

Be the Bee, Part 2: Do Classroom-grown Cucumbers that are Hand-pollinated Via Pollen Transfer with a Paint Brush Produce More Fruits than Untouched Plants?

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Grade levels targeted: 6-8

Estimated time required to conduct the experiment:

30 minutes to set up on first day

20 minutes / day to water plants, hand-pollinate flowers, clip and count fruits, and record data

Introduction:

Bees are needed by many garden plants to produce seeds and, sometimes, the plant parts that we eat. In most cases bees do the pollination although other animals such as butterflies and moths contribute to garden pollination.

Adult bees feed exclusively on nectar. Bee larvae drink nectar too, but they also need to eat pollen for the protein it supplies for their growth. Adult bees are kept very busy collecting pollen and nectar to bring back to their nests for their larvae. In the process bees transport pollen on their bodies from one flower to another, resulting in "cross-pollination" between flowers. For many plants, this is the only way they can produce seeds and fruits. For example, squashes, cucumbers, strawberries, and raspberries are cross-pollinated by bees.

MORE ABOUT BEES AND POLLEN:

- The average pollen grain is less than the width of a human hair
- A honey bee will visit 50 to 350 flowers for each load of pollen flown back to the hive
- Pollen is around 20% protein on average, nearly twice that of an egg.

Question:

Do cucumber plants with flowers that are pollinated by hand with a small paint brush (to simulate a pollen-dusted bee) produce a higher number of cucumbers than plants whose flowers are left untouched?

Hypothesis:

In the absence of bees, female cucumber flowers that have pollen brushed onto them by hand are more likely to become fertilized and produce cucumbers than flowers that have been left alone.

Materials and Methods:

This project requires starting cucumbers from seed because school is typically in session during the cold season when garden plants are not available. For a summer-session class it will be easier to purchase started cucumber plants from a nursery. You may also use garden cucumbers

growing outdoors but they must be enclosed with screening or row cover fabric to keep bees away from them.

Choose the cucumber variety for this experiment carefully. Avoid hybrid cultivars because they are often either seedless (and don't require any pollination) or are highly self-pollinating compared with traditional cultivars. A good choice would be one of the Spacemaster cultivars. They are small plants well-suited to growing in pots, and they are "open-pollinated."

Item*	Quantity	Cost Each (Approximate)	Cost Total (Approximate)
10" (5-quart) plastic plant pot	6	\$ 2.00	\$ 12.00
Bag (32-quart) all-purpose potting soil	1	\$ 7.00	\$ 7.00
Box Miracle-Gro® All-Purpose Plant Food	1	\$ 6.00	\$ 6.00
Packet of cucumber seeds**	1	\$ 3.00	\$ 3.00
Tomato / Vegetable Cages	6	\$ 5.00	\$ 30.00
Grow lamps, fluorescent type	2	\$ 25.00	\$ 50.00
Indoor plug-in light timer	1	\$ 15.00	\$ 15.00
Plastic bowl	1	\$ 2.00	\$ 2.00
Scissors	2	\$ 3.00	\$ 6.00
Clipboard w/ data sheet and pencil	1	\$ 2.00	\$ 2.00
		TOTAL:	\$133.00
*OPTIONAL: Seedling heat mat, 20x20-in ²	2	\$ 50.00	Add \$100.00
**Do NOT use self-pollinating variety!			

We are using a total of six plants, divided equally between two different types of experimental handling, or "treatments." In science, a **treatment** is a set of procedures that researchers use on experimental units. The experimental units in this case are the cucumber plants. In this experiment, there are two treatments. Treatment A uses a group of three cucumber plants from which pollen will be collected from the male flowers and transferred to female flowers. The flowers on the remaining three cucumber plants in Treatment B will be left untouched. Later we can compare the results of the two treatments.

We are using three plants in each treatment to be sure we have good **replication**. Although we are raising the cucumbers under the same conditions of light, temperature, and humidity etc., we can't rule out individual variation in fruiting production. Replication is built-in repetition within an experiment using the same or similar conditions, and it is important because its averaging effect strengthens our ability to trust the estimates we will draw from our data.

Part 1 – Growing the Plants

- Select two "treatment" areas in the classroom. The three cucumber plants within each treatment can be clustered together, but the two treatments should be separated by at least five feet if possible, so that pollen from the hand-pollinated plants is less likely to drift onto the untreated plants.
- Arrange three pots in each treatment area underneath one grow lamp. Mark them with numbers 1-6, corresponding to the numbers on the [data sheet](#).

- Fill plant pots with soil and push three seeds into the center of each pot; cover with ½” soil, and water. The potting soil must be kept at or above 70°F night and day, so electric seedling mats will be needed if the room is not warm enough.
- Surround pots with vegetable cages, to support vines as they develop.
- Set grow lamp timers for ___ hours of daylight (e.g., 6:00 a.m. to 10:00 p.m.).
- Water pots daily or as needed, being sure to water all pots equally. Seedlings will appear in 3-5 days post-planting.
- After emergence, choose the strongest seedling to keep and clip the other two at the soil line.
- Continue watering schedule, and feed with Miracle-Gro as directed on label.
- The first male flowers will open at about five or six weeks post-planting. The first female flowers will open about one week later.
- By seven or eight weeks the first little cucumbers will be growing on flowers that have been successfully pollinated.

Part 2 – Hand-Pollinating and Fruit Counts

- The experiment begins on the day the first female flowers open.
- Treatment A (do not touch the plants in Treatment B). Locate a male flower and gently rub the bristles of the small paintbrush on the anthers to pick up some pollen.
- You will see a light dusting of pollen on the hairs of the paint brush. Gently brush a little pollen onto the centers of all open female flowers. You may need to visit other male flowers to collect more pollen. You can carry the pollen to flowers on the same plant or on a different plant, as long as all of the plants are in Treatment A.
- In the ensuing days, each mature flower will either be fertilized and develop into a fruit, or it will absciss (shriveled and drop off the vine). The fertilized flowers will shed their petals, style and stigma, and you will see the ovaries swell into little cucumbers.
- Treatment A: Identify flowers that have growing cucumbers on them, at least 2 inches long. This means that they have been pollinated successfully. The growing cucumbers are cut from the plant into the bowl for counting. But, **be careful** not to clip unfertilized female flowers – they have swellings that look like little cucumbers, but they may not have been pollinated yet.



- When finished clipping cucumbers, count the fruits and enter that number on the daily log on the clipboard. Transfer pollen to all remaining flowers.
- Repeat the clipping and counting procedure for Treatment B. However, the flowers in Treatment B are left untouched – no pollen is transferred to flowers.



Results:

- Add up the total number of cucumbers produced by each plant.
- Calculate the average number of cucumbers produced by each treatment.
- Create a graph of your data. You can do this on-line using “Kids’ Zone Create A Graph” at <http://nces.ed.gov/nceskids/createagraph/>. You can choose to make a bar graph on the “Design” tab, and then on the “Data” tab you can list your six values organized into two groups of data (“pollen transferred” and “pollen not transferred”). This is a fun program to use, and you can really see what your data looks like.

Discussion:

Discuss your results and whether your results appear to confirm or reject your hypothesis. Was there much variation within each treatment? Can you say anything about how well artificial pollination with a paint brush works? Discuss future experiments you may want to perform based on your results.



References:

Information on different types of grow-lights:
http://en.wikipedia.org/wiki/Grow_light

Source for economically-priced fluorescent grow lights, 2-pack:
<http://www.htgsupply.com/Product-2-Pack-of-GrowBright-2-Foot-Single-Lamp-T5-Light.asp>

On-line graph creation with elementary-aged students: <http://nces.ed.gov/nceskids/createagraph/>