Sterile Pollen Technique as a Novel Weed Management Tool

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Introduction

- Irradiated pollen is physiologically alive but sterile.
- The sterile pollen interferes with fertile pollen in the process of fertilization, thereby reducing seed production.
- High doses of UV, gamma, and X-ray irradiation are often used for pollen sterilization; however, the technique has never been envisioned as weed control technique.
- **Using dioecious Palmer amaranth (*Amaranthus palmeri*) as a model system I hypothesize that seed production in this weed can be reduced by pollinating with irradiated and sterile pollen.**
- Although the focus of this project is a single weed (i.e. Palmer amaranth), the method can be extended address the problem of multiple weed species (broad-spectrum weed control): sterile pollen from multiple weed species can be mixed and released in a single application.

Objectives

1) To evaluate the effect of different dosages of irradiation pollen on disrupting seed production of Palmer amaranth.
2) To investigate the influence of different storage temperatures on irradiated pollen viability.

Methods

- Seventy male and female Palmer amaranth were grown in the greenhouse and then separated at the beginning of flowering stage.
- The fresh and mature pollen from male plants were collected and irradiated with gamma-ray from Cesium-137 at dosages of 0, 100, 200, 300, 400 and 500 Gy.
- Irradiated and untreated pollen were immediately used for two experiments: hand-pollination and pollen viability study.

Hand-pollination

- Each dosage had six treatments with five replications .
- On each female plant, six lateral inflorescences of similar size were selected, which received

1) no pollen
2) only non-irradiated pollen
3) only irradiated pollen
4) non-irradiated pollen after irradiated pollen
5) irradiated pollen after non-irradiated pollen
6) open pollination (Fig 1).

The inflorescences were bagged immediately after pollination (except open pollination).

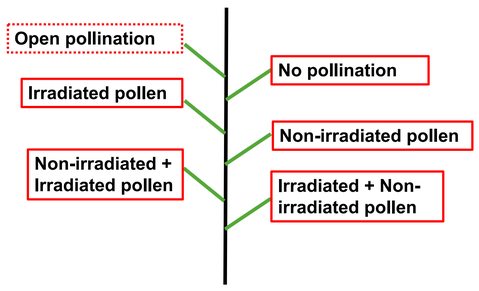

Figure 1. Hand pollination experiments for different irradiation doses with different treatments

- Flower and seed number were documented from five 1cm section of plant branches

Figure 2. Hand pollination

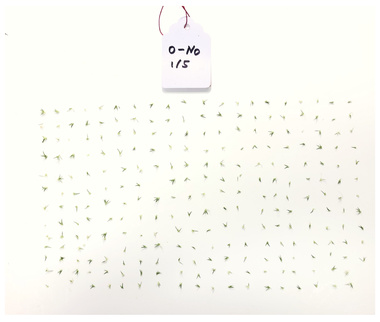

Figure 3. Dissected flowers

Figure 4. Dissected single flower

Pollen viability test

- Storage time: right after irradiation, and after one week, 1 month, 3 months and 6 months
- Storage temperature: -80, -20, 4, and 20 °C respectively
- The test solution consisted of a 1% concentration of the substrate 2,5-diphenyl tetrazolium bromide (MTT) in 5% sucrose.
- Pollen grains images were captured and analyzed using digital camera (Leica MC190 HD) and ImageJ respectively.

Results and Discussion

The effect of different dosages of irradiation pollen on seed production

- Pollinating with irradiated pollen before non-irradiated pollen is more efficient to reduce seed production than pollinating with non-irradiated pollen before irradiated pollen (Fig 5).
- 300 Gy is the most effective irradiation, which reduced seed production by about 46% (Fig 5).

The effect of different storage temperatures on irradiated pollen viability

- Only dose 500 Gy significantly decreased pollen viability (Fig 7).
- -80 °C is the optimal temperature to maintain the viability of irradiated pollen (Fig 8).

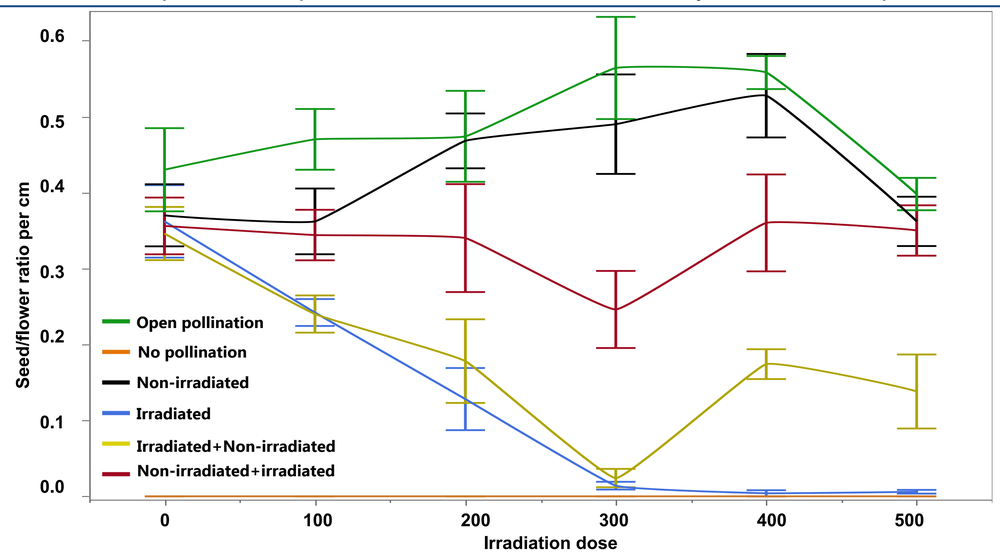

Figure 5. The effect of different irradiation doses on seed/flower ratio per centimeter

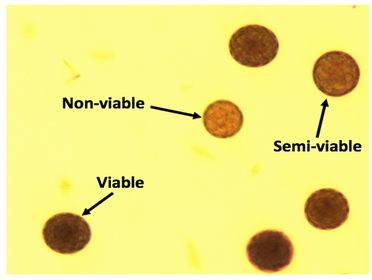

Figure 6. Pollen stained with MTT in different intensities.

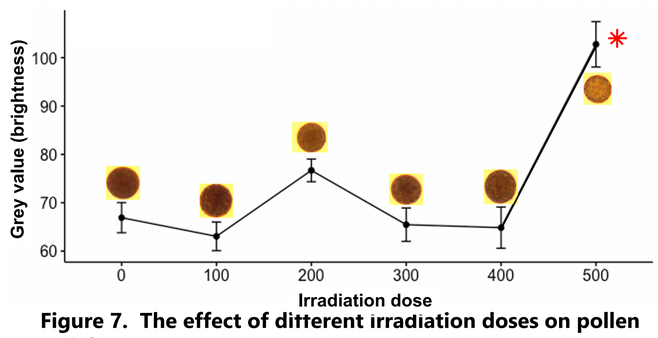

Figure 7. The effect of different irradiation doses on pollen viability

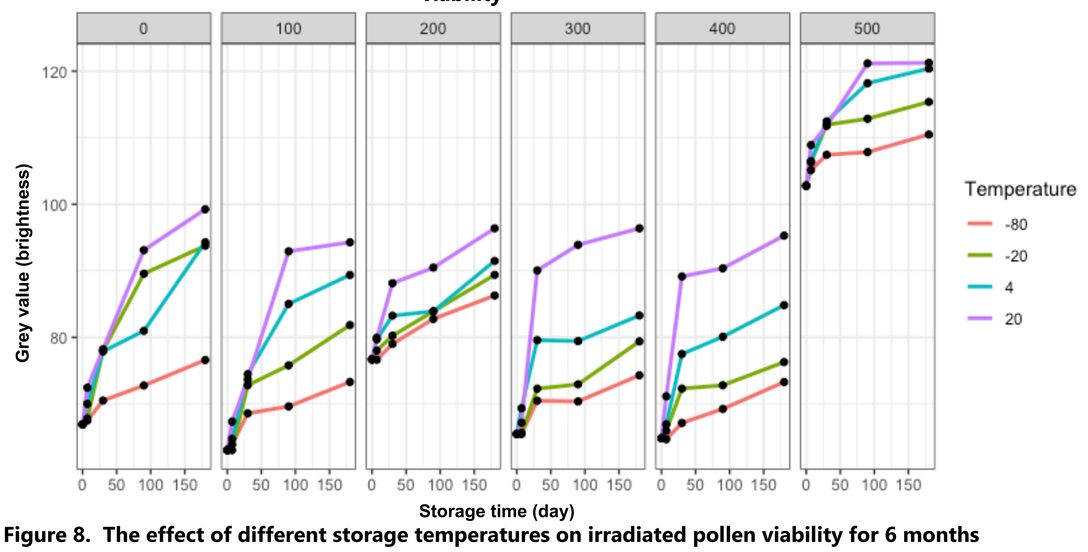

Figure 8. The effect of different storage temperatures on irradiated pollen viability for 6 months

Conclusion

- ❖ Seed production in Palmer amaranth can be most effectively reduced by pollinating with 300 Gy (gamma-ray) irradiated pollen right after female plants flowering.
- ❖ In order to achieve Sterile Pollen Technique (SPT), irradiated pollen should store at -80°C to maintain viability for large scale application. This technique can be particularly helpful for managing herbicide resistant weeds that have withstood in-season control and hence ready to produce seeds.

Future work

Hand pollination experiment and pollen storage experiment will be performed again this year. More irradiation doses (gamma-ray from Cesium-137) ranging from 200 Gy to 400 Gy will be used. Also, X-ray irradiation will be employed.