WISCONSIN FAST PLANTS® PROGRAM

Plant Breeding Lab with Fast Plants
Selecting for Stem Color

Before You Begin the Investigation

- Review Fast Plants Growing Instructions (see *www.fastplants.org/prep* for help getting started)
- Prepare your lighting system, growing systems, planting mix and fertilizer
- Obtain F2 Non-Purple Stem, Hairless Wisconsin Fast Plants Seeds (Note: This selection investigation requires a **minimum population size of about 120-180 plants** per class. Plan for students to grow enough to achieve this population size).

First Generation

# days after planting	record your dates here	classroom activities and discussion
DAY 0 (Monday)	_____	Work in pairs or small teams to plant F2 Non-Purple Fast Plants seeds in a growing system. **(Plant enough growing systems to achieve a minimum population size of 120-180 plants per class.)**
DAY 1 (after planting)	_____	Check that soil in growing systems is damp at the surface. Verify that growing systems are positioned close to your electric light source.
DAY 2-3	_____	Observe seedling emergence, and discuss variation in stem color (connecting to variation in *Brassica* vegetables). Discuss plant breeding (selection) and the potential heritability of variation in traits.
DAY 4	_____	Record data: count seedlings of each stem color, per growing system; calculate percentages. Check reservoirs!
DAY 7	_____	Combine individual growing system data into Generation 1 class data set. Calculate stem color percentages with combined class data and compare/contrast with smaller sample size from individual growing system data.
DAY 8-9	_____	Work individually or in teams to design the selection experiment. Discuss experimental designs and how selection will be implemented. **As a class, choose one stem color (green or purple) to select (breed) for.**
DAY 10-11	_____	Implement selection, cutting and removing green OR purple stem plants. **(Keep only one color of plants to intermate.)** Discuss the predicted effects of the conducted selections on the next generation. Check reservoirs!
DAY 14	_____	Observe plants as they elongate and begin flowering. Make bee sticks to prepare for pollination. Discuss flower and bee anatomy. (learn more at *www.fastplants.org/pollination*)
DAY 15-18	_____	Intermate all Generation 1 selected plants. (Pollination can be done daily or every-other-day for a total of 2-4 pollination sessions.) Groups should cross-pollinate their plants with other groups' plants. Check reservoirs!
DAY 21-40	_____	Observe plants as seeds and pods develop. Continue to monitor growing system reservoirs and refill as needed.
DAY 40-42 (approx.)	_____	Count 20 days past the last day of pollination, and on that day, remove the plants from water. Allow parent plants and pods to dry for approximately 1 week. (learn more at *www.fastplants.org/seed-harvest*)
DAY 49+ (approx.)	_____	When seed pods are dried and crispy, the seeds can be harvested for planting of the next generation. Harvest Generation 2 seeds from dry pods on Generation 1 parent plants. (learn more at *www.fastplants.org/harvest*)

Second Generation

DAY 0	_____	Work in pairs or small teams to start Generation 2 seeds germinating on wet paper towel in Petri dishes. (10-20 seeds per Petri dish) **(Germinate enough seeds to achieve a minimum population size of 120-180 plants).**
DAY 1-2	_____	Observe germinating seeds. Review data collection practices and discuss potential analyses of Generation 2 data.
DAY 3-4	_____	Record data: count seedlings of each stem color, per growing system.
DAY 3-4+	_____	Combine individual growing system data into Generation 2 class data set. Calculate stem color percentages for Generation 2 plants and compare to data from Generation 1. Work individually or in teams to develop evidence based explanations for the effects of selection on Generation 2. Share and critique explanations. Discuss how Generation 2 results may or may not be evidence of selection.

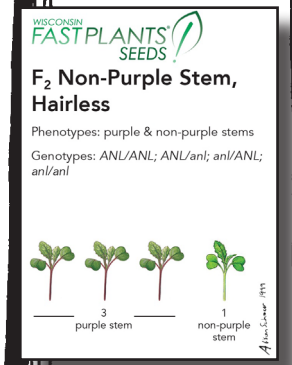
January 2023

WISCONSIN FASTPLANTS® PROGRAM

Plant Breeding Lab with Fast Plants: Selecting for Stem Color

Student implemented selection experiment: Generation 1

Key
Green text = work with seeds/plants
Blue text = discussion & data analysis



Monday	Tuesday	Wednesday	Thursday	Friday
Work in pairs or small teams to plant F2 Non-Purple Fast Plants seeds in a growing system. (Minimum population size of 120-180 plants per class.) day 0 start planting	Check that soil is damp and growing systems are positioned close to your electric light source. day 1 after planting	Observe seedling emergence and begin to notice variation in seedling stem color. Discuss how variation in stem color connects to variation in Brassica vegetables. Discuss plant breeding (selection) and potential heritability of variation in traits. day 2	day 3	• F2 Non-Purple Stem Seeds • Growing systems • Soilfree mix & fertilizer • 24hr electric light source materials prep day
			Record data: count seedlings of each stem color. Calculate percentages of each stem color. Check reservoirs! day 4	
Combine individual growing system data into class data set. Calculate stem color percentages with class data and compare/contrast to individual growing system data. day 7	Work individually or in teams to design the selection experiment. Discuss experimental designs and how selection will be implemented. **As a class, choose one stem color trait (green or purple) to select/breed for in Generation 1 plants.** day 8	day 9	Implement selection: cutting and removing green OR purple stem plants. **(Keep only one color of plants to intermate).** Discuss the predicted effects of the selection on the next generation of plants. day 10	Check reservoirs! day 11
Observe plants elongate and begin flowering. Make bee sticks to prepare for pollination. Discuss flower and bee anatomy. day 14	• Intermate all Generation 1 selected plants (Pollination can be done daily or every-other-day for a total of 2-4 pollination sessions). Groups should cross-pollinate their plants with other groups' plants. • Learn reproductive structures & functions. • Observe cause and effect relationships (e.g. pollination->fertilization->pistil elongation->pod & seed development).			Check reservoirs! days 15–18

***Note**: Germinating & keeping plants alive over weekends is best accomplished with a water-wicking growing system with water reservoir.

For more information and resources, visit www.fastplants.org

WISCONSIN FASTPLANTS® PROGRAM

Plant Breeding Lab with Fast Plants: Selecting for Stem Color

Student implemented selection experiment: Generation 2

Key
Green text = work with seeds/plants
Blue text = discussion & data analysis

Optional research:
- Reproduction in plants
- Differential reproductive success in nature
- Heredity & variation in survival.
- Variation & adaptation / agricultural selection

Monday

Work in pairs or small groups to start Generation 2 seeds germinating on wet paper towel in Petri dishes.
(10-20 seeds per Petri dish, minimum of 120-180 seeds total)

(Start on a Monday or Tuesday to allow recording data within the same week.)

Start Generation 2 germination

Tuesday

Wednesday

Thursday

Count 20 days past the last day of pollination, and on that day, remove the plants from water (but keep them under light).
Allow parent plants and pods to dry for approximately 1 week. (learn more at www.fastplants.org/seed-harvest)
When pods are dried and crispy, harvest Generation 2 seeds from dry pods on Generation 1 parent plants.
(learn more at www.fastplants.org/harvest)

Approximately 27 days after the last pollination

Observe germinating seeds. Evaluate seedlings 3-4 days after starting germination.
Record data: count seedlings of each stem color.

Review data collection practices and discuss potential analyses of Generation 2 data.

Evaluate seedlings 3-4 days after starting germination

- Combine individual growing system data into Generation 2 class data set.
- Calculate stem color percentages for Generation 2 plants and compare to data from Generation 1.
- Work individually or in teams to develop evidence based explanations for the effects of selection on Generation 2.
- Share and critique explanations. Discuss how Generation 2 results may or may not be evidence of selection.

Friday

- Mature Gen 2 seeds, harvested from Gen 1
- Petri dishes
- Paper towel
- 24hr electric light source

Generation 2 materials

***Note**: Germinating & keeping plants alive over weekends is best accomplished with a water-wicking growing system with water reservoir.

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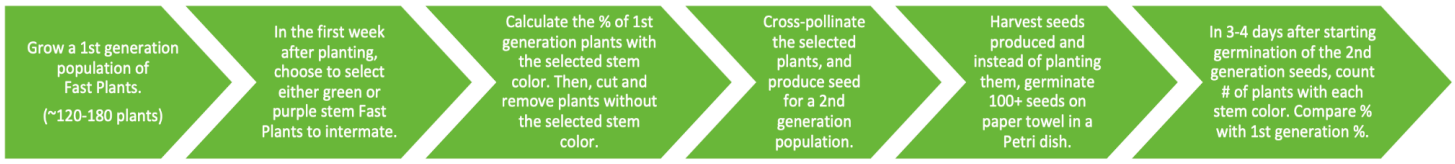
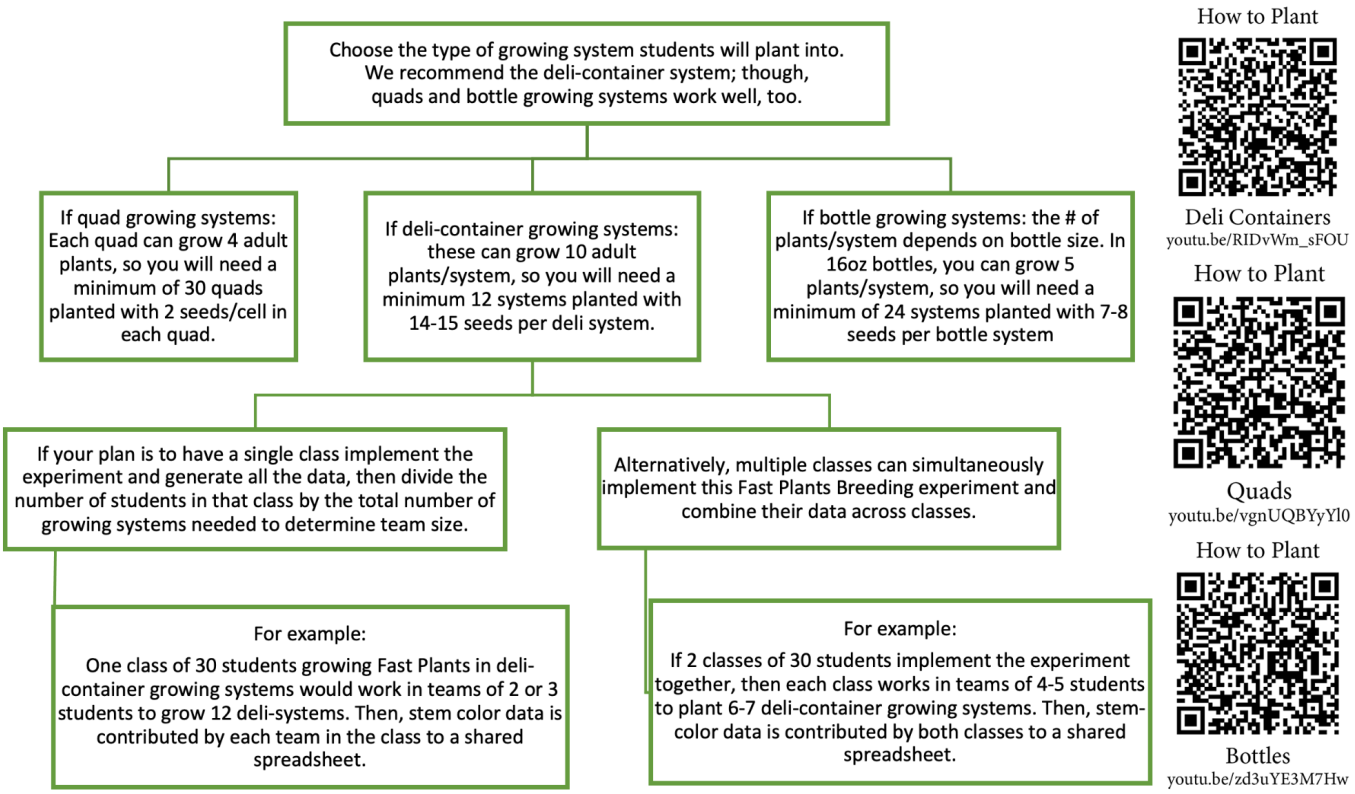
Appendix A: Planning logistics for the Plant Breeding Investigation

Planning for a successful plant breeding experiment requires having minimum population sizes of 120-180 plants per generation to have a sufficient sample size for significant results. With less than 100 plants in either the first or second generation, the results can be skewed. The following flow chart provides an experimental overview.



This investigation is designed for students to work in teams, growing a portion of the total 120-180 plant population, then they combine data to achieve a sufficient sample size. Team size and number of plants grown per team depends on the number of student groups sharing data and the number of plants that can be grown in your chosen growing system (see Figure below).



Please note that the size of your population of adult plants (and the number of seeds you produce) will be affected by the stem color trait you choose to select for. This experiment uses F2 Non-Purple Stem Fast Plants, which will be approximately ~75% purple stem and ~25% green stem. Experimental results can be generated in both selection conditions. If you choose to select for purple stem plants, your selected/intermated population will be larger (and thus, you will produce more seeds) than if you choose to select for green stem plants. Selection for purple stem (the dominant trait) should result in an increased % of purple stem in the second generation. Though selection for green stem will result in a smaller population (and less produced seed) the results of selection for the recessive trait can be striking. Selection for green stem (the recessive trait) should result in >95% green stem in the second generation.