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An Inquiry Approach to Wisconsin Fast Plants

Background and learning objectives: Though development and use of Wisconsin Fast Plants is already extensive, I found nothing about them that was designed to be inquiry-based. Vast amounts of information can be obtained from the web. This includes descriptions of more than 10 easily accessible (Carolina Biological Supply) mutant forms and a myriad of exercises. These cover different forms of inheritance, uses of statistics, methods of measuring and understanding variation, artificial selection, plant growth, development and flowering. These form a wealth of resources, but all are essentially demonstration exercises.

Websites:
1) The basic site: http://www.fastplants.org/
I found these site pages especially interesting:

http://www.fastplants.org/teachingmaterials/Activites.htm
http://www.fastplants.org/teachingmaterials/Labs.htm
http://www.fastplants.org/Introduction/Plants.htm
http://www.fastplants.org/teachingmaterials/Labs/FALL.pdf

Our primary reason for introducing these plants to class was to give students a tangible experience with quantitative variation and heritability that would broaden their understanding of genetics beyond Mendelian inheritance and could facilitate conceptualization of natural selection in the future. Growing these plants also provided a reference for lessons in plant development, life cycles, photosynthesis, reproduction, nutrition, and experimental design. In a long term, multi-generational, experiment like this the notebooks and records that students kept became obviously and critically important. This was a simple and yet grand lesson.

The element of INQUIRY: The fundamental modification we made to the design of our exercise (close to that described in the above website as an artificial selection experiment for plant hairiness) was to allow the students to select (given the objective of artificial selection) whatever trait they wished: hairiness, smoothness, height, or purple color. The idea then changed from only observing heritability, to determining heritability. Because height and purple color are environmentally as well as genetically determined, this also introduced possible questions for future *B. rapa* generations. In addition to deciding which traits would be selected, students also determined when and how they would be measured, as well as other aspects of the experimental design such as fertilization rates and watering schedules, etc. This offered opportunities for MANY discussions of experimental design. I do not believe it would have been possible to overemphasize this topic!

Materials and Equipment: Most of what is described about the necessary growing conditions in the cited web pages is true. This should not be daunting though! You will need planting trays with inserts. You will need grow lights. You DO NOT need extra special potting soil or elaborate water wicking arrangements. We did not use any plant stakes. But our plants bent over in ways that made height difficult to measure and made it easy for them to become tangled. Bamboo skewers would make good cheap plant stakes. We used pelleted fertilizer so that students could easily regulate amounts given by counting pellets.

"Standard" fast plant seed does not include enough variability for purple color, and ours had only a few hairy plants. I recommend mixing "standard" and "Purple stem, hairy" seeds for the first parent generation. Much of the info about the different *B. rapa* traits is designed to set a teacher up for a particular exercise, without letting on much about the mechanism of inheritance involved. What I gathered about the following basic traits was this:

<u>Height</u> --- Some plants in the "standard" mix may have tall (increased gibberellic acid) or dwarf traits. So, there could be a genetic component to some plants' height. But, of course, much about height will be determined environmentally.

<u>Hairiness</u> --- Hairs are a quantitatively genetically determined trait only. An unknown number of loci are involved and there is no environmental component.

<u>Purple Color</u> --- Anthocyanin expression results in purple color, which can increase in intensity as a result of more light or reduced fertilizer. The capability of any anthocyanin expression is a Mendelian trait for which the homozygous recessive has none.

Ideas for Interactive Research: Depending on growing conditions and time allowed, several generations of *B. rapa* can fit into a school year. The concept of heritability can be addressed with one or more generations. There are also fast plant mutants that could be explored, observed, mixed, segregated, etc. Effects of environment, e.g. light, nutrients, crowding, can be tested as well. If strict parental lines can be maintained genetic questions can be followed more precisely. But this may require more plants than can fit in the classroom!

One idea I had that would have take several plant generations would be to test oviposition preference for hairy or smooth lines of plants. [I was just dreaming this up when Carolina started advertising *P. rapae* cultures in combination with *B. rapa* plants. They have the nerve to call *P. rapae* "Fast Plant Butterflies"!!!!! In any case, they have only raised the idea of rearing *P. rapae* on *B. rapa* and watching oviposition and larval development, etc.] *Pieris rapae* are very easy butterflies to rear because the larvae don't wander much at all. They stay on their host plant until they totally consume it. And they are beautiful! I believe they need to oviposit with a lot of natural light, though.

If lines of hairy and smooth plants were developed (or purple vs. green) *P. rapae* oviposition preference for and larval development on the alternate plant types could be tested. This would be a great way to link the artificial selection experiment with natural selection.