Volume 13, No. 1 2000

WISCONSIN FAST PLANTS notes BOTTLE BIOLOGY WISCONSIN

A Big Idea: Fast Plants, Environment, Heredity and You

One of the big ideas in biology is addressed in the following activity and is captured in the question, "Who are you?" Huh? Answer: you are you because of your heredity, the genes you inherited from your parents and you are also you because of how you live (your environment), and because of your age (your stage of development).

This rather abstract notion embraces a number of the fundamental ideas that will help you better understand life on earth. Think about it. Like you, every living organism, at any moment in its life, is what it is because its genes, inherited from its parents, have guided it's development through all the environmental conditions under which it has lived and grown.

Understanding more about how your environment influences who you are is important. You can use the experimental organism called Fast Plants to investigate various aspects of this big idea. In Activity I, you will learn how the environment and heredity influences their growth and development.

Figure 1: Excerpt from the new Fast Plants manual. See page 4.

"Is More food Better?" aligns with the Science Standards

Science as Inquiry
K-12

Life Science Content

K-4
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

5-8
- Structure and function in living systems
- Reproduction and heredity
- Populations and ecosystems

9-12
- Biological evolution
- Interdependence of organisms
- Data organization and analysis

Activity I: *"Is More Food Better?"*

Introduction

Because of their ease of growth and short life cycle (seed to seed in 35 days) Fast Plants are an organism suitable for many kinds of home and classroom scientific investigations. They are particularly interesting because, like humans, they exhibit considerable variation in many observable characteristics. Fast Plants are useful for experiments investigating the effects of environment (light, nutrition, etc.) on variation in growth, development and reproduction.

This activity addresses the effect of nutrient on growth and reproduction. Specifically you will investigate how much fertilizer (nutrient or plant food) is best for the production of a crop of Fast Plants seed. This is the same question that farmers ask every time they plant a crop.

An Observation

Farmers and gardeners generally believe that more fertilizer (plant food) is better for plant growth and crop production. But do they really know how much food is better?

The Question

This investigation is designed to examine the question "**Is more food better for Fast Plants?**" Better, of course, depends on the perspective or point of view you choose to take and can differ widely. For example, if you were a farmer growing Fast Plants, would you be growing the plants for feeding to cattle and sheep, for salad greens, or for a crop of seed to sell? For the purposes of this investigation you should consider the production of seed to be used by you and your friends for future experiments as the goal for determining "better." Therefore, more seed is better.

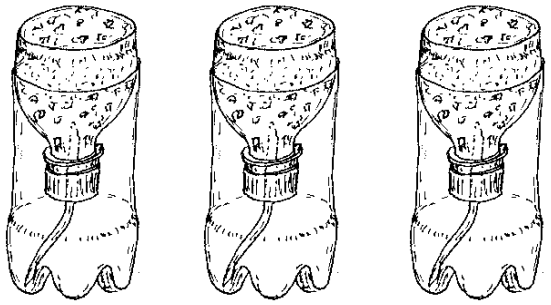


Figure 2: Three Bottle Growing Systems, BGS. Each designed to hold a different concentrations of nutrient solution, 1/32 strength, 1/16 strength, and 1/8 strength

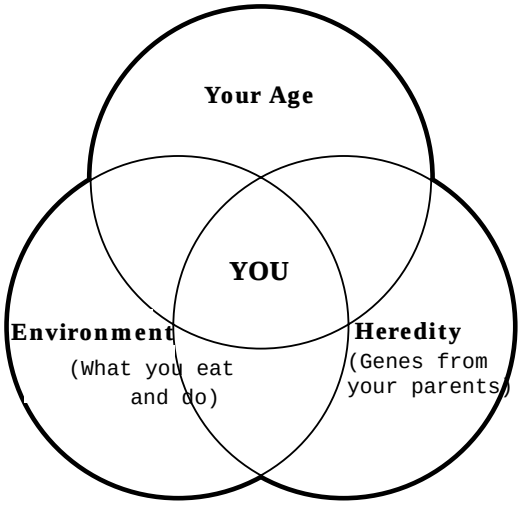
The Hypothesis

In a scientific investigation the conversion of a question, such as "Is more food better?," into a *hypothesis* (statement) that claims "**more food is better for Fast Plants seed production**" is a way of examining the question. Making a hypothesis is a useful approach to an investigation because you can experimentally generate evidence that tests (supports or disagrees with) the hypothesis.

Experimental Design (Testing the Hypothesis)

You will grow a crop of Fast Plants under an optimal growth environment for Fast Plants introducing a single environmental variable, nutrients (fertilizer). You will create three dilutions of chemical fertilizer to be used in growing your plants. Six growing systems with six Fast Plants in each will be grown under three different treatment levels of nutrients; two systems (n= 12 plants) for each nutrient level. Individual plants in each set of 12 plants will be numbered and observed, and selected traits representing growth (height), development (# of leaves, # of hairs) and reproduction (# of flowers pollinated and # of seeds produced will be measured and recorded. After summarizing and graphing the data collected, you will be able to determine the degree that the various parts of the growing plant are affected by the nutrient environment.

From the knowledge of plants which you gain in this investigation and from the data that you generate, you'll be able to evaluate the hypothesis, "More food (nutrient) is better for seed production." In addition to seed production you will observe that nutrition influences some traits a lot and some very little, if at all.



This newsletter highlights a new activity, *"Is More Food Better"* from the WFP Program. A complete version of this activity is available on the

Fast Plants website at: www.fastplants.org/wfp

It includes instructions for:

- Constructing a Plant Light House
- Making Bottle Growing Systems (BGS)
- Preparing the Nutrient Solutions
- Planting
- Pollinating
- Harvesting
- Data collection, organization, and analysis

Observing, Measuring and Recording Data

- # of leaves on the main stem, including cotyledons
- count number of hairs on margin of 1st true leaf, days 12-14
- total # of flowers pollinated, on day 18 after terminalization
- record height in mm at day 18 after terminalization
- total # of seeds per plant

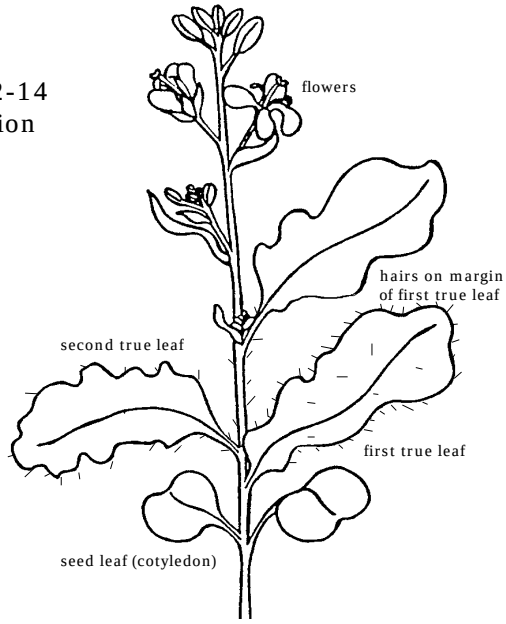


Figure 3: Caricature of a Fast Plants illustrating different morphological traits that can be counted or measured on a Fast Plant.

Table 1(c) 3/2/00 PHW

Fast Plants Growth, Development & Reproduction

Your name: Paul H. Williams Date of sowing 10/23/99

Plant Variety: Standard Fast Plants, C1-33, BW198

Standard environment: PLH, BGS

Variable environment: 1/8X Peters nutrient

Plant #	Plant Trait Measured					
	height (mm) 18das	# of leaves on stem	# hair, 1st leaf margin	# flowers pollinated	# seeds	other
1	308	6	15	18	72	
2	278	6	21	18	83	
3	290	5	38	15	34	
4	267	6	55	25	108	
5	229	7	18	15	140	
6	138	6	21	2	1	
7	200	6	2	13	61	
8	304	6	0	17	32	
9	312	5	1	22	148	
10	276	6	2	22	161	
11	262	7	4	17	144	
12	265	6	6	21	77	
n	12	12	12	12	12	
x̄	261	6.0	15	17	88	
s	50	0.6	16.9	5.9	52.2	
r	174	2	55	23	160	

n = number of plants measured

x̄ = average measure = sum of measures ÷ n

r = range of variation = highest - lowest value

s = standard deviation, = average variation around the average, x̄

Table 1: Raw data from Paul Williams' research notebook. (Fast Plants growth and development data)

Table 2. 3/2/00 PHW

Your name: Paul H. Williams Date: 10/23/99

Effect of Nutrition on Fast Plants Growth, Development & Reproduction (Summary Table)

Plant trait measured	Nutrient Level, Peters, 20-20-20, 1X											
	1/32X				1/16X				1/8X			
	n	x̄	s	r	n	x̄	s	r	n	x̄	s	r
height, 18das	12	141	26	89	12	224	60	177	12	261	50	174
#leaves	12	6.1	0.5	2	12	6.2	0.8	2	12	6.0	0.6	2
#hairs on 1st leaf margin	12	13	7.4	29	12	17	11.6	34	12	15	16.9	55
#flowers, pol	12	9	2.0	6	12	14	3.2	11	12	17	5.9	23
#seed/plant	12	29	10	36	12	82	45	166	12	88	52	160
other												
other												
other												

n = number of plants measured.

x̄ = average = sum ÷ n

s = standard deviation

r = range = highest - lowest value

Table 2: Summary data from Paul Williams' research notebook. (Effect of Nutrition on Fast Plants Growth, Development and Reproduction data)

Analysis and Questions

As you summarize and graph the data from your experiment you will notice that some traits of the growing plant are affected by the nutrient environment more than others. From this knowledge you should be able to evaluate the hypothesis, "More food (nutrient) is better for seed production."

From your data you also have evidence that demonstrates that some developmental traits such as leaf number on the main stem and average number of hairs on the margin of the first true leaf are not as strongly influenced by environment as are number of flowers and seeds produced. You might also notice that of the two developmental traits, leaf and hair number, that hair number was much more variable from plant to plant in the population than was leaf number.

From these observations come many questions of importance to understanding the relative contributions of both environment and heredity to the individual.

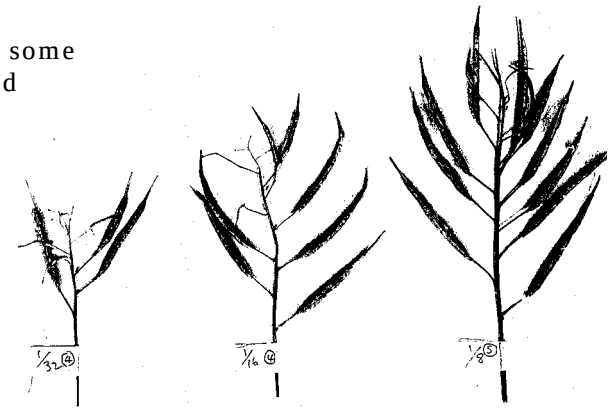


Figure 6: Actual dried seed pods on 35 day old Fast Plants growth at three nutrient concentrations, 1/32 strength, 1/16 strength, and 1/8 strength. (not actual size, reduced)

A companion article, ***Activity II:*** *"Creating the Wooly Booger: Hairy's Inheritance"* addressing heredity and the environment will be found on-line late summer 2000.

Additional reading and activities on the inheritance of hairs can be found on the Fast Plants website:
Hairy's Inheritance, Wisconsin Fast Plants Program, 1993.
Unraveling the Mysteries of Hairy's Inheritance, Wisconsin Fast Plants Program, 1998.

www.fastplants.org
New Fast Plants website, April 2000

Developed from the original Wisconsin Fast Plants website, this new website features the latest ideas and activities with Fast Plants. The new format is designed to service teachers, students, and scientist using Fast Plants more effectively. Currently the site contains:

- nearly 200 Fast Plants activities at all levels
- current research and student research ideas
- links to other Fast Plants websites
- information on the Fast Plants seed stocks
- new growing instructions
- meeting the science standards
- Electronic newsletter, *Notes**
- Bottle Biology and Bottle Cap Gardening
- ordering information for Fast Plants materials

*After 13 years in print the *Wisconsin Fast Plants and Bottle Biology Notes* will only be available electronically. If you would like to be notified when newsletters are posted, register on the website or email: info@fastplants.org
(All subscribers email addresses will be confidential.)

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