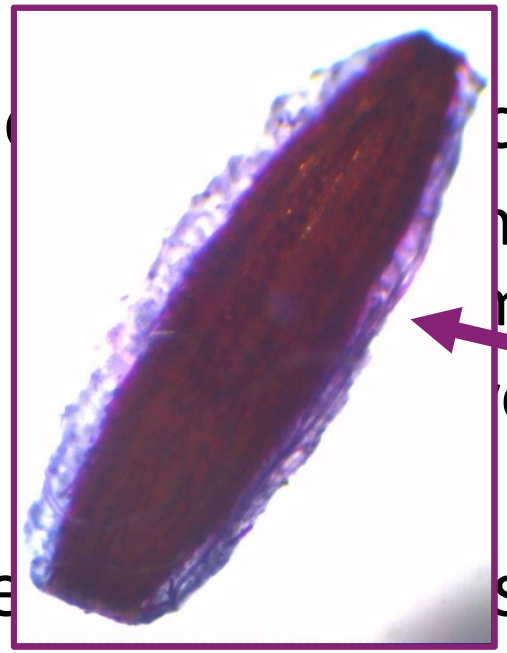
Myxospermy: Experimental Progress

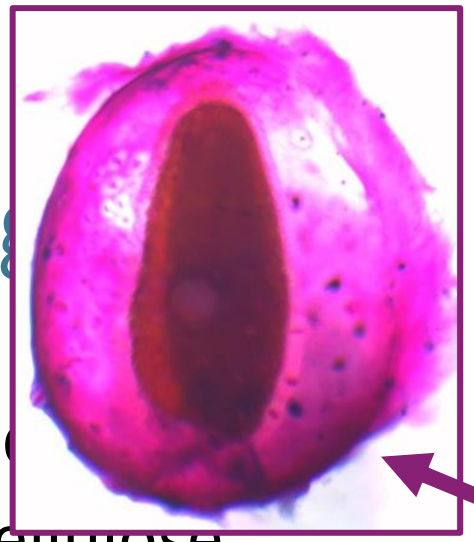


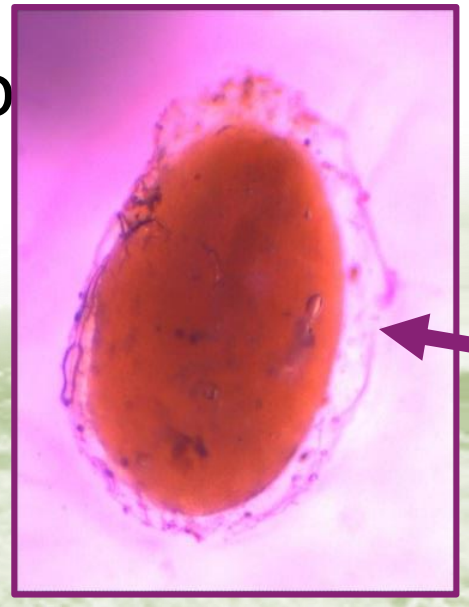
- Variable pH?
- Variable sugar composition?
- Variable adhesive power?
- Wetting, drying, re-wetting?

Myxospermy: Dig

- Se cilag
  - ner cellulose
  - me digestion
  - er extracted by
- 2 e s co







Dry Seed Weight Loss	Inner Component	Outer Component
Arabidopsis thaliana	2-8%	14-21%
Capsella bursa-pastoris	1-7%	20-22%
Euphorbia helioscopia	2-4%	10-11%
Plantago major	1-4%	30-40%
Senecio vulgaris	4%	23-27%
Urtica urens	3%	20-27%
Veronica arvensis	2-3%	3-4%

Myxospermy: Digestion

- Seed weight:mucilage ratio
  - Extraction of inner cellulose layer with enzyme digestion
  - Outer pectin layer extracted by water
- 2 extraction trials completed
  - Inner layer is difficult to remove
  - Remaining sugar?

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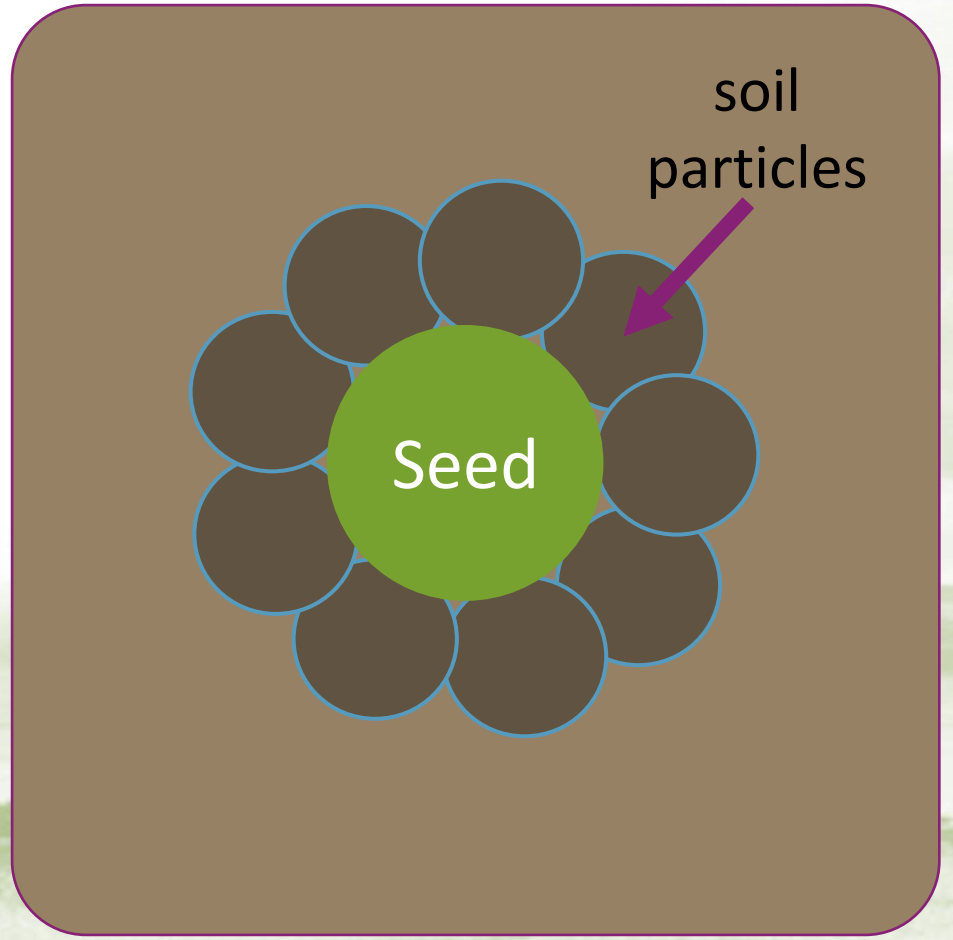
Myxospermy: Future Work

- Experimental Plan
  1. Aggregation and adherence of soil particles
  2. Mucilage interaction with soil properties
  3. Adhesive power

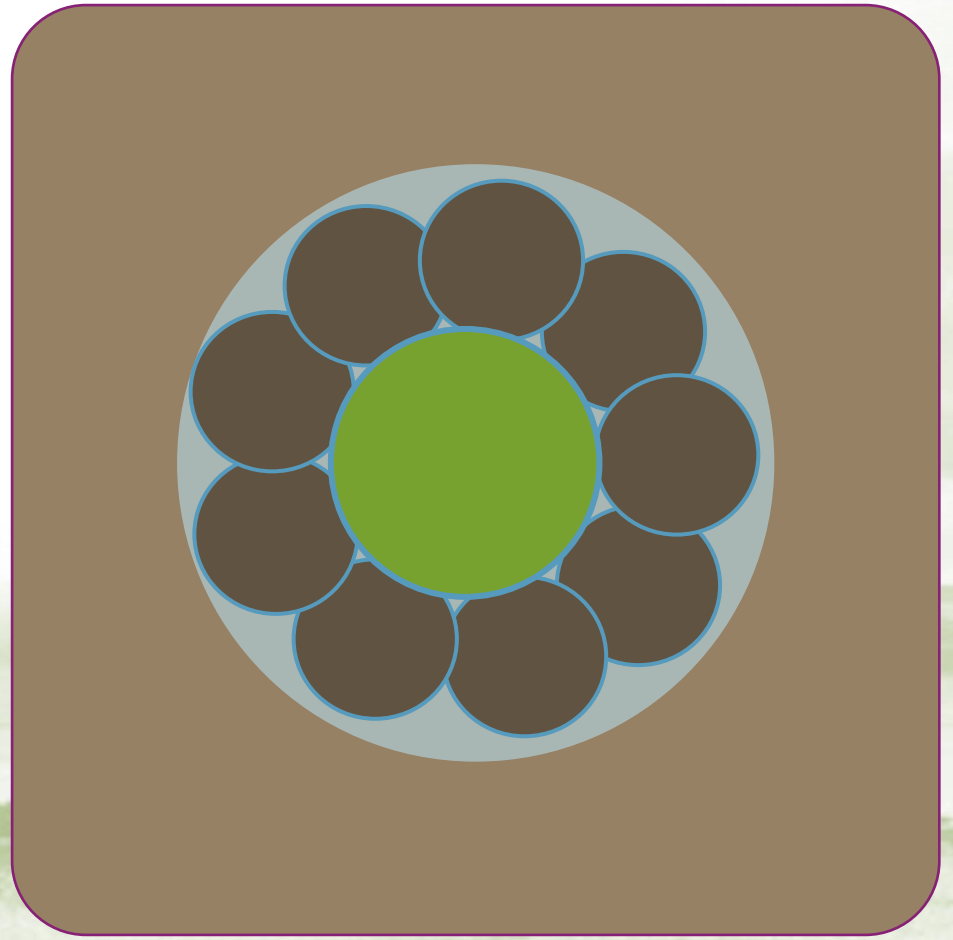
Myxospermy: Future Work

- 1. Quantify soil particle mass adhered to seed + mucilage matrix



Myxospermy: Future Work

- 1. Quantify soil particle mass adhered to seed + mucilage matrix
  - Identify the “zone of influence”



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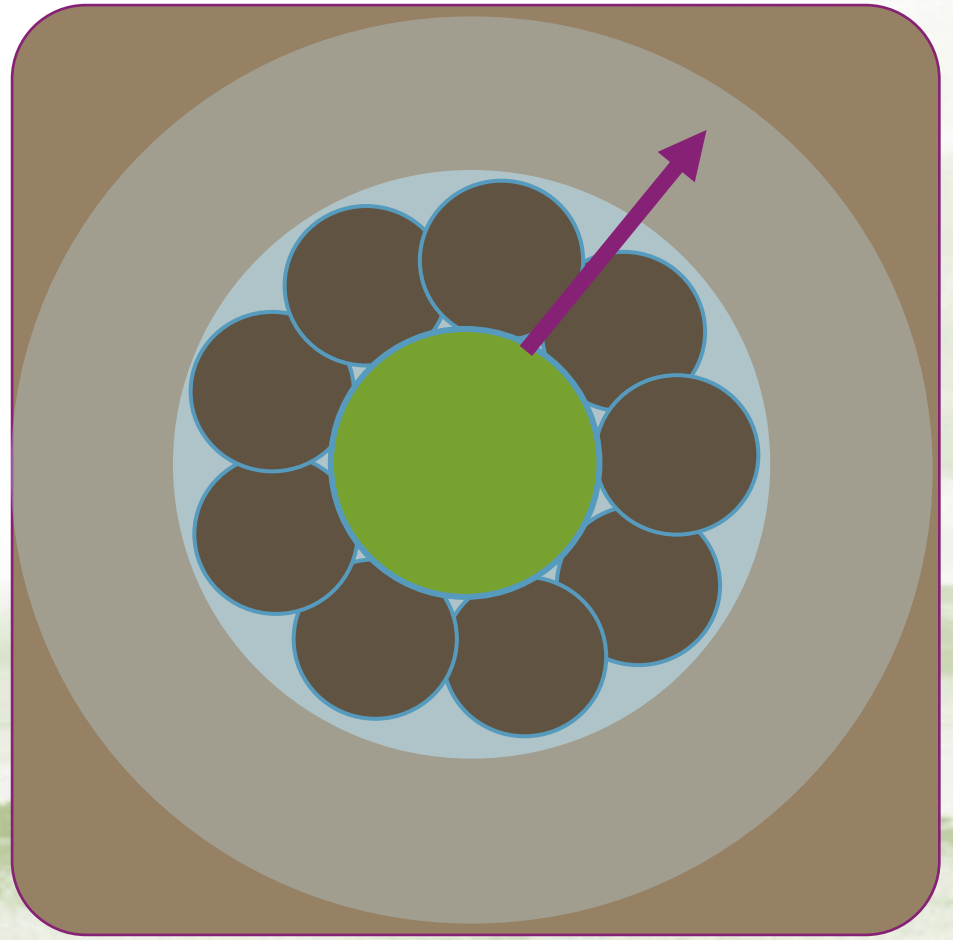

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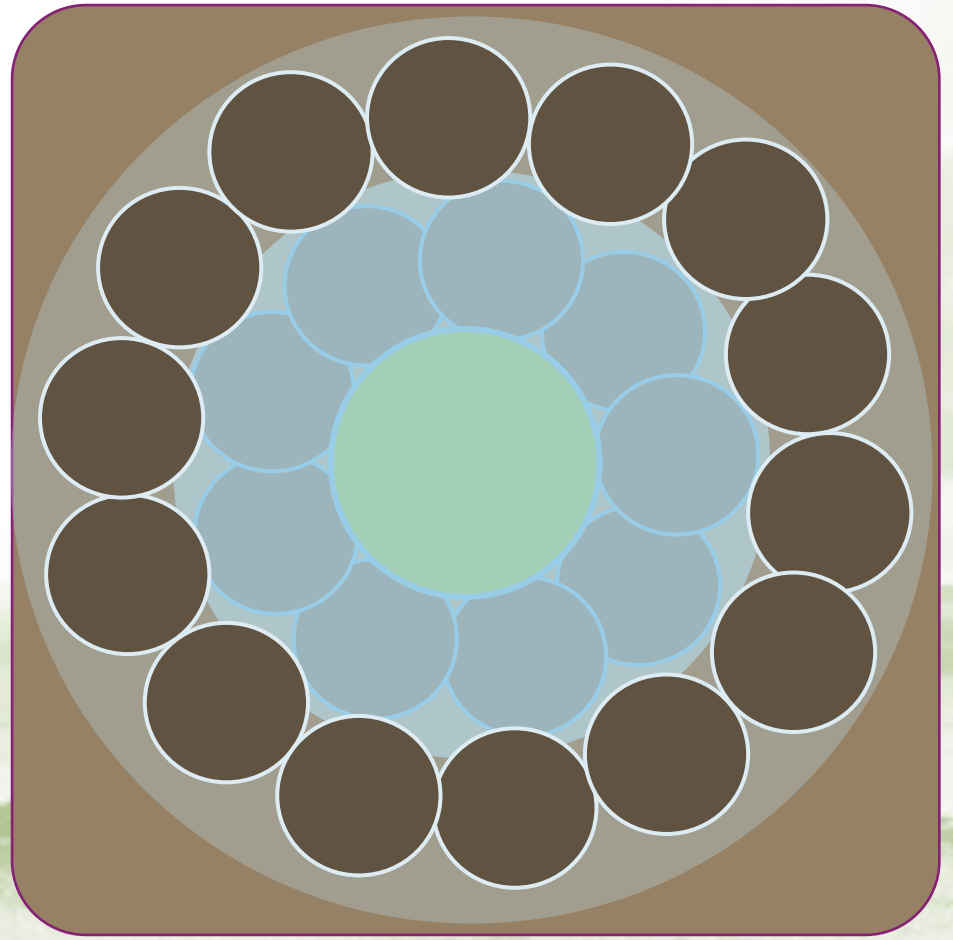
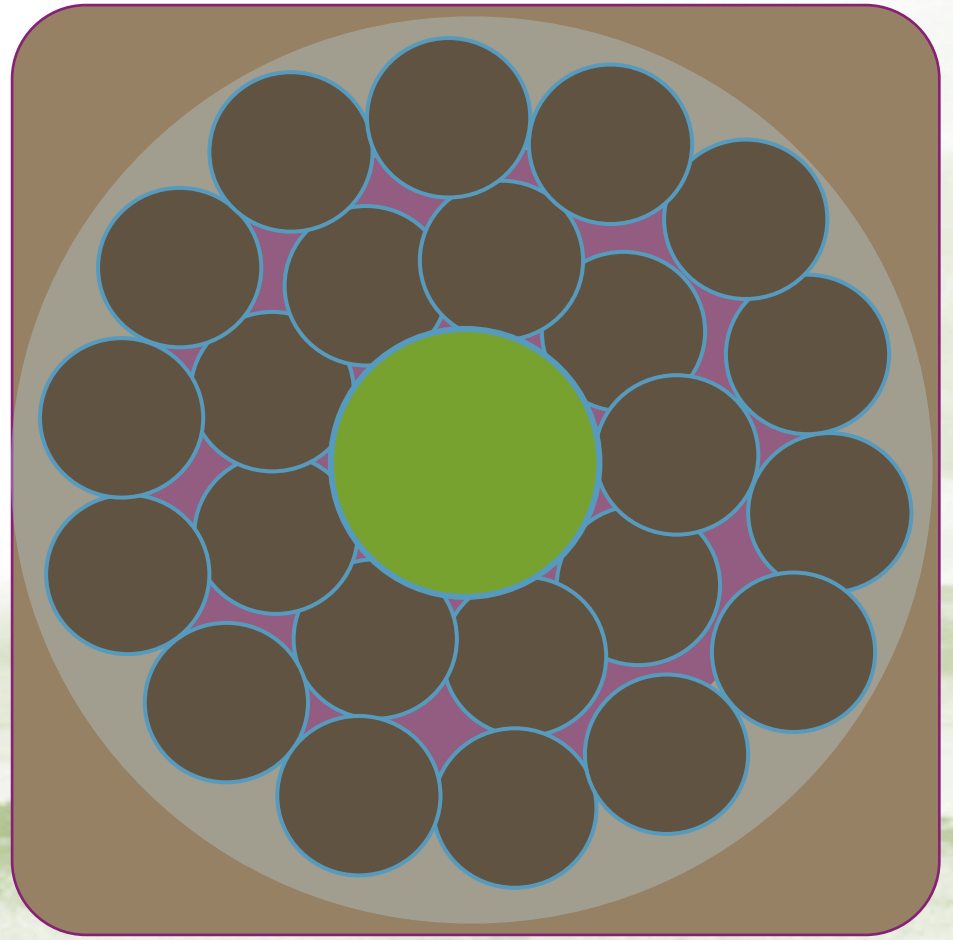


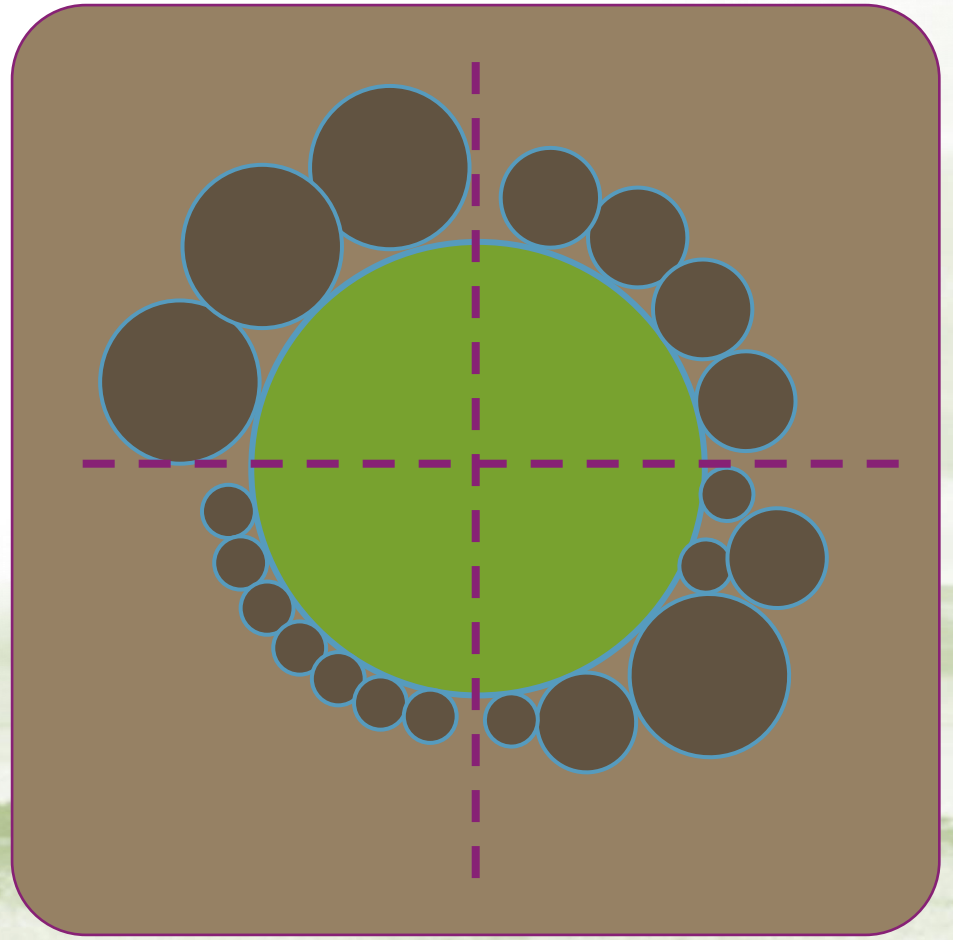
Myxospermy: Future Work

- 1. Quantify soil particle mass adhered to seed + mucilage matrix
  - Identify the “zone of influence”
  - Mucilage interaction within pore spaces



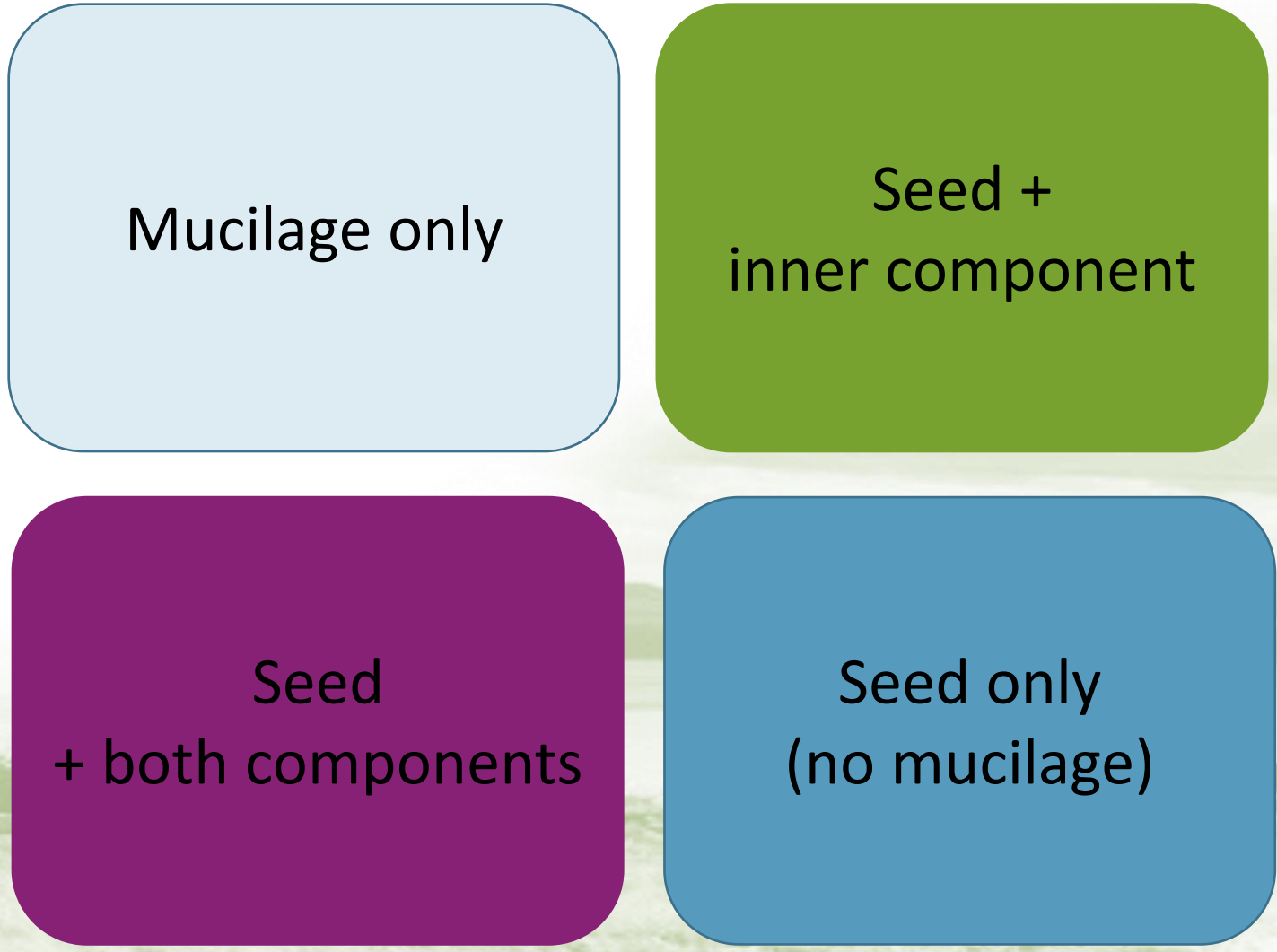
Myxospermy: Future Work

- 1. Quantify soil particle mass adhered to seed + mucilage matrix
  - Identify the “zone of influence”
  - Mucilage interaction within pore spaces
  - Different particle sizes



Myxospermy: Future Work

2. Testing influence of mucilage on soil properties
    - Soil strength
    - Aggregate stability
    - Water retention
- Alter concentrations of mucilage applied to soil
- Involve assemblage mix rather than single species



Myxospermy: Future Work

3. Adhesive power
   - Rainfall simulator
   - Varying slopes
   - Soil textures
   - Assemblage mixes including both myxospermous and non-myxospermous species

How can we relate these seed-soil interactions to what we see in the field?

Conclusions

- Weeds are key indicators of management in arable systems
- Tillage and crop type influences seedbank distribution and composition
- Mucilage – retain soil structure in erosive environments?

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Questions?

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