Seed Production Used to Determine Pollen Limitation in *Helianthus* Sp.

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Abstract

Land fragmentation today has proved to pose many threats to plant biodiversity (Aizen, Ashworth, & Galetto 2002). In an attempt to prevent further loss of flower species scientists search for ways to determine causes of reproductive failure. In a study done by Stuart Wagenius on *Echinacea angustifolia*, he found that some plants are self-incompatible, meaning that they decline in pollination and seed production when pollinated with their own pollen. Style persistence, the mean duration of persistence of style rows on the head of a plant, has shown to be a successful method for quantifying pollen limitation (Wagenius, 2004). In this study, we help our mentor, Karen Taira, test whether style persistence can be a noninvasive method to predict successful reproduction for the species *Helianthus* (common name Sunflower), by observing seed production. *Helianthus* is a perennial species that is made of composite inflorescences and are self-incompatible as well. The total seed production of the entire composite flower is recorded based on the pollination treatment that each experimental flower received; self, outcrossed, excluded or open. Karen Taira and others at the Chicago Botanic Garden completed the pollination treatments during the summer of 2012. The flower heads were cut, cleaned and x-rayed to observe seed sets. In this specific study we looked to see if seed set correlated to each pollen treatment. With these findings, in the future land owners can potentially have the ability to analyze pollination and reproductive success during flowering seasons and in general hopefully improve plant biodiversity.

Introduction

In this study, we used *Helianthus strumosus* and *Helianthus microcephalus* to determine if seed set accurately corresponds with pollen treatments: open pollinated and cross-pollinated flowers would show a higher seed set than self-pollinated and non-pollinated flowers.
Helianthus is a **self incompatible** species, meaning it can not fertilize itself.
Helianthus is a **composite flower,** multitude of inflorescences and sterile ray flowers
Achenes: all shells produced by the flower
Seed: Shells that contain viable embryos
This information will be used to support that self-incompatible plants fail at reproduction and that pollen from other plants is required to have successful pollination and reproduction.

Hypothesis: Quality of pollen directly affects the seed production of the flower
Null Hypothesis: Quality of pollen will have no affect on the seed production of the flower.

Methods

- 2 species were chosen: *Helianthus Strumosus* and *Helianthus microcephalus* (at least 12 plants from each species and both from an Illinois prairie)
- Double Blind Study
  - Interns were unaware of which flower head received which treatment until specimens had been x-rayed and all data collected.
- Plants were divided among the pollination treatments equally and labeled with identification numbers
- After treatment, flower heads, including the labels, were removed from the plant once the heads were completely dried and placed in paper bags labeled with their identification number (Fig. 1)
- Flower heads are cleaned and the achenes are removed
  - On a data table for each flower head the id number, condition of the head, and additional notes on the flower head was recorded prior to retrieving achenes.
  - Achenes were cleaned using forceps and placed into small envelopes labeled with the ID numbers to be x-rayed later.
- Achenes from individual flower heads were x-rayed on the Faxitron X-Ray Specimen Radiography System. After, the total amount of achenes and the amount of full achenes were recorded on the data sheet for later analysis. (Fig. 2)

Figure 1. Flower head in pollination bag and labeled paper bag with id number.

Figure 2. Faxitron X-Ray Specimen Radiography System used to x-ray seed sets.

Results

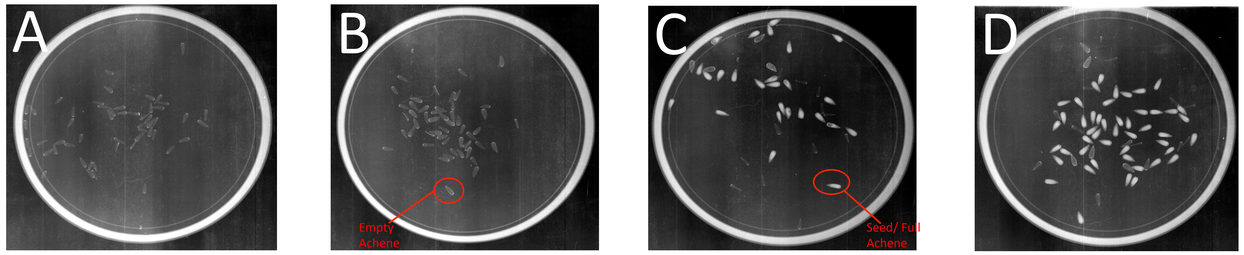

Figure 3. X-Ray scans of seed sets from *Helianthus strumosus* . The light gray achenes are empty. The bright white achenes contain viable embryos or seeds.
A.) s2102 Exclusion. No seeds present.
B.) s2011 Self. No seeds present
C.) s2012b Open 26 seeds/41 achenes
D.) s2013b Cross 48 seeds/ 62 achenes

Seed Set Comparison of *H. microcephalus*

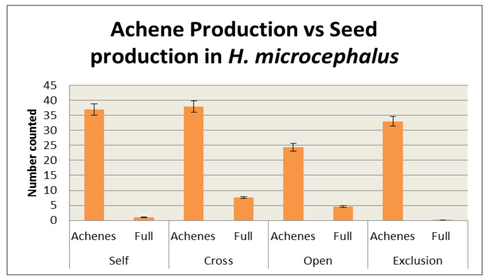

Figure 4. Species *H. microcephalus* Comparison of achene production to the number of viable seeds according to treatments. All treatments show that the flowers produced achenes. There is a correlation between pollination treatment and viable seeds produced: self and exclusion treatments produced significantly fewer full achenes.

Seed Set Comparison of *H. strumosus*

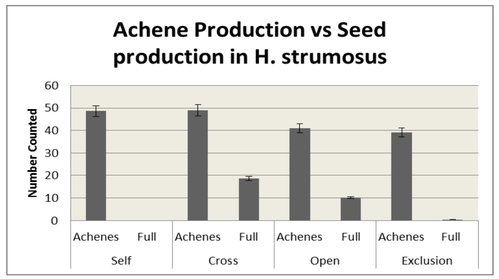

Figure 5. Species *H. strumosus* Comparison of achene production to the number of viable seeds according to treatments. All treatments show that the flowers produce achenes. There is a correlation between pollination treatment and viable seeds produced: self and exclusion treatments produced significantly fewer full achenes.

Future Studies

- Are style persistence and seed set related for the *Helianthus* species*?*
- The prairies studied were near civilization. Does this have an impact on the flowers in the population? Study the same experiment in other populations, near civilization and completely isolated.
- Can style persistence be used to analyze all flower species? Test more species to determine if style persistence pertains to species versus location.
- Perform more experiments to determine why *H. strumosus* had more dramatic results than *H. microcephalus*.

Discussion

- In the scientific community it is understood that land fragmentation presents many threats for biodiversity and reproduction of plants. For this reason, studies have been conducted to discover ways to stop or prevent loss of biodiversity in many habitats(Hufford & Mazer 2003).
- In this study, pollen limitation, style persistence and seed set were observed for *Helianthus Strumosus* and *Helianthus microcephalus.* With the collected data in this study, reproductive and pollination success was observed based on seed set
- Both species, *Helianthus strumosus* and *Helianthus microcephalus,* showed that our hypothesis was supported. Flowers treated with self-pollination and eliminated pollination treatments produced significantly fewer seeds, or no seeds at all, in comparison to open pollination and cross pollination treatments (Fig. 4 and Fig. 5).
- *Helianthus strumosus* yielded a larger total amount of achenes per treatment and overall displayed results that better supported our hypothesis (Fig. 5).
- Both species showed that they were self-incompatible, and that seed set can in fact be used to predict reproductive fitness.

Literature Cited

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