Effect of Lag Phase on Soybean Seed Development

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Introduction

- During *Glycine* max (soybean) seed development, the seed goes through three developmental stages: lag phase, seed filling phase, and maturation phase.
- The lag phase is when the embryo and endosperm cells are actively dividing, but not yet expanding.
- Environmental stress during the lag phase has shown to have a larger negative effect on seed size and number compared to the seed filling phase.
- Seeds can only grow to a certain size in perfect conditions, which suggests there is predetermined genetic control of seed size by the plant.
- There is no research into how the lag phase controls final seed size. If the mechanisms can be identified, they may be able to be altered in order to increase yield.

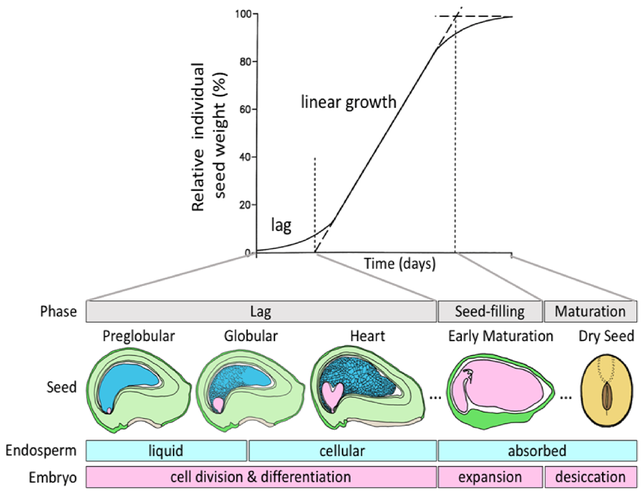

Figure 1: Phases of soybean seed development. (I) Lag phase: embryo (pink) grows from pre-globular to heart stage; the endosperm (blue) begins liquid and cellularizes before the seed enters the seed filling phase. (II) Seed filling phase: cells start to expand and the embryo grows rapidly. (III) Maturation stage: Seed completely dries.

Hypothesis / Objective

The objective of this experiment is to identify a correlation between length of lag phase and final seed size using 2 cultivars with small seeds (Cultivar 1 and 2) and 2 cultivars with large seeds (Cultivar 3 and 4).

Materials and Methods

Cultivar Information

Cultivar	Seed Weight (g)	Yield (megagram/ha)
607835 (Cultivar 1)	6	1.21
593655 (Cultivar 2)	8.3	1.88
603322 (Cultivar 3)	21.9	1.70
594245 (Cultivar 4)	24	1.37

Table 1: Cultivar information was retrieved from the USDA Germplasm Resources Information Network

- All cultivars are maturity group 0
- Soybean plants were grown at the University of Kentucky greenhouse under the same conditions in 1 gallon plastic pots.
- 35 plants per cultivar for a total of 140 plants. 20 plants were used for normal growth and 15 plants were used for de-podded experiment.
  - 5 plants were used for data collection and harvest, 10 plants were used for microscopy (only 5 plants for de-podded), and 5 plants were used for *in vitro* cotyledon growth rate analysis.
  - Plants were de-podded to reduce competition for assimilates at each node to see if the pods will grow larger than with competition conditions.

Whole Plant Data Collection

- Flower abortion and seed abortion rate recorded
- Pod elongation rate recorded
- Pod number, number of seeds, pod weight, seed size, and seed weight recorded at harvest
- Dates of R1, R3, R5, R6, and R7 were recorded

Microscopic Data Collection

- 3 different stages of pods (1 cm- 3 cm) were collected.
- Collected all marked pods from one node at a time
- Pod length measured and recorded

***In vitro* cotyledon growth rate analysis**

- 3 different stages of pods (1 cm- 3 cm) were collected.
- Collected all marked pods at R5.5 growth stage
- Pod length measured and recorded

Preliminary Results

Figure 2: Pictures of the 4 different cultivars plants during flowering time (left to right: Cultivar 1, Cultivar 2, Cultivar 3, Cultivar 4).

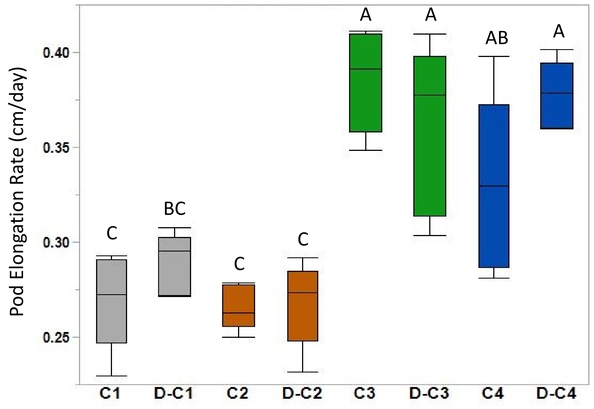

Figure 3: Mean of pod elongation rate for all cultivars under both non de-podded (C1 to C4) and de-podded conditions (D-C1 to D-C4). Data collected from 5 mm pod to 4 cm pod. Levels not connected by the same letter (A,B,C) are significantly different ($p < 0.05$, Tukey-Kramer HSD test). The box spans first and third quartiles, and the line inside the box shows the median. Bars on the top and bottom represent the maximum and minimum value.

- There is a relationship between seed size and pod elongation rate. Significantly increased pod elongation rate was observed in bigger seeds cultivars compared to small seeds cultivars.
- The elongation rates were very similar between the de-podded and the non de-podded conditions.
- Assimilates supply did not affect pod elongation rate.

Figure 4: No de-podded (Left) plant and de-podded (Right) plant from Cultivar 2.

Future Implications

- Continuing research into how the lag phase is controlled using molecular biology.
- More understanding of soybean lag phase development.
- Once the genetic mechanisms are identified, farmers can use new methods and/ or new cultivars that override these mechanisms and can increase yield.
- These genetic mechanisms may also apply to other agronomic crops, which presents more research opportunities.

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