Hormone-induced Parthenocarpy in Rapid-cycling *Brassica rapa*

The following protocol for investigating parthenocarpy was shared by Dr. Daniel L. Schadler from Oglethorpe University and is printed here with minimal edits. It is most suitable for the college level or for advanced high school students.

Abstract

Three plant hormones/plant growth regulators were tested for their ability to induce *parthenocarpy* (induction of seedless fruits by plant hormones) in rapid-cycling *Brassica rapa* (Fast Plants.) The three compounds used were *auxins*: indole-3-acetic acid, indolebutyric acid and naphthaleneacetic acid. All three of the hormones produced seedless fruits under experimental conditions.

Exercises for classroom use involving parthenocarpy have appeared in the literature (2). The long time needed for growth of the plants and for production of the fruit after experimental treatment limits the usefulness of such exercises. Use of self-pollinating plants can produce confusing results if students are not technically proficient.

Rapid-cycling *Brassica rapa* offers a potential means to overcome these limitations because the plants grow rapidly and produce flower buds nine to ten days after planting. The pod, or fruit (silique) is fully mature three weeks later. Further, random pollination is minimized due to pollen-stigma incompatibility of flower buds on the same plant.

Auxins are known to induce parthenocarpy in many plant species (4). In this experiment the naturally occurring auxin plant hormone indole-3-acetic acid (IAA) and two synthetic plant growth regulators, indolebutyric acid (IBA) and naphthaleneacetic acid (NAA), were tested to determine if they would induce parthenocarpy in rapid-cycling *Brassica rapa*.

Materials and Methods

Wildtype, rapid-cycling *B. rapa* were grown under conditions recommended by the supplier (5). When flower buds opened, the stamens were removed using fine forceps, thus exposing the pistil adequately for treatment and reducing opportunities for self pollination. IAA, IBA or NAA was applied to the pistil by using a flat toothpick to smear the entire pistil with lanolin (see Figure 1). Each pistil was coated with 0.7 to 0.8 mg of lanolin or lanolin containing 5,000 ppm of hormone/growth regulator obtained pre-mixed from the Carolina Biological Supply Company. Pure lanolin was used in control treatments.

The plants were divided into six groups. One group received no lanolin or hormone and served to determine the extent of random pollinations. One group was treated with pure lanolin. One group received IAA, one received IBA and one received NAA. A sixth group was cross pollinated to provide fruits for comparison with any induced by other treatments; pollination was accomplished using bee-sticks (5). A maximum of six flowers on each plant were treated; the growing tip of the plant was removed after the last treatment and flower buds forming subsequent to the final treatment were removed.

When the fruit had grown large enough to determine the presence of seeds in them, the plants were allowed to dry and the fruits examined by dissection. A number of plants in each treatment were maintained until the fruit stopped growing and reached visually apparent maturity. All experiments were repeated three times, with four to six plants receiving each treatment.

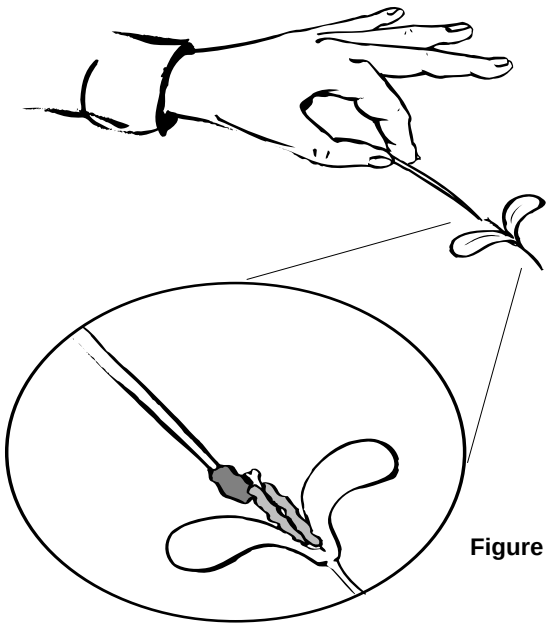

Figure 1

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Results

After treatment with lanolin, hormone/growth regulator or pollination, the petals on the flowers *senesced* and underwent *abscission* (e.g., withered and dropped off.) In flowers that had been pollinated or treated with hormone/growth regulator, the pistil grew in length and increased in diameter. Increase in length was often visible within 24 hours, but growth in diameter occurred more slowly. If ovules had been fertilized, seeds were visible within the fruit 7 to 10 days after pollination.

All three hormones/growth regulators caused the formation of pathenocarpic fruit. However, the fruits did not grow at equal rates; IBA consistently caused the most rapid growth, followed by IAA; NAA induced the slowest growth.

In all trials, IBA most often induced fruit that duplicated the size and shape of seed bearing fruit at maturity; the IBA-induced fruit, however, did not have swellings caused by seed inside the fruit, except in rare cases (less than 5% of such flowers).

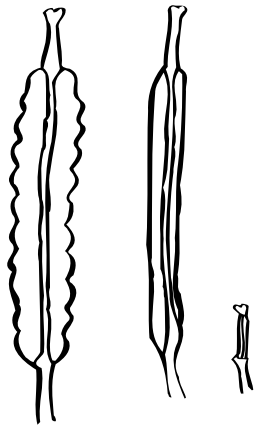
Treatment with lanolin alone did not induce fruit formation and may have inhibited growth in a few of the plants. Pollination (the control) caused the growth and development of fruit as described previously (5).

Discussion

IAA, IBA and NAA all caused the induction of parthenocarpic fruit in *B. rapa*. Results were clear and easy to observe, with appropriate controls readily established. The general availability, simple growth requirements, small size and ease of manipulation of rapid-cycling *B. rapa* make the species highly desirable for studies of parthenocarpy in the classroom.

The differences in growth rates of the fruit induced by the hormones/growth regulators tested here may be due to the different rates of metabolism induced by the specific compounds in *B. rapa*. IBA may also be more stable than the other molecules, and thus have a longer lasting effect. Also, IBA may be able to penetrate the external tissues of the pistil more easily than IAA or NAA and reach a higher concentration within the developing fruit. NAA is reported to be more toxic to plants than
IBA (3).

Several hypotheses regarding the role of auxins in causing fruit development have been offered. One view holds that pollen and pollen tubes contain a growth stimulator, possibly auxin, which is responsible for fruit development, mainly by stimulating growth of the ovary (2). Another perspective is that developing seed contains auxin and causes growth of the fruit (1). Although the current study does not specifically support either mechanism, it is consistent with earlier general studies of parthenocarpy (4).



Which pistil received the hormone treatment?

Questions for further experiments

- Will other hormones/growth regulators, e.g., gibberellins, induce parthenocarpy in Fast Plants?
- Would a combined treatment of hormones and pollination have a similar effect?
- Does pollen from plants in other crucifer genera or brassica species (e.g., broccoli flowers, silver dollar plant, alyssum, wild mustard) have any effect on Fast Plants? Does it result in parthenocarpy or seed production in Fast Plants?
- Does pollen from other families of plants have any effect on Fast Plants? Try using fresh beesticks to collect pollen from flowers in a garden, in the wild, or from house plants. Be sure to label each beestick as to the pollen it's carrying.

Literature Cited

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