

# Impact of Seed Technology on Seed Germination



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# Flower Seeds

## BIOLOGY AND TECHNOLOGY



Edited by M.B. McDonald and F.Y. Kwong



CABI Publishing

# Seed Testing

Seed lots are routinely tested for:

1. Purity
2. Standard germination
3. Vigor
4. Seed health
5. Noxious weed seed



# Seed Testing

Seed lots are routinely tested for:

1. Purity
2. Standard germination
3. Vigor
4. Seed health
5. Noxious weed seed



# Seed Testing

## Standard Germination

International rules for testing seeds are published by the International Seed Testing Association.



# Seed Testing

## Standard Germination

Standard germination is measured as the percentage of normal seedlings produced under optimal conditions.



Rolled towel



Petri dish



Blotter

# Seed Testing

## Standard Germination



# Seed Vigor

Seed vigor is the potential for rapid and uniform emergence of usable seedlings under a variety of environmental conditions.



# Seed Vigor

Implications of seed vigor on crop production :

Seed tests can indicate  
> 90% germination.

Seedling emergence can  
be significantly lower.



# Seed Vigor

Therefore, even seed lots with high standard germination can have different levels of seed vigor.



High vigor



Low vigor

# Seed Vigor

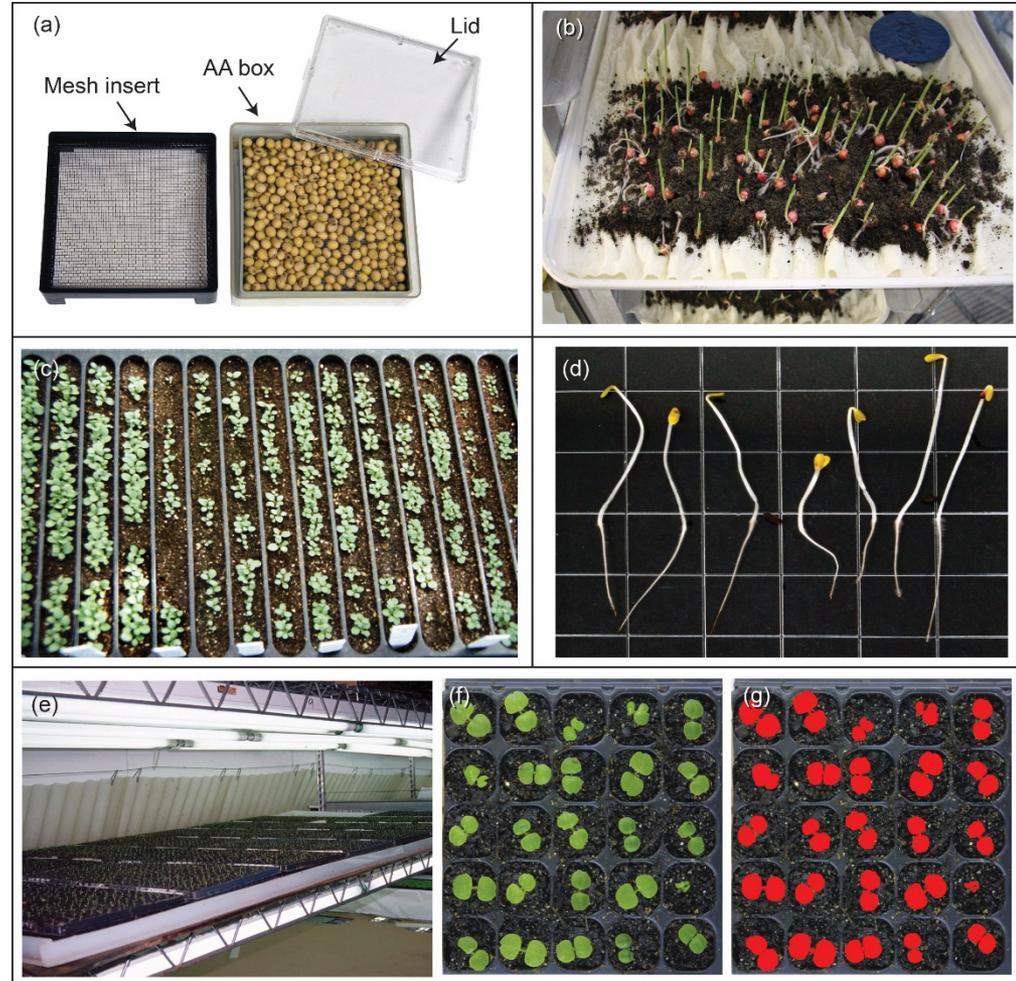
Therefore, even seed lots with high standard germination can have different levels of seed vigor.



# Types of vigor tests

## Vigor Tests

- Greenhouse grow out
- Controlled deterioration
- Accelerated aging
- Cold test
- Electrolyte leakage
- Seedling growth rate



# Types of vigor tests

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## Greenhouse grow out test

Seedlings are grown under commercial conditions.

Expensive for a routine test.

Difficult to standardize growing conditions.



# Types of vigor tests

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## Artificial aging tests

Controlled deterioration

Accelerated aging (AA)



# Types of vigor tests

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## Accelerated aging

Seeds are placed on nylon mesh screens.

Suspended over water in plastic boxes.



# Types of vigor tests

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## Accelerated aging

Seeds are placed on nylon mesh screens.

Suspended over water in plastic boxes.

Seed moisture content >40%.

Temperature is held between 40 and 45°C.

Duration 72 hours or more.

Designed for large -seeded crops.



# Types of vigor tests

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## Accelerated aging

An accelerated aging chamber has an outer jacket to keep temperature from fluctuating.



# Types of vigor tests

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## Saturated salts accelerated aging

Seeds are placed on nylon mesh screens.

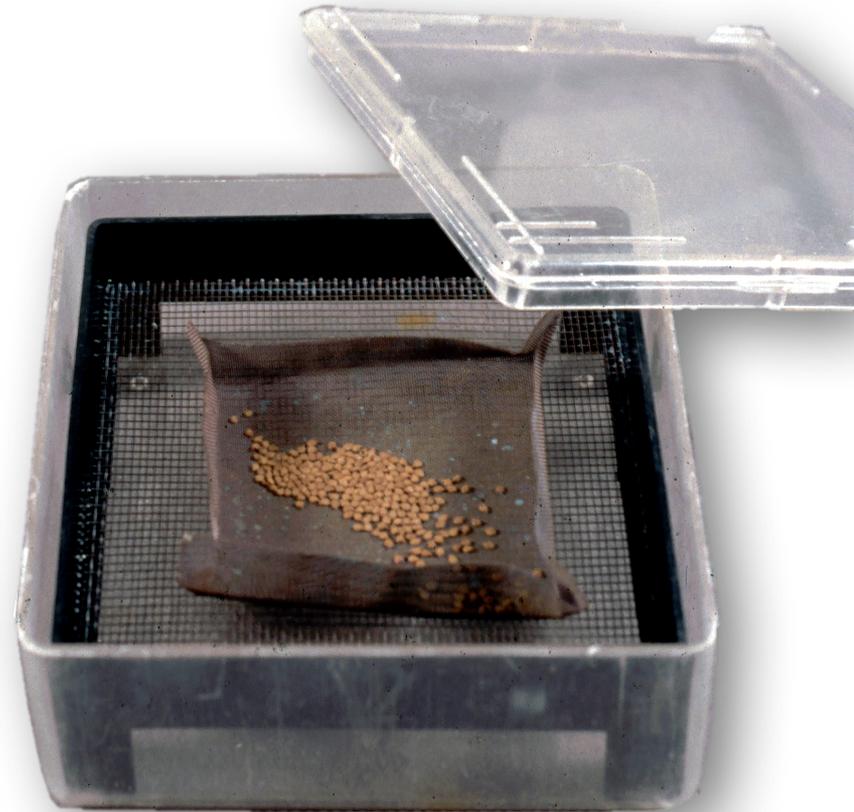
Suspended over KCl or NaCl in plastic boxes.

Seed moisture reduced compared to water.

Temperature is held between 35 and 41°C.

Duration between 24 and 72 hours.

Better than standard accelerated aging for small-seeded crops.



# Types of vigor tests

## Cold test

Seeds placed on soil over moist Kimpack.

Chilling temperature for several days (10°C for 7 days).

Seedling emergence at warm (25°C) temperature.



# Types of vigor tests

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## Cold test

Preferred vigor test for corn.

High vigor



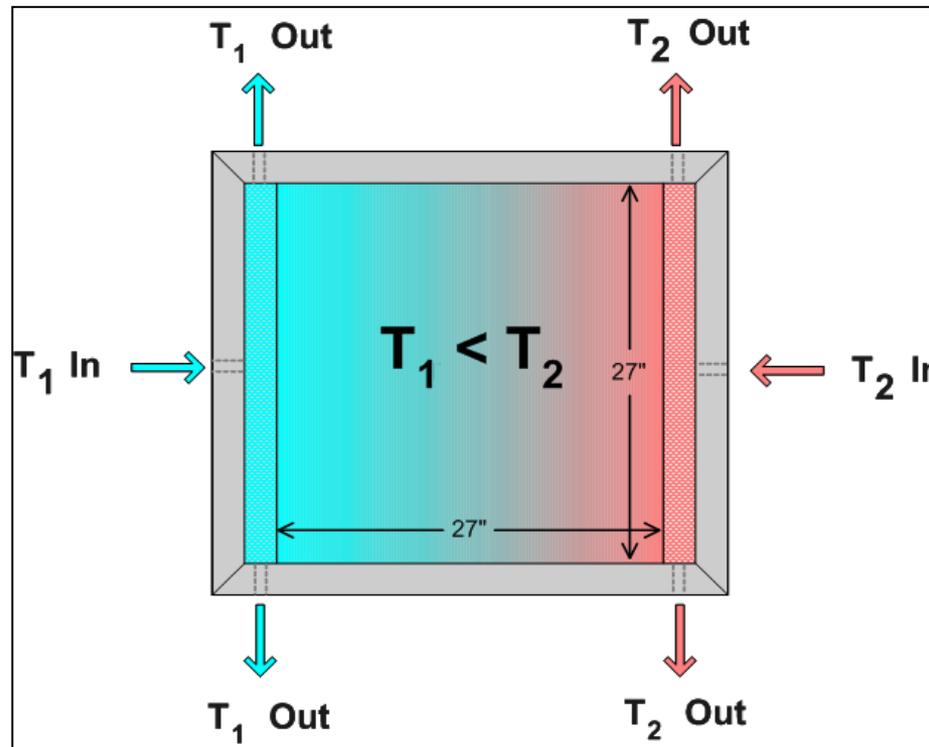
Low vigor



# Types of vigor tests

## Germination across a thermal gradient

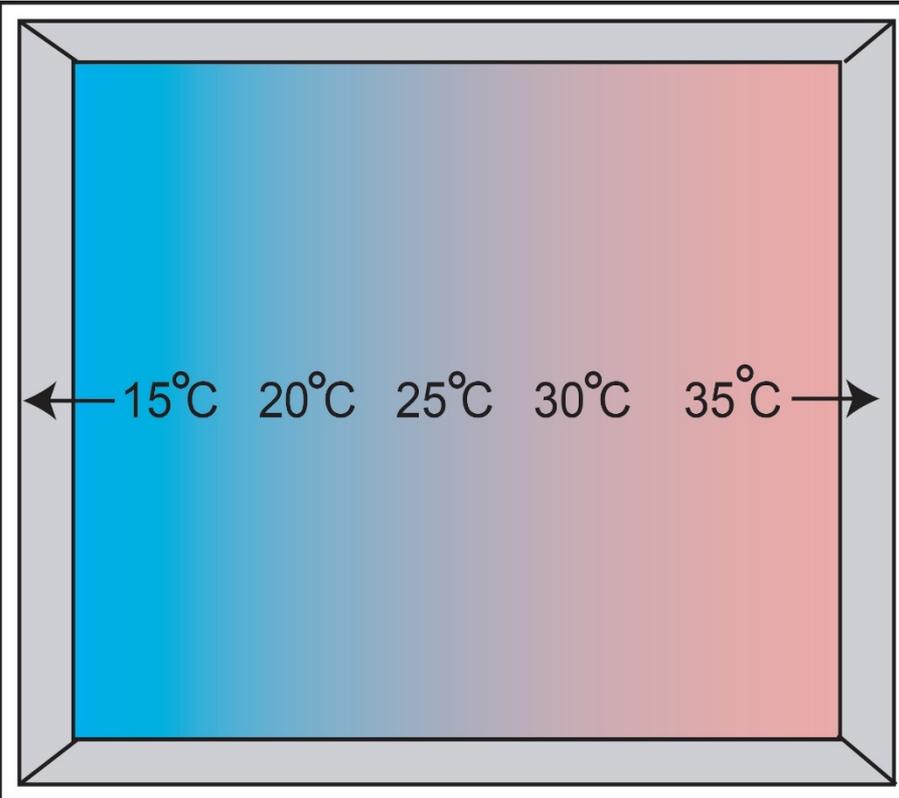
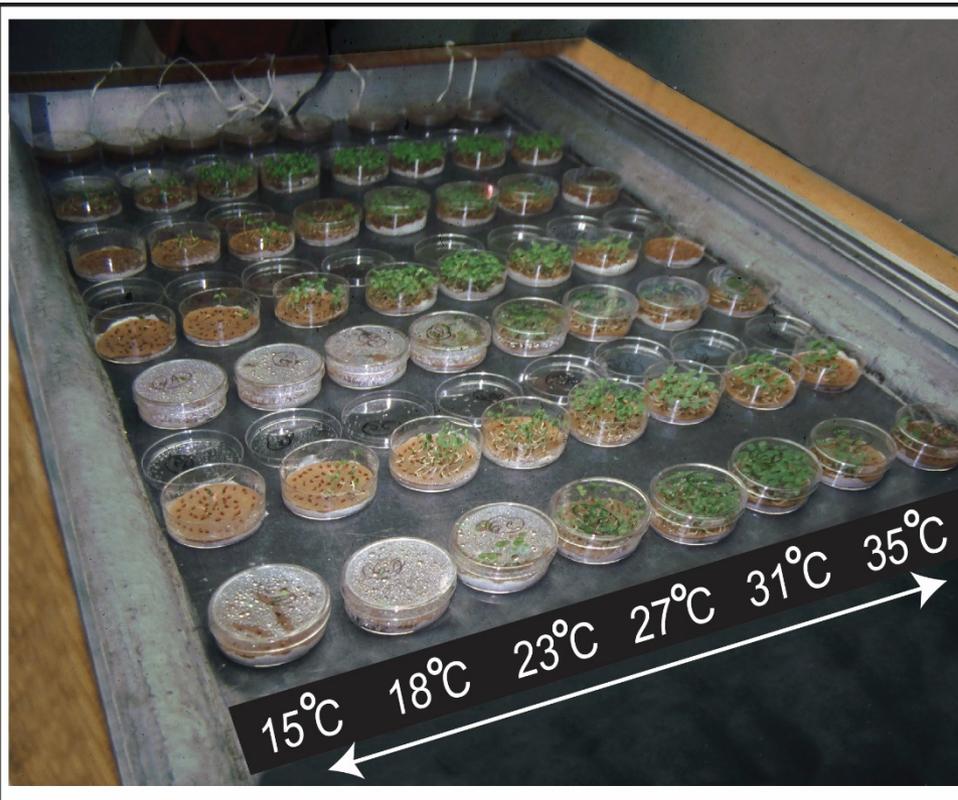
Allows for the simultaneous testing of seeds over a range of temperature extremes.



# Types of vigor tests

## Germination across a thermal gradient

Higher vigor seeds germinate at higher percentages at the temperature extremes.



# Types of vigor tests

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## Seedling growth

Seedling growth determined by length, area, or weight.

Seedling growth over time (rate).

Estimated by measuring seedling size after a set period of time.



# Types of vigor tests

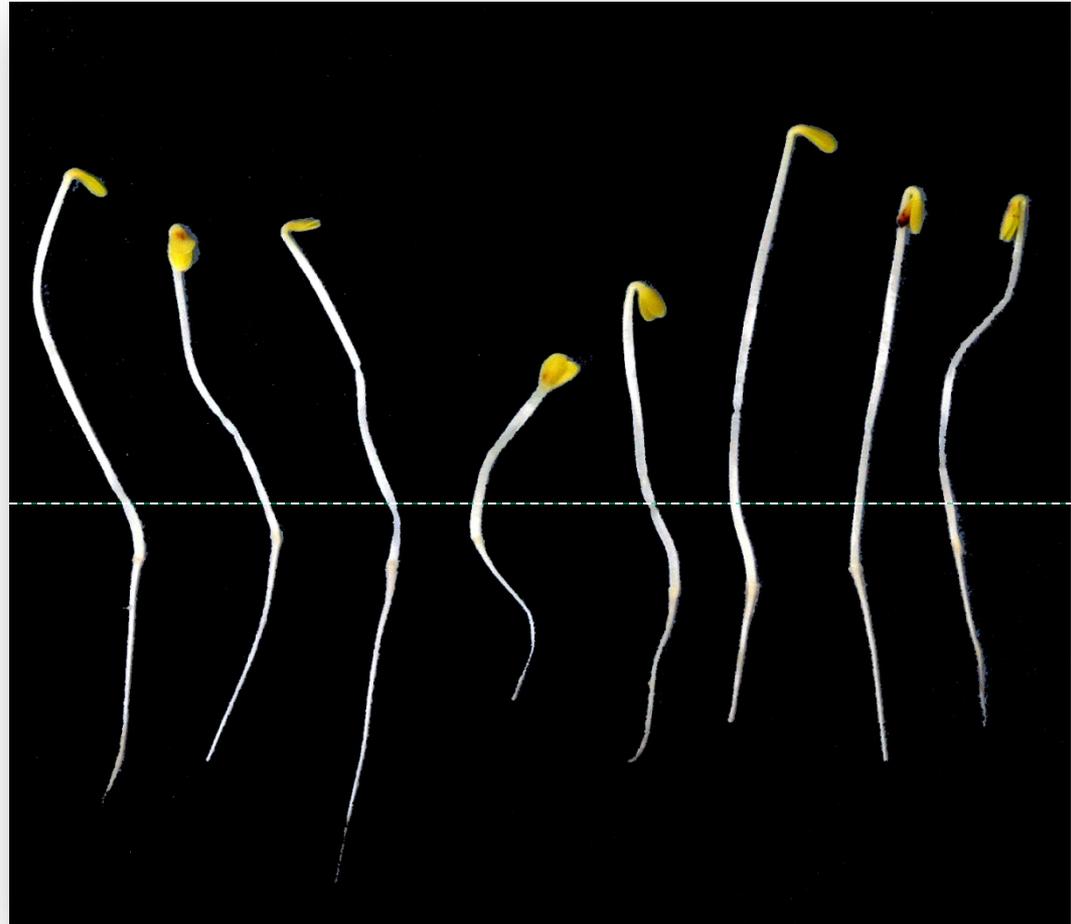
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## Slant board test

Used to measure radicle length by hand.

Time consuming for the analyst.

Used commercially for flower seeds.



# Types of vigor tests

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## Computer-aided machine vision

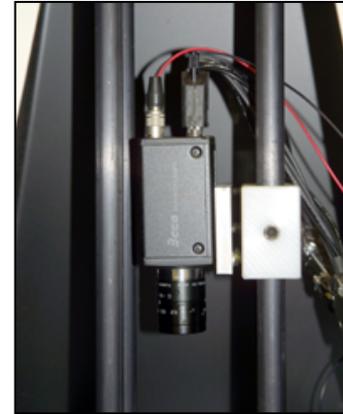
Consistent imaging conditions.

Resolution of small seeds.

Consistent environment.

Low cost.

Unbiased and repeatable results.



CCD camera



Flat bed scanner

# Types of vigor tests

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## Ball vigor index

Uses a digital camera to capture images of seedlings.

It uses cotyledon area.

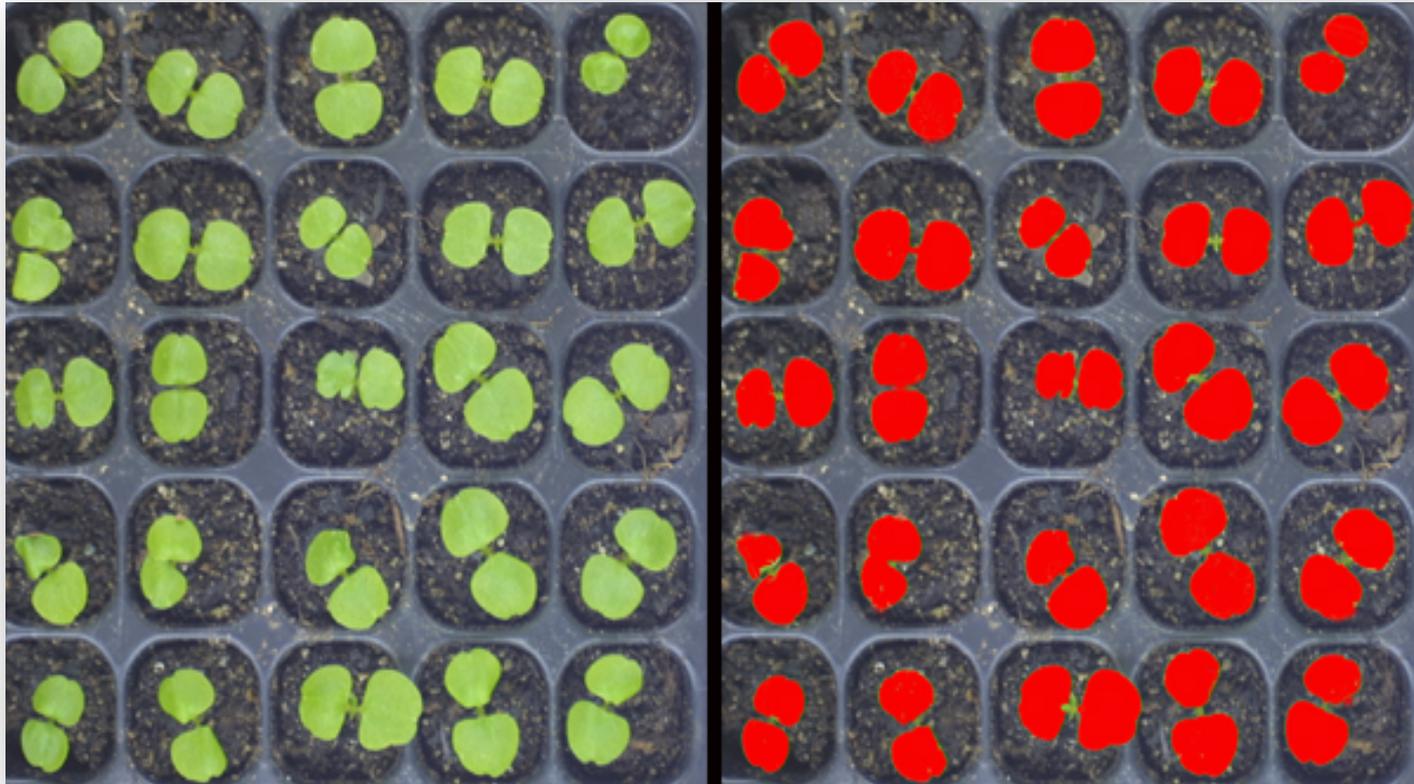


# Types of vigor tests

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## Ball vigor index

Total leaf area of seedlings in a plug flat divided by its standard deviation multiplied by the germination percentage.



# Types of vigor tests

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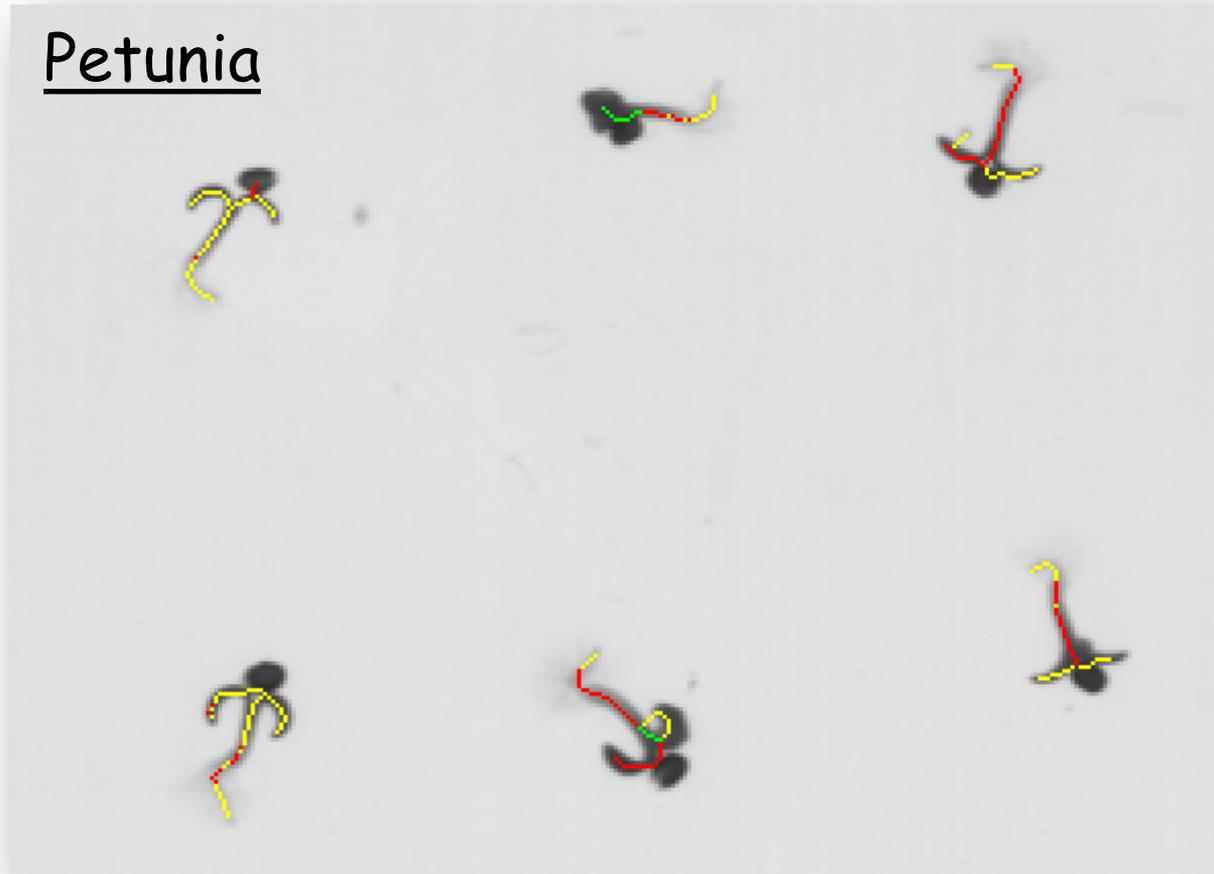
## Flat bed scanner imaging



# Types of vigor tests

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## Seedling length



# Types of vigor tests

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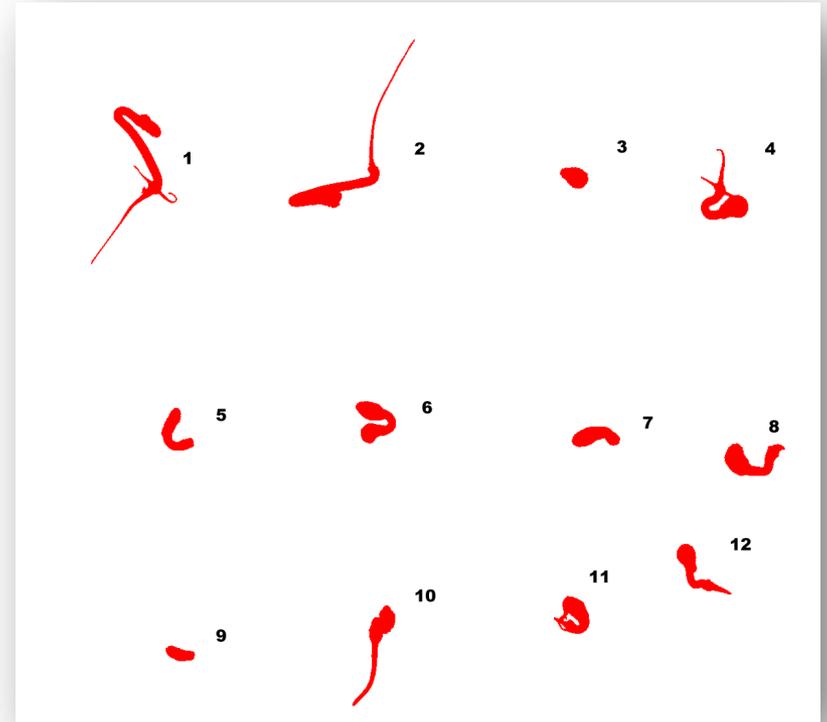
## Seedling length



# Types of vigor tests

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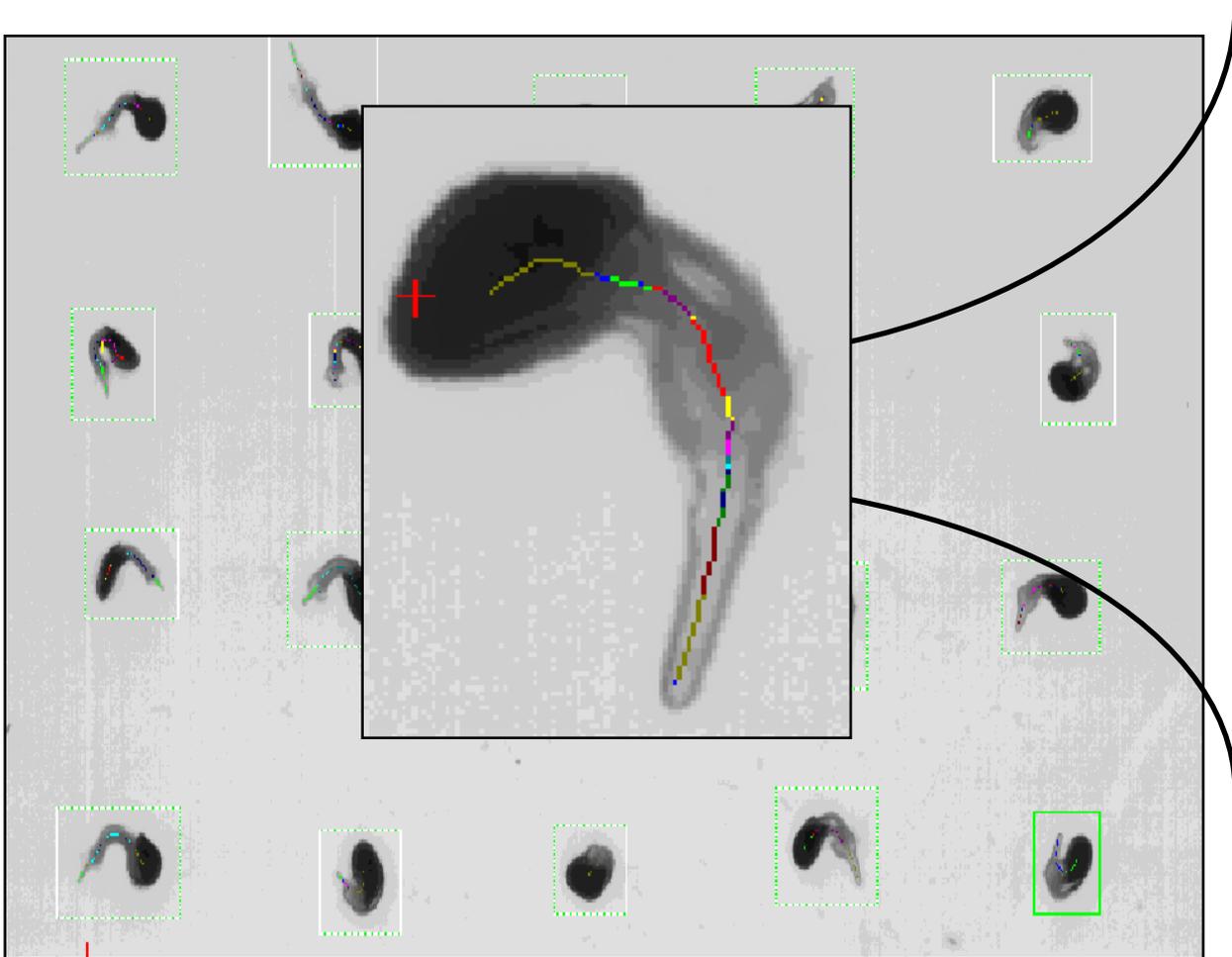
## Seedling area



## Impatiens

# Vigor tests - Seed imaging

## Impatiens



# Vigor tests - Seed imaging

Standard germination and seed vigour determined by several methods for *impatiens* seeds varying in initial seed quality.

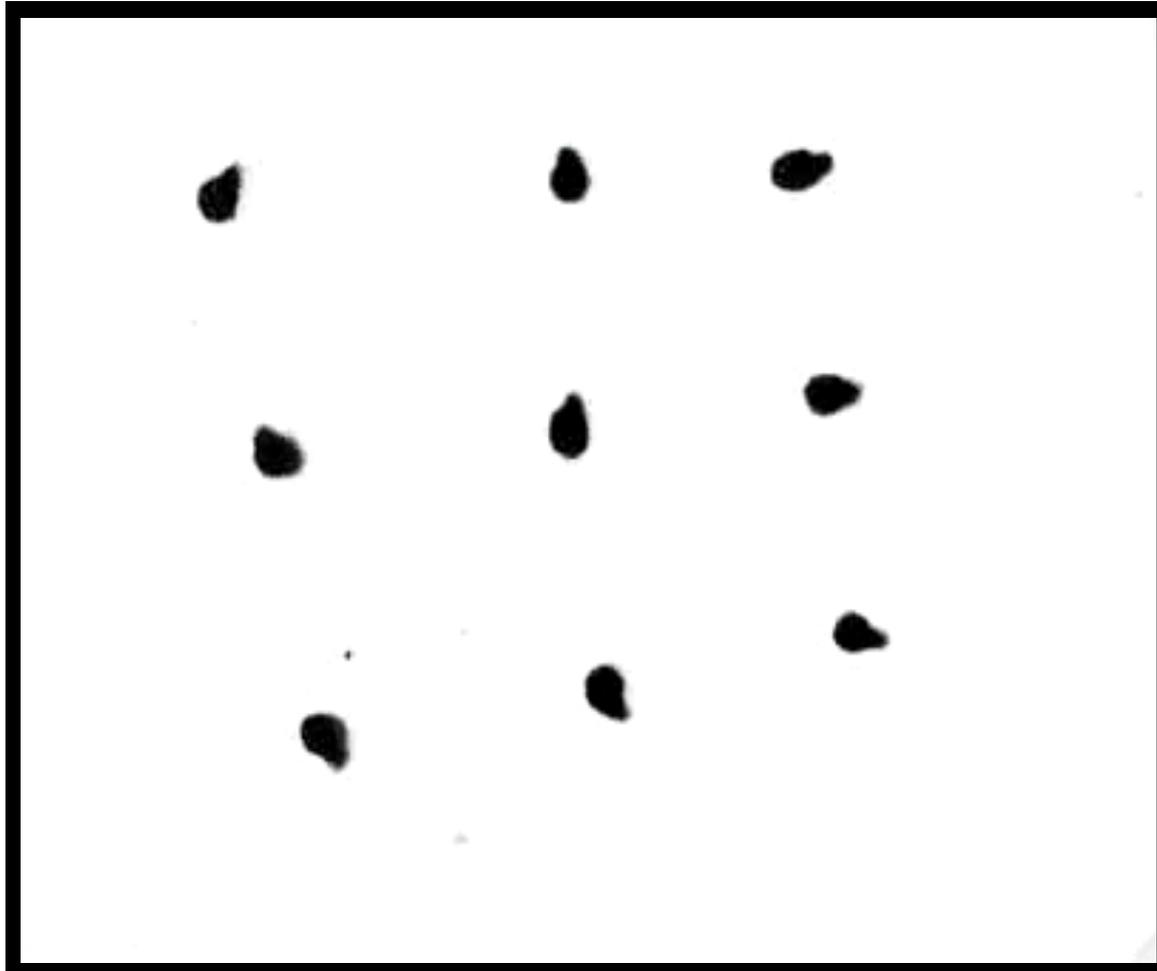
Seed lot	Standard Germination (%)	Ball Vigor Index	Saturated Salts Accelerated aging (%)	Seedling size after 7 days	
				Length (cm)	Area (mm <sup>2</sup> )
1	96 a	651	81 a <sup>z</sup>	1.05 b	0.74 b
2	97 a	642	84 a	1.44 a	1.04 a
3	97 a	561	69 bc	1.15 b	0.94 a
4	96 a	505	75 b	0.70 c	0.71 b
5	98 a	485	54 c	0.70 c	0.59 c
6	96 a	440	48 c	0.61 c	0.48 c

<sup>z</sup>Means with the same letter within a column were not different by Tukey's test (5%).

# Vigor tests - Sequential seed imaging

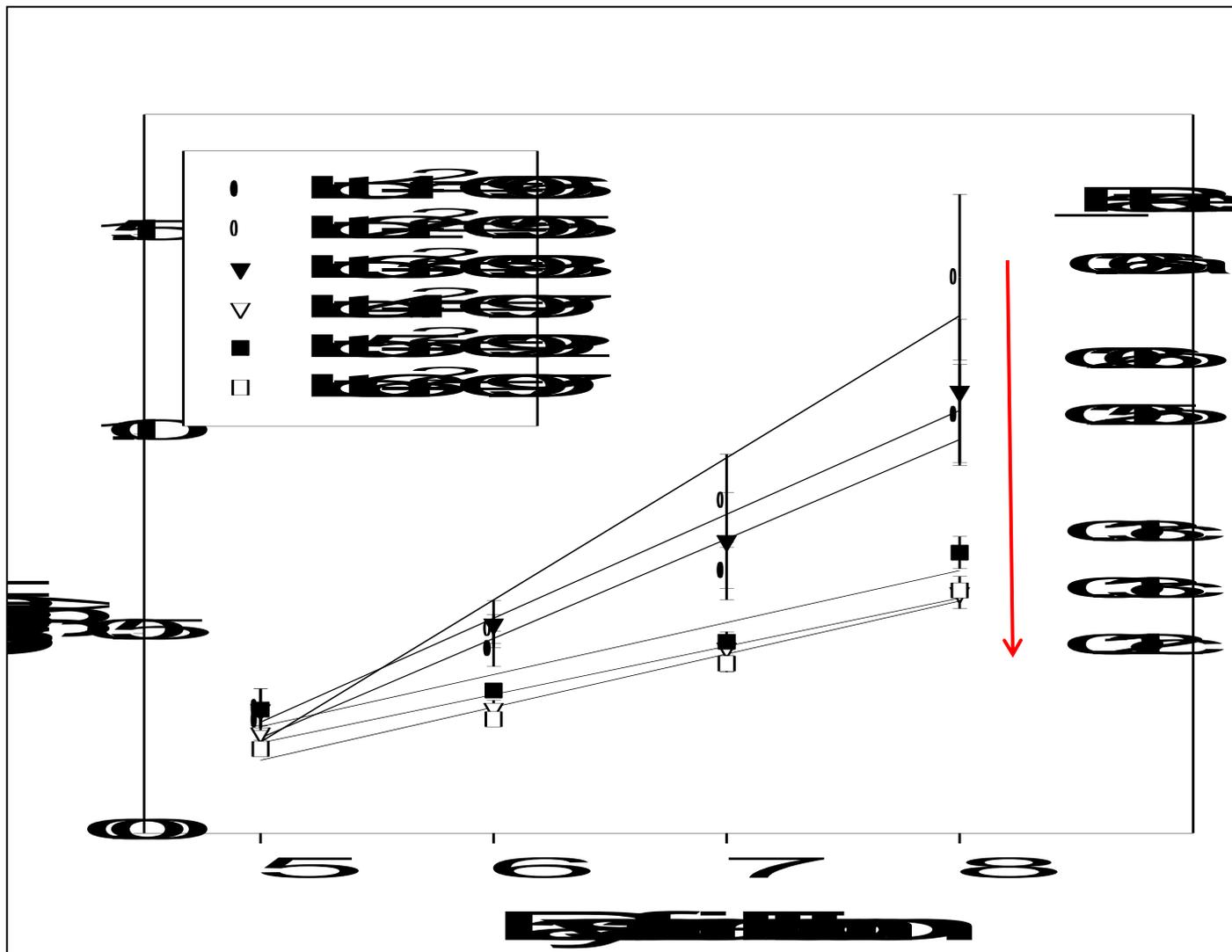
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Impatiens



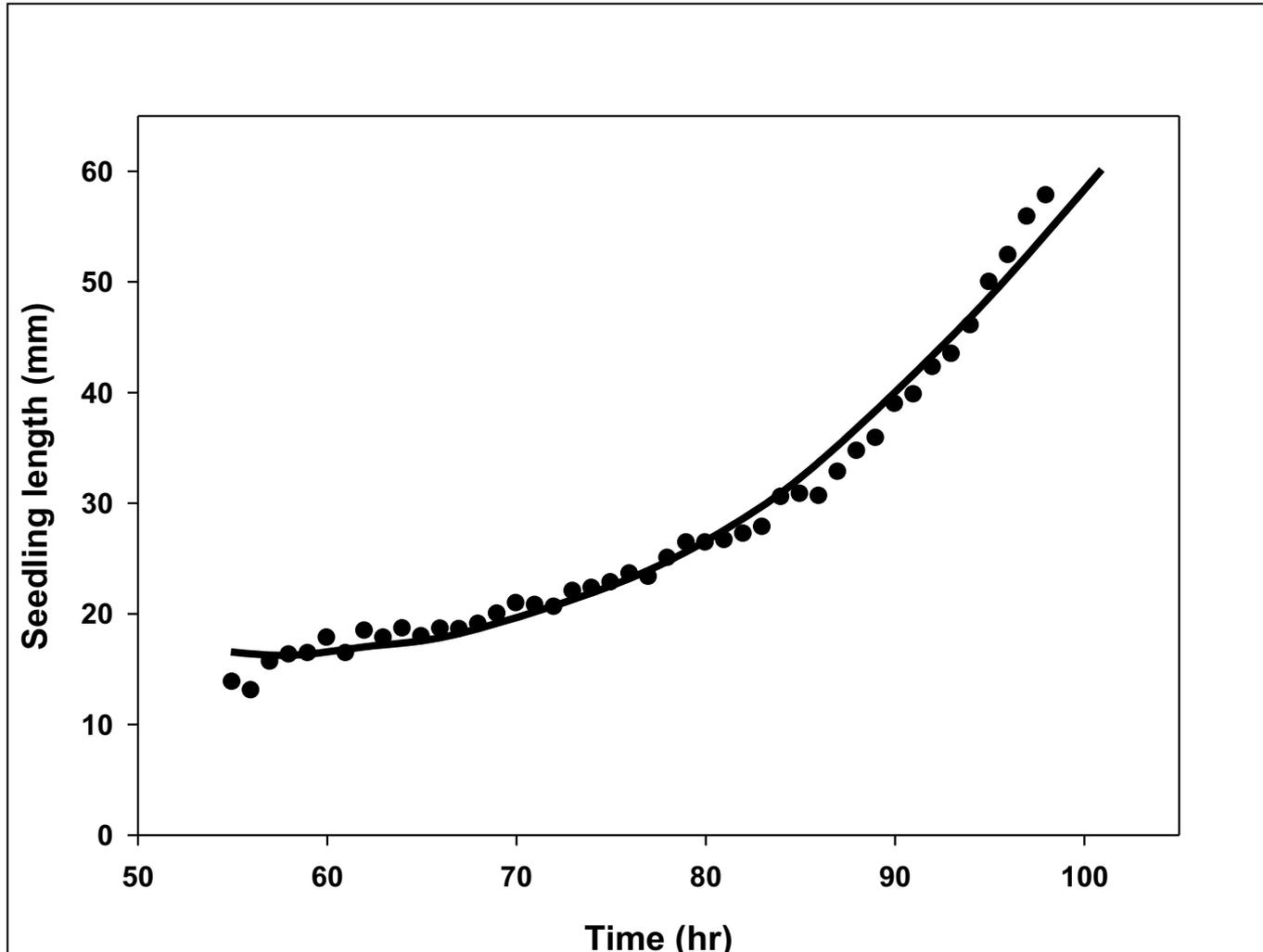
# Vigor tests - Sequential seed imaging

Seedling growth rates for six impatiens seed lots



# Vigor tests - Sequential seed imaging

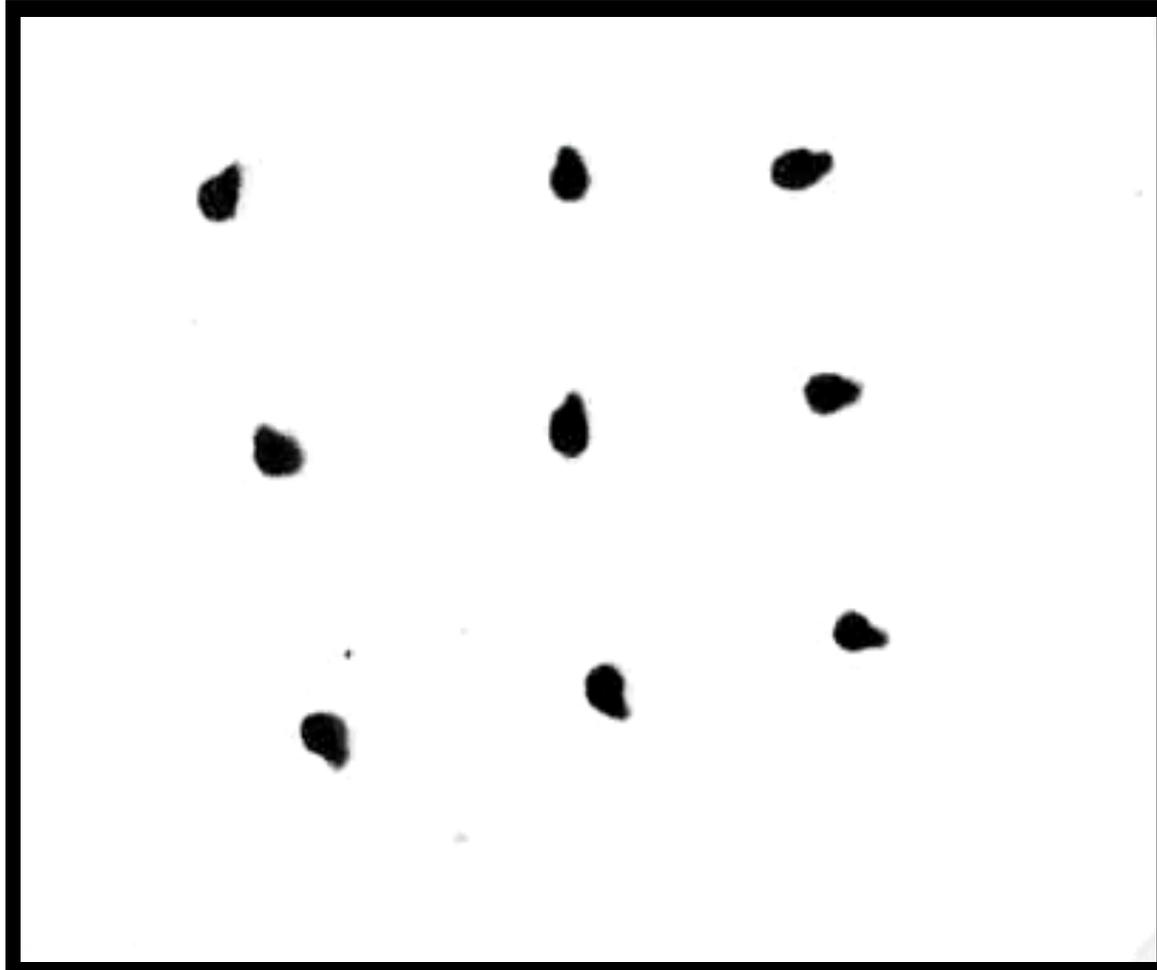
## Impatiens



# Vigor tests - Sequential seed imaging

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Impatiens

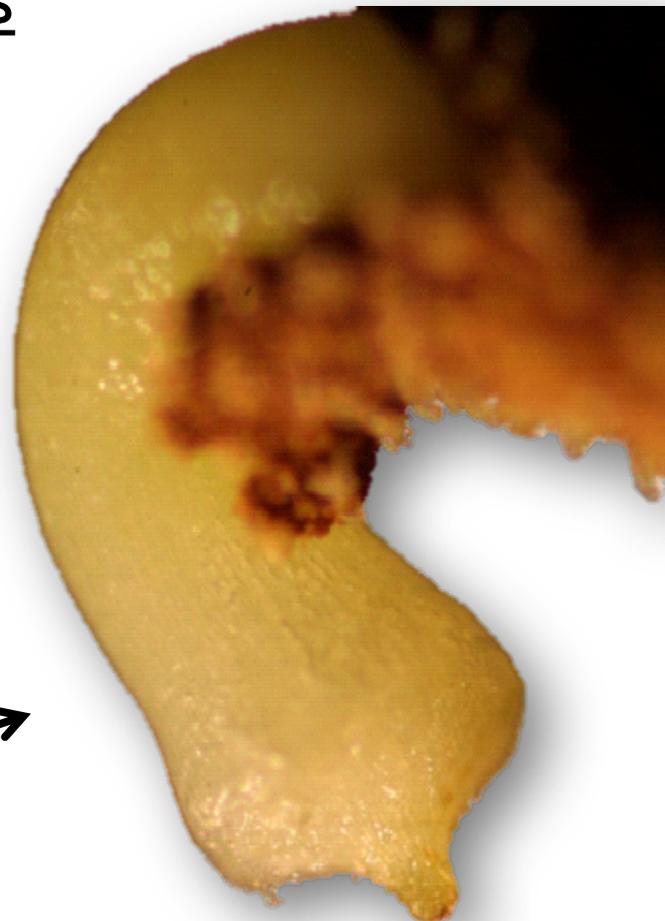
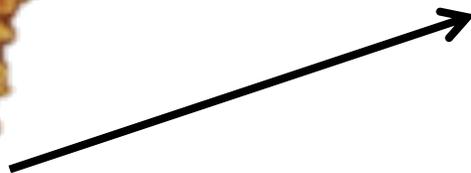


# Vigor tests - Sequential seed imaging

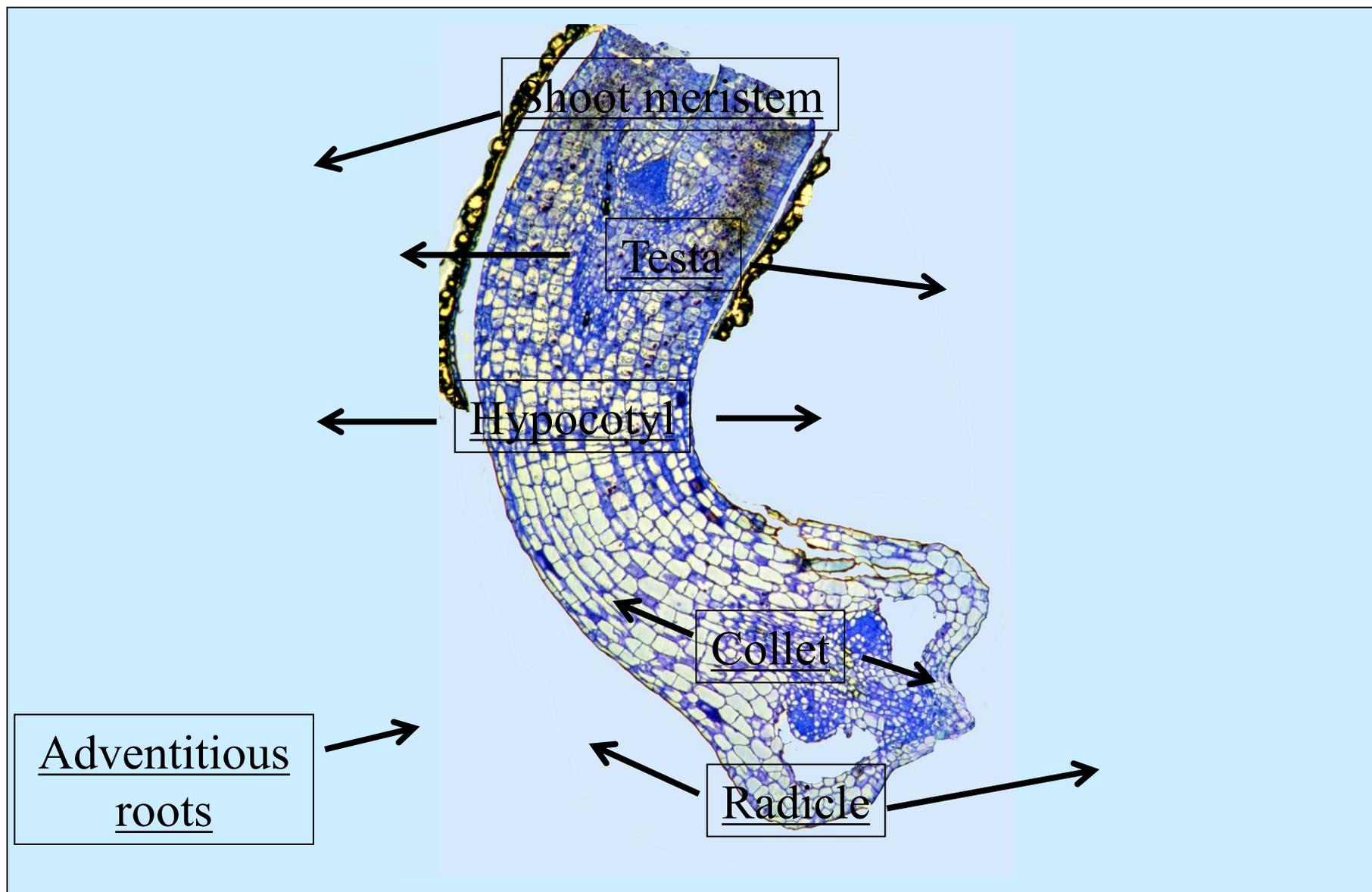
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Impatiens

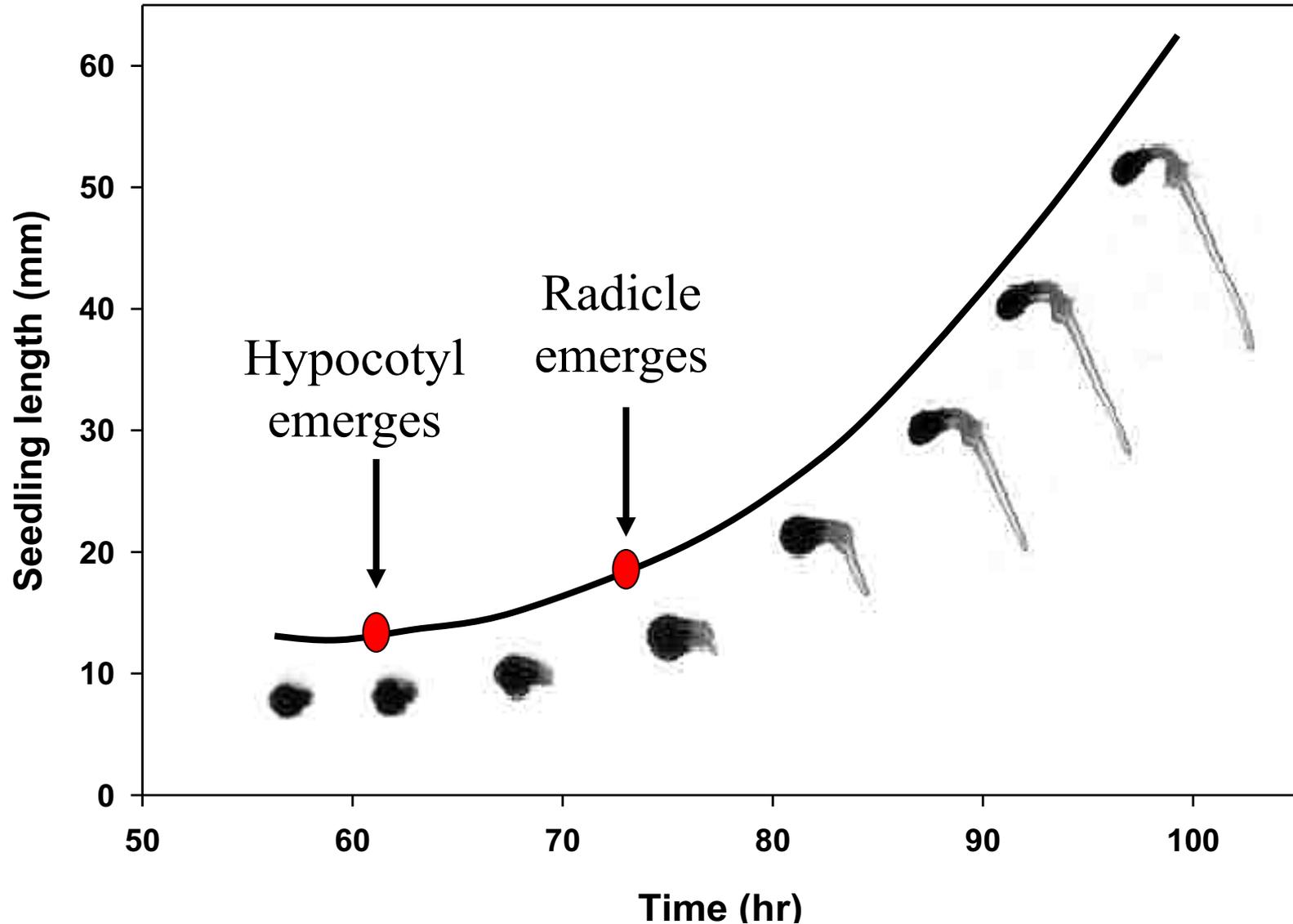
Early seedling growth



# Vigor tests - Sequential seed imaging

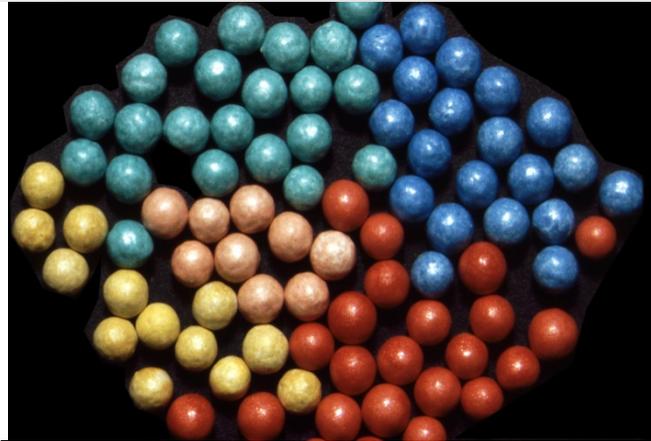


# Vigor tests - Sequential seed imaging



# Seed Treatments

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# Seed Treatments

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## Seed treatment types

Seed protectants

Germination enhancement

Inoculation with  
nitrogen-fixing bacteria

Seed coatings



# Seed Treatments

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## Seed treatment types

Seed protectants

Germination enhancement

Inoculation with  
nitrogen-fixing bacteria

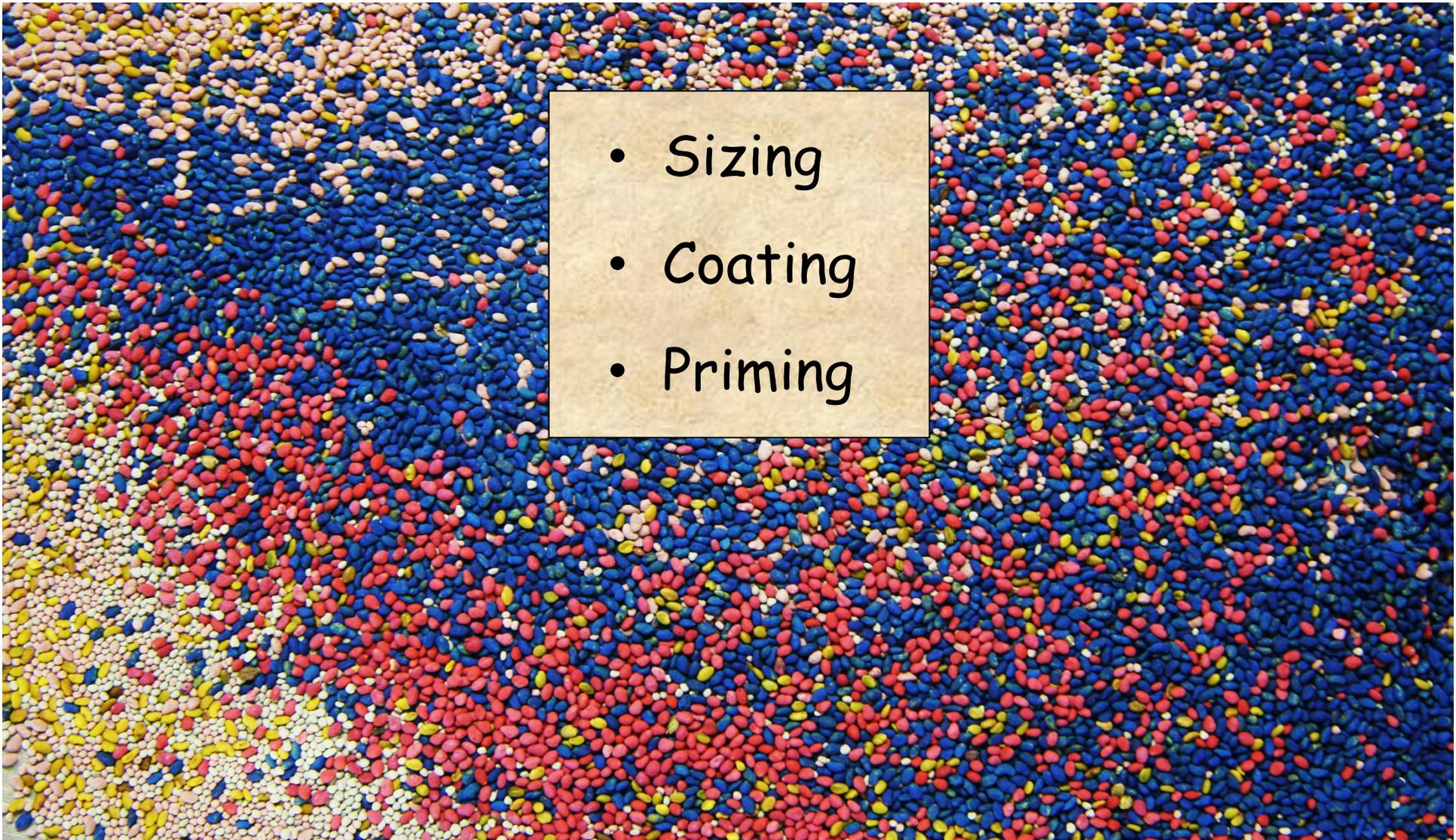
Seed coatings



# Seed Treatments

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## Germination enhancements

- 
- Sizing
  - Coating
  - Priming

# Seed Treatments

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## Seed sizing

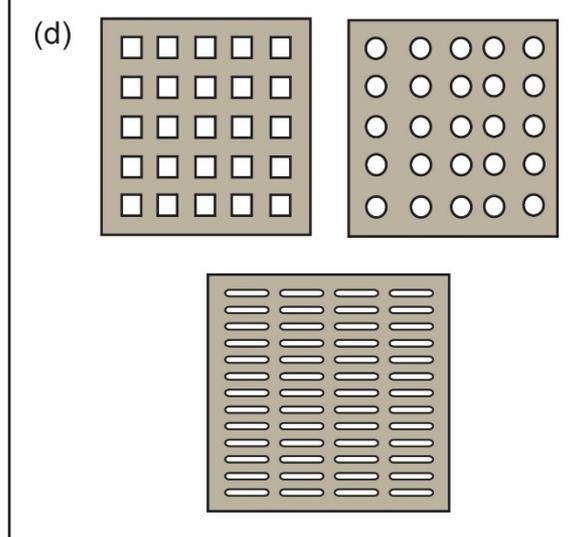
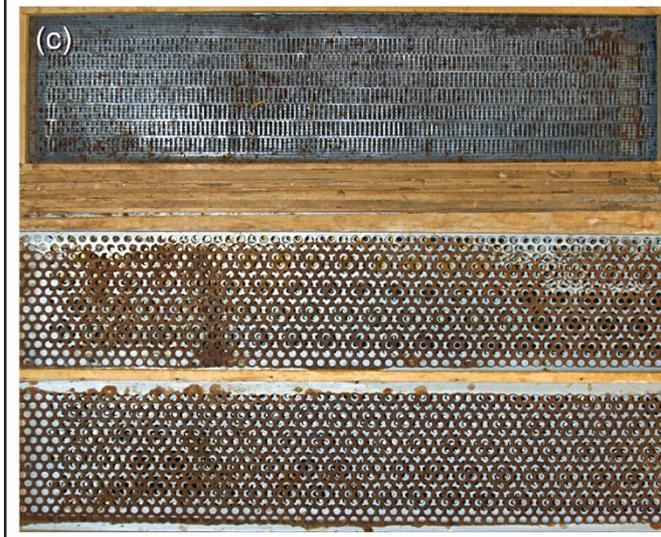
Comparison of select vs. non-select seeds



*Impatiens*

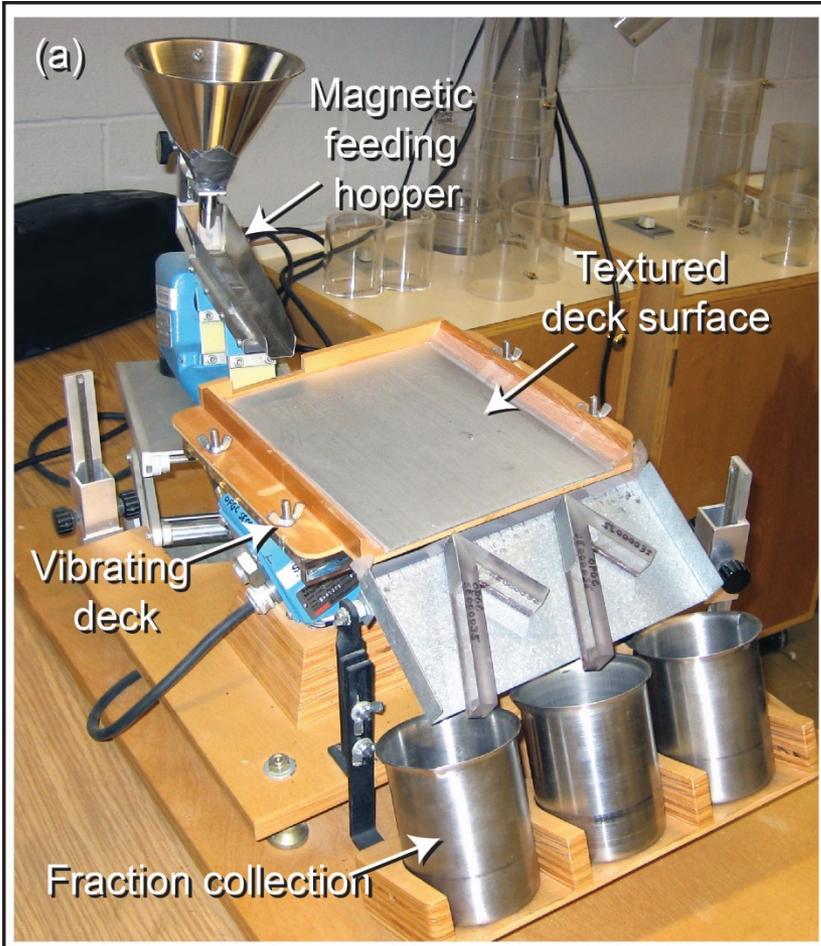
# Seed Treatments

## Seed sizing - screens

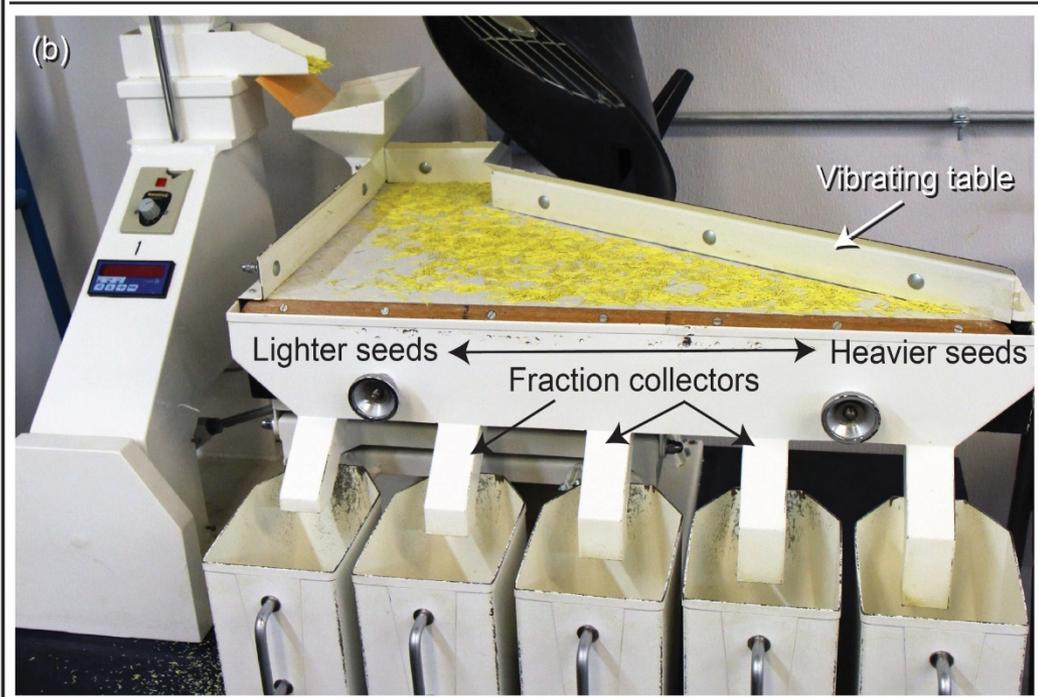


# Seed Treatments

## Seed sizing



Seeds can be separated on a vibrating gravity table.



# Seed Treatments

## Seed sizing

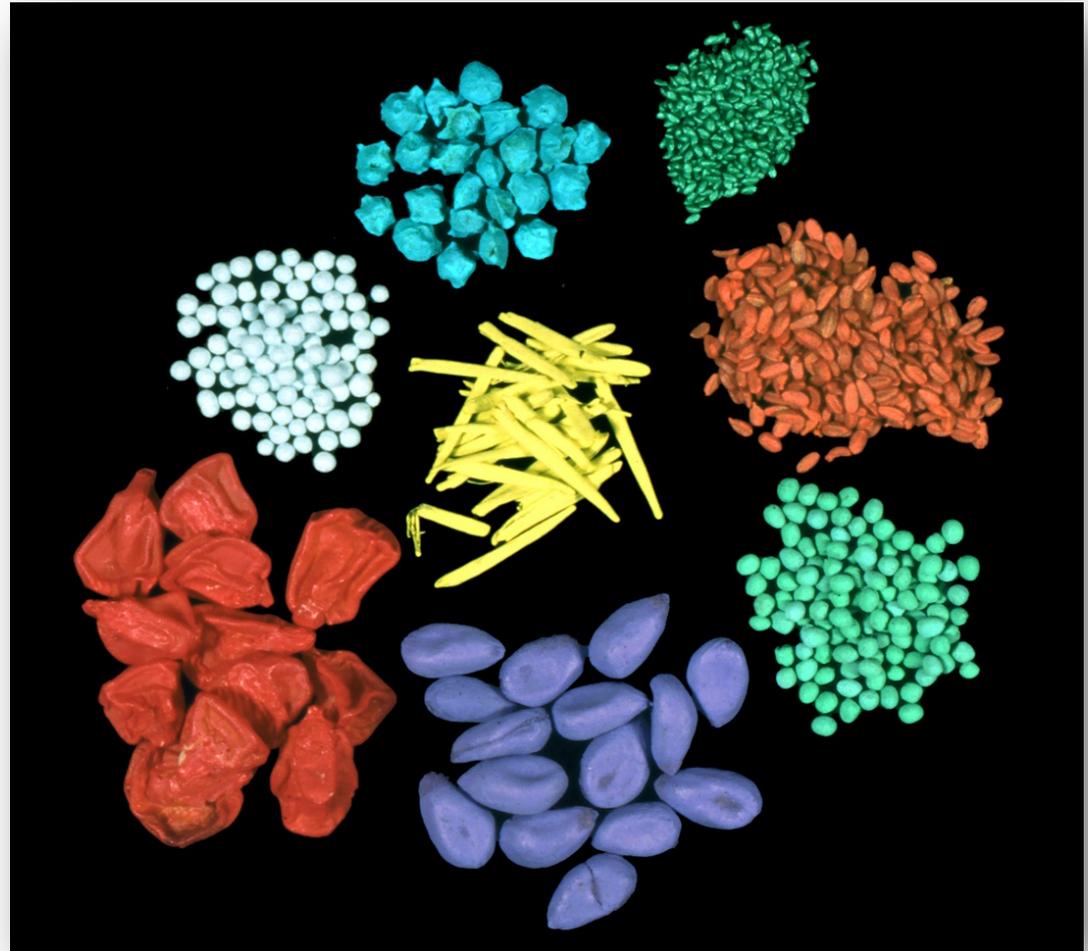


# Seed Treatments

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## Coated Seeds

- Pelleted
- Encrusted
- Film coated

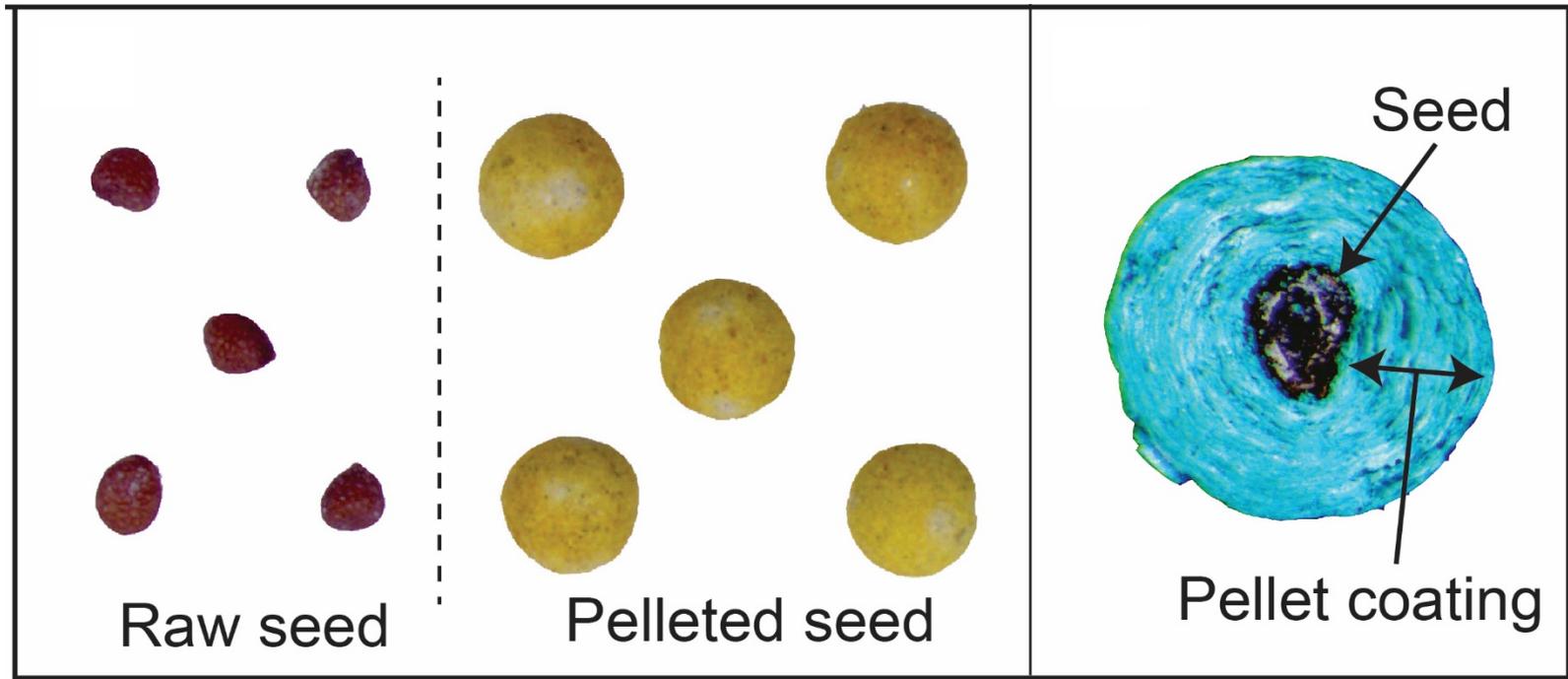


# Seed Treatments

## Pelleted seeds

Increases size

Uniform shape



# Seed Treatments

## Pelleted seeds

Encrusted pellets add  
<10% increase in size



Raw  
seed



Encrusted  
seed

# Seed Treatments

## Pelleted seeds



# Seed Treatments

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## Pelleted seeds

### Binders 5-15%

PVA-Polyvinyl alcohol

PVP-Polyvinylpyrrolidone

Hydroxypropyl-methylcellulose

Maltodextrin

Gum Arabic

### Fillers

Diatomaceous earth

Silica

Perlite

Vermiculite

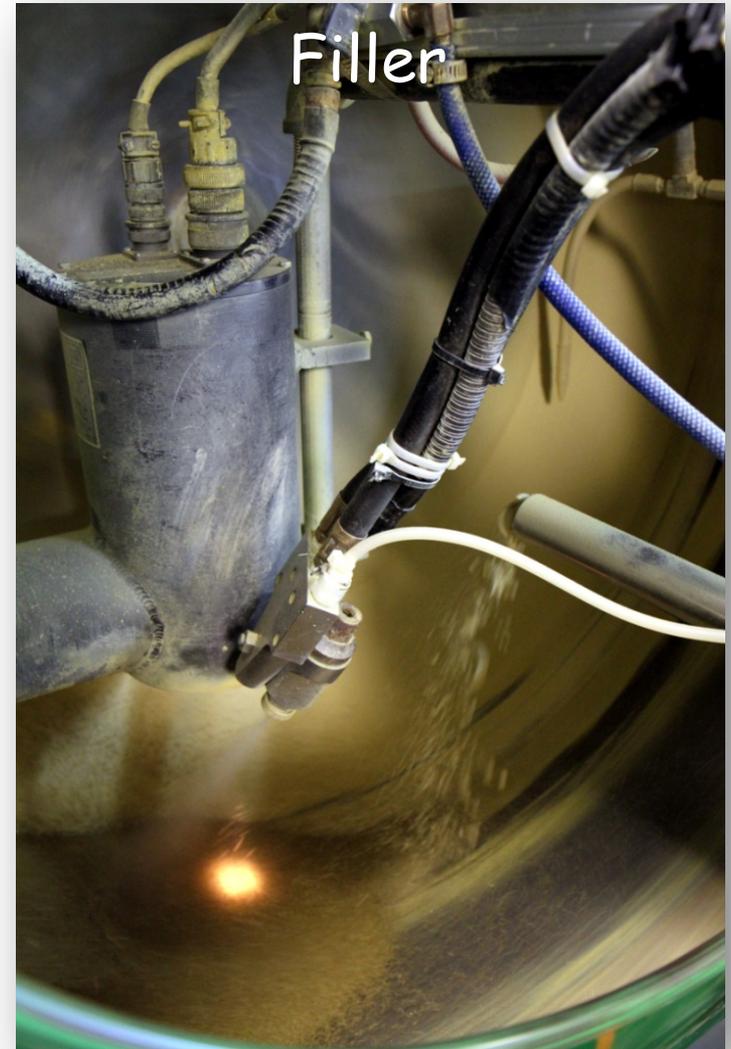
Bentonite clays

Talc

# Seed Treatments

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## Pelleted seeds



# Seed Treatments

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## Pelleted seeds



# Seed Treatments

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## Pelleted seeds



Split coat type

Pellets can either split or melt away to release the seedling.

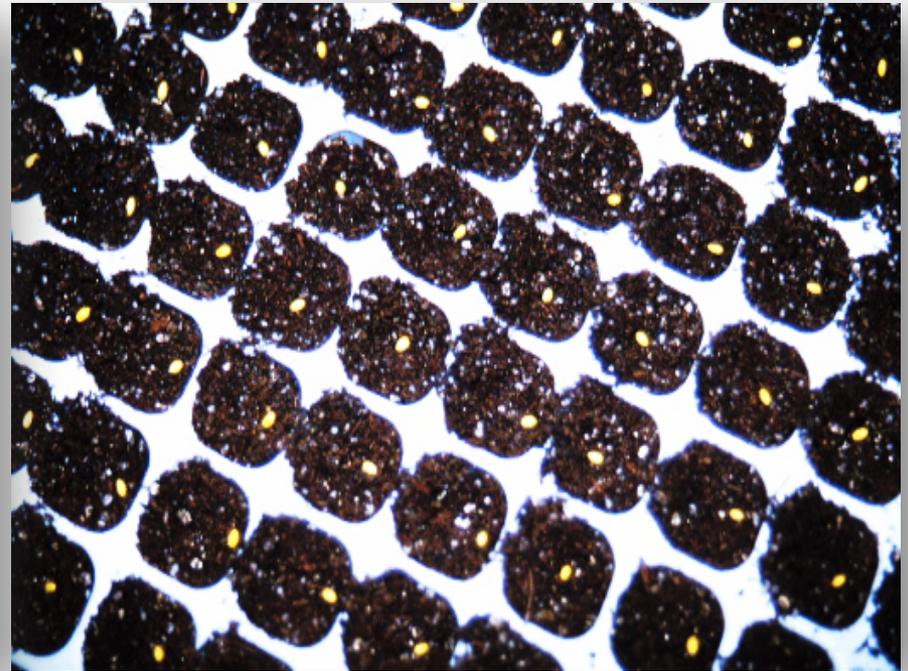


# Seed Treatments

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## Pelleted seeds

The major advantage to pelleted seeds is that they can be easily sown mechanically in plug trays.



# Seed Treatments

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## Pelleted seeds

Multi-pellets contain more than one seed per pellet.



# Seed Treatments

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## Pelleted seeds

Multi-pellets can contain different seed cultivars.



# Seed Treatments

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## Pelleted seeds



# Seed Treatments

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## Film coated seeds

Corn



Squash



Polymer film adds 1-5%.

Improves flowability.

Carrier for pesticides.

# Seed Treatments

## Film coated seeds



# Seed Treatments

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## Film coated seeds

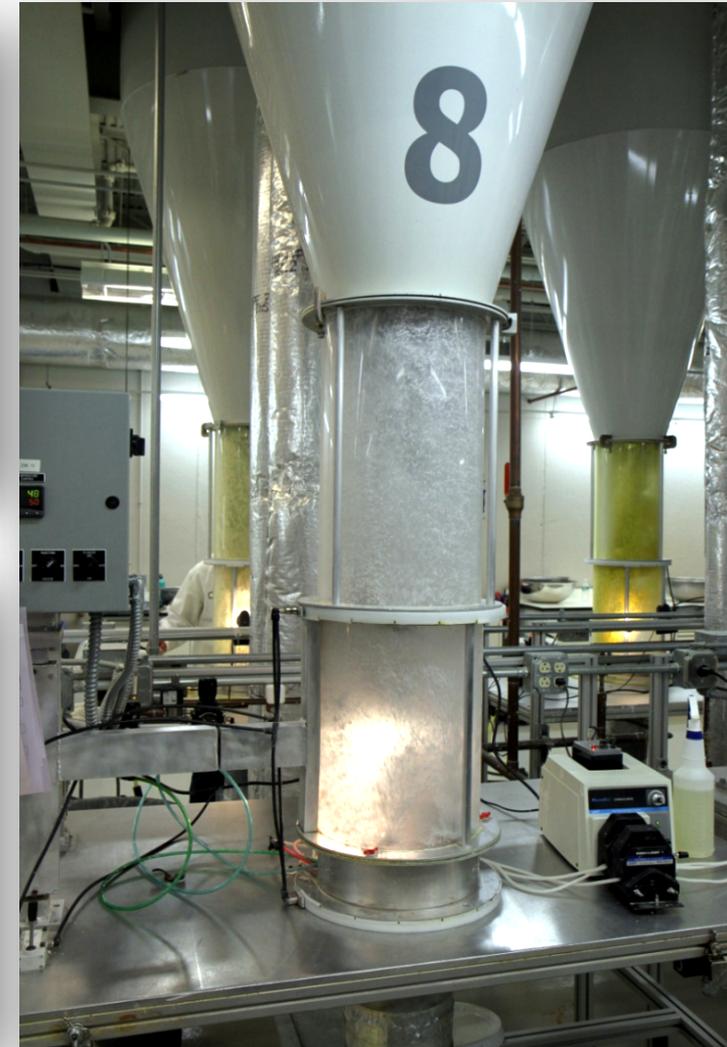
Untreated seeds.



An undercoat is applied.



It may contain a growth regulator.



# Seed Treatments

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## Film coated seeds

Next, the pigmented outer coating is applied.



# Seed Treatments

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## Film coated seeds



# Seed Treatments

---

## Film coated seeds



# Seed Treatments

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## Seed priming

Controlled hydration treatment.

Reduces time to radicle emergence.

Germination is more uniform among seeds.

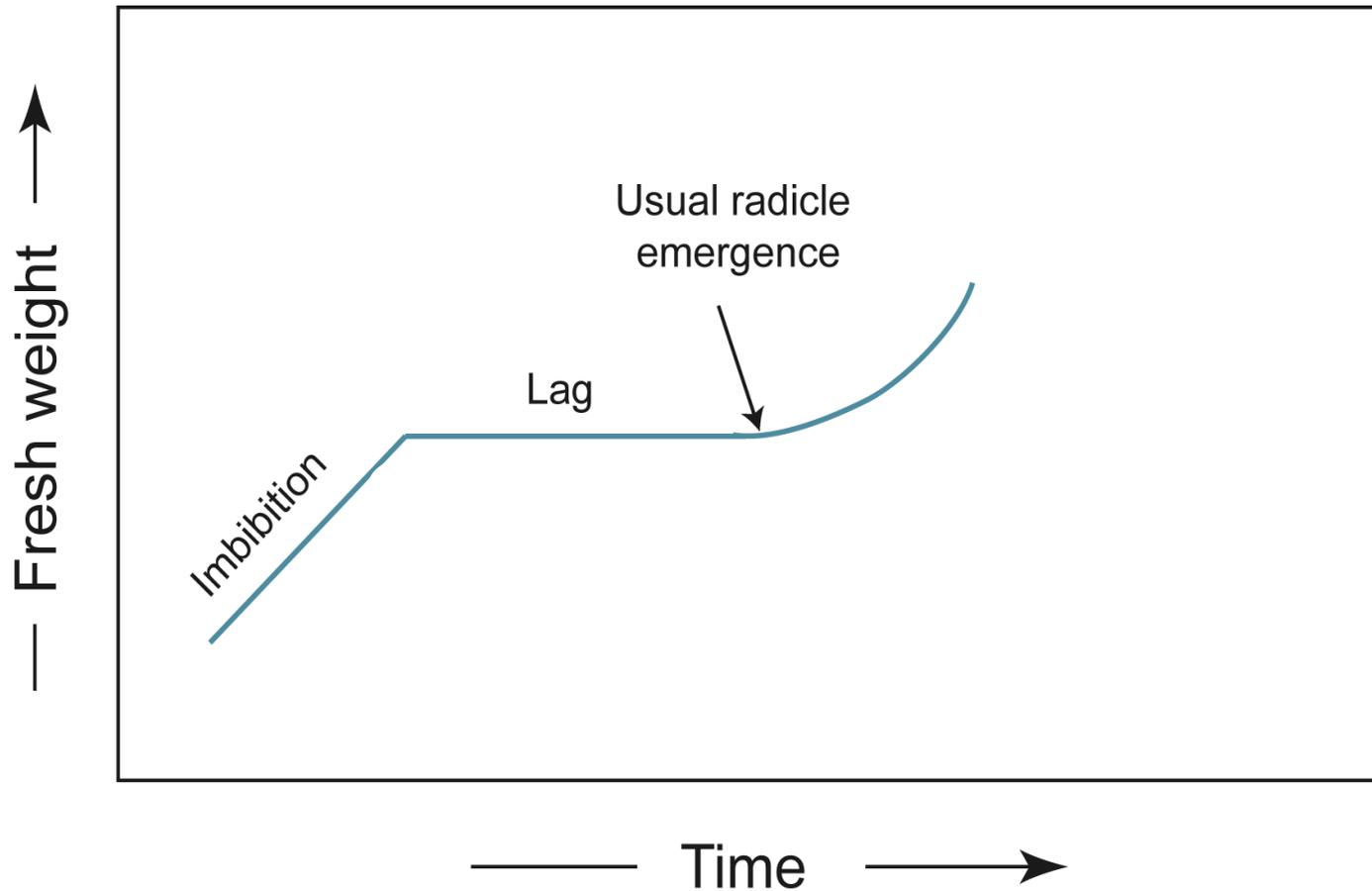
Performs better under less than ideal environments.



# Seed Treatments

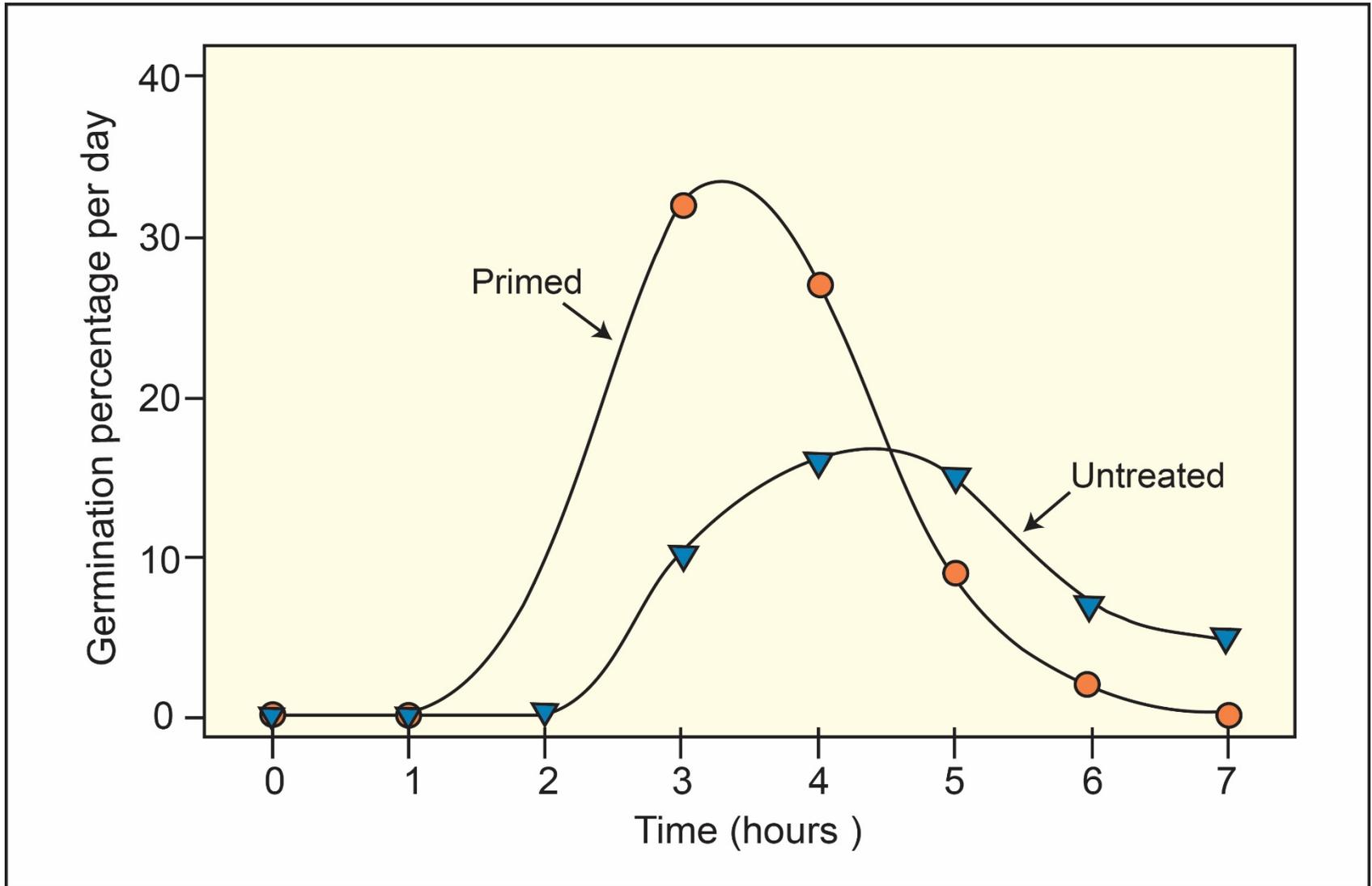
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## Seed priming



# Seed Treatments

## Seed priming



# Seed Treatments

## Seed priming

Temperature	Control	Primed
15°C	85 %	87 %
20°C	90 %	91 %
25°C	84 %	88 %
30°C	56 %	84 %
35°C	10 %	51 %

Thermodormancy in pansy - Cantliffe, 1991

# Seed Treatments

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## Seed priming

Osmotic priming  
PEG or salt solutions

Matrix priming  
Clay or vermiculite

Drum priming



Image courtesy of Val Maxwell

# Seed Treatments

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## Seed priming

### Impatiens

Osmoticum: Bubbled PEG, -1.2 MPa  
Duration: 3-6 days  
Temp: 15°C  
Drying: 20°C @ 93% RH 2 days  
29°C, 30% RH until 6%



Image courtesy of Val Maxwell

# Impact of Seed Technology on Seed Germination



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