

Successful Growth of RIL *Arabidopsis thaliana* Offspring Based on Traits Shared with Parent Plants

Cailen Herriford, April 24th 2020

MSUB Department of Biological and Physical Sciences, Faculty Mentor: Dr. Jason Comer

Introduction

Arabidopsis thaliana (L.) Heynh, a member of the family Brassicaceae, is widely used in research and educational settings due to its status as a “model” organism. Its small size, short life span, and tolerance to laboratory growth conditions make it ideal for robust, efficient scientific studies. *Arabidopsis* plants are also ideal for phenotypic studies, as the many ecotypes show distinctive physical traits that can be observed even without a microscope. Crossing of two *Arabidopsis* ecotype parent lines produced a number of recombinant inbred lines, which are offspring that have been allowed to self-pollinate over a series of generations in an attempt to fix recognizable homozygotic traits (Genetics, 2016). In this study, the parent plants were ecotypes Columbia (CS933) and Landsberg (CS20), and six recombinant inbred line (RIL) offspring were chosen for phenotypic analysis. It was hypothesized that traits relating to successful growth and fecundity (fertility) would occur more prominently in offspring lines that resembled the CS933 parent, which naturally grows at temperatures more closely approximated by the conditions in the growth room (Swindell et al., 2007). Additionally it was hypothesized that rosette diameter would have a predictive effect on the overall growth and fecundity of the plant. A series of measurements were therefore taken from both the parent plants and the offspring beginning February 3rd and concluding March 16th (43 days), specifically focusing on rosette diameter, inflorescence height, silique number, and branch number, to establish connections between heritable traits and successful growth.

Materials and Methods

Planting and Growth Conditions:

- Parental ecotypes: CS933 (Columbia) and CS20 (Landsberg)
- RIL offspring: CS1973, CS1992, CS1979, CS1978, CS1971, and CS1989
- Stored at 4°C for a cold treatment lasting five days
- Kept in the growth room at an ambient temperature of 36.5°C. Received 16 hours of light per day

Data Collection:

- Rosette diameter (shown right) was measured with a 15 cm ruler approximately once every week or at developmental landmarks such as bolting, flowering, or end of growth period
- Inflorescence height measured at bolting and flowering, otherwise measured weekly and at end of growth period
- Final silique number and branch number counted at end of growth period



Statistical Analysis:

- Data on rosette diameter, inflorescence height, silique number, and branch number were averaged in Excel for pots that had multiple plants growing in them
- The data was partitioned into three groups: CS933, CS20, and Offspring in SPSS, where the mean, standard deviation, and standard error of the mean were found for each group in each category
- A linear regression was run on the CS933 and Offspring data in order to determine the predictive effect that rosette diameter had on inflorescence height, silique number, and branch number

Results

The characteristics deemed most relevant to this study were rosette diameter, inflorescence height, silique number, and branch number upon end of growing period. Offspring plants were found to have the highest average rosette diameter (4.26 cm), inflorescence height (28.5 cm), silique number (54), and branch number (3), followed closely by CS933 in all categories. CS20 plants had significantly lower averages than both of the other groups, but had little variability between individual plants, indicated by extremely small error bars for three of the traits (see Figure 1).

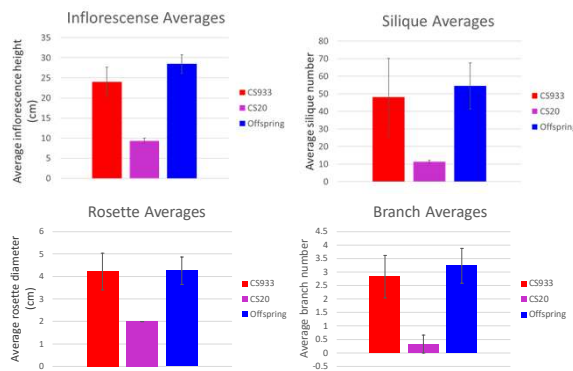


Figure 1: Averages for inflorescence height, silique number, rosette diameter, and branch number

As rosette diameter was hypothesized to be predictive of overall inflorescence height, silique number, and branch number, linear regressions were run for the CS933 and Offspring lines (see Figure 2). The positive slopes of each best fit line on the graphs below indicate a positive influence of rosette diameter on each of the measured traits (linear regressions not performed on CS20 due to prohibitively small sample size).

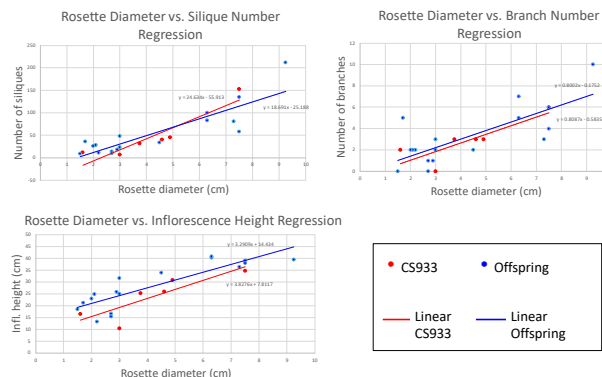


Figure 2: Linear regressions with rosette diameter as independent variable and inflorescence height, silique number and branch number as dependent variables

Discussion

It was initially hypothesized that the most successful RIL offspring would share more traits with the CS933 parents, and those that shared more traits with the CS20 parents would not be as successful. This was, in some ways, supported by the data. All of the offspring, except for CS1992, shared the floppy inflorescence and pointy siliques of the CS933 parents (Data not shown). CS1992 had an erect inflorescence and blunt siliques, like the CS20 parents, and showed the lowest averages in inflorescence height and branch number amongst the offspring, and the second lowest average for silique number. Between the parents, CS933 had much greater averages for all measured traits, as can be seen from Figure 1.

Rosette diameters were conjectured to be predictive of success. Thus, a linear regression analysis was performed to see whether or not rosette diameter has an influence on inflorescence height, silique number, and branch number. Figure 2 shows the regression lines for each of the traits analyzed, with rosette diameter as the independent variable and inflorescence height, silique number, and branch number as the dependent variables. The slopes of each best fit line are positive for all regressions. This indicates that as the independent variable increases (rosette diameter), it has a positive influence on the magnitude of the dependent variable (inflorescence height, silique number, and branch number), thus supporting the hypothesis.

The extremely small sample size of the CS20 parent was a major hindrance in accurate statistical analysis and comparisons in this study. This was in part due to the insect population in the growth room that seemed to prefer eating CS20 plants. Therefore in a future study it would be important to make sure the growth room is free of insects, and that a larger population of all plant lines is grown. It would also be interesting in a future study to determine root phenotypes for different *Arabidopsis* RILs and parents, as observations from this study indicated a sturdy root structure is likely necessary for growth of large rosettes and the increased development of subsequent traits.



Figure 3: Parent and offspring plants at beginning, middle, and end of growth period

Works Cited

- Genetics in inbred lines of *Arabidopsis thaliana* – student sheets. (2016). Retrieved April 6, 2020, from <https://www.plantingscience.org/resources/108>
- Boyes, D., et al. (2001). Growth stage-based phenotypic analysis of *Arabidopsis*: A model for high throughput functional genomics in plants. *The plant cell*, 13, 1499-1510.
- Swindell, W. et al. (2007). Plastic and adaptive gene expression patterns associated with temperature stress in *Arabidopsis thaliana*. *Heredity*, 99(2), 143-150. doi:10.1038. Retrieved from https://www.researchgate.net/figure/Arabidopsis-ecotypes-and-geographic-locations-from-which-accessions-originated_tbl1_6355947

