Reina Nielsen

Echinacea Project Proposal

July 1, 2013

Photosynthetic rates between different crosses of *Echinacea angustifolia* plants and basal and inflorescence leaves

**Introduction**

Fragmentation of any habitat can cause a variety of genetic problems. A common problem is often a loss of genetic variation within populations (Ridley, 2011). The tallgrass prairie of North America is a habitat that has become reduced to small fragmented remnants, but is still home to many different plants. The long-term survival of these plants is not certain, as the genetic composition between different plants may result in a lower overall fitness. How these genetic variations impact physiological processes such as photosynthetic rates may play an important role in understanding the long-term survival and reproduction of the species.

One such species within the remnants is *Echinacea* *angustifolia,* a perennial plant. By studying photosynthetic rates in *Echinacea angustifolia* inbred crosses, crosses between remnants, and crosses within unrelated remnant plants, the physiological effects of fragmentation on *Echinacea angustifolia* can be more fully understood. Wagenius found evidence that inbred plants of *Echinacea angustifolia* have significantly decreased long-term survival and reproduction then the crosses between remnants and crosses within unrelated remnant plants (2010). These patterns may be linked to carbon fixation within the plant crosses. Previously studied plants in natural populations have shown that separated populations do exhibit different photosynthetic rates (Arntz, 2001).

Another way to understand the differences between the Echinacea crosses are to look at the photosynthetic rates of their basal and inflorescent leaves. During flowering, the carbon fixed by the inflorescence leaves could account for the extra energy needed to reproduce (Hogan, 1998). By measuring the photosynthetic rate of the leaves within the *Echinacea angustifolia* crosses, physiological process can be more fully understood and can be used to examine how these processes may affect survival and reproduction at remnant sites.

**Procedure**

*Pam Kittelson’s Project:*

To assess photosynthetic efficiency in *Echinacea angustifolia* crosses, photosynthetic rates such as Amax, conductance, and transpiration will be measured on Echinacea plants that have been inbreed, breed between different remnants, and breed from within remnants with plants not closely related to each other. The plants in the INB1 garden and the INB2 garden will be randomly selected and a basal leaf from each selected plant measured. In INB1 garden, roughly 100 plants will be measured, and in the INB2 garden, roughly 400 plants will be measured. This will be done using the Li-Cor 6400XT machine, and will be repeated a total of three times throughout the season in order to collect data from different development stages. The light will be set to 1600μmol/m2/sec. The same leaf will be measured every time and kept track of by loosely twisting a twist-tie around the base of the leaf.

*Reina’s spin-off project:*

The Li-Cor 6400XT machine will be used to measure Amax of basal and flowering leaves on the same plant. The light will be set to 1600μmol/m2/sec. This treatment will be done on a total of 47 plants in the INB1 garden- 8 plants from the within crosses, 15 plants from the inbreed crosses, and 24 plants from within the between crosses. The plants will be chosen randomly from a variety of paternal and maternal parents within each cross. This treatment will be repeated a total of three times. These trials will occur prior to the plants flowering, during flowering, and during the time that Echinacea angustifolia will be setting seed. The same leaves will be used each time. The leaves will be kept track of by loosely tying a twist-tie around the base of the leaf.

**Equipment**

P*am Kittelson’s Project:*

Li-Cor 6400XT machine

Visor

Meter stick

Metric ruler

Flags

Twist-ties

The equipment used will be purchased with money from the NSF grant or borrowed from the Echinacea Project research base.

*Reina’s spin-off project:*

Li-Cor 6400XT machine

Visor

Meter stick

Metric ruler

Twist-ties

All the equipment needed is already on the research base. The Li-Cor 6400XT machine is under the possession of Pam Kittelson and will be used with her permission and under her supervision. All other equipment will be borrowed from the Echinacea Project base.

**Sample Data Sheet**

*Pam Kittelson’s Project:*

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*Reina’s spin-off project:*

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| Row | Position | Leaf | Plant status | Amax | SA | Notes |
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Plant status: BF – Before Flowering, F-flowering, SS- setting seed

**Statistical Analysis**

*Pam Kittelson’s Project:*

For this project, ANOVA will be used to analyze the data collected.

*Reina’s spin-off project:*

This project will include several methods of analyzing data. To analyze data collected on individual plants (basal vs. inflorescence leaves), a paired T-test will be used. Between different crosses and between different growth seasons, ANOVA will be tentatively used to analyze the data collected.

**Timeline**

*Pam Kittelson’s Project:*

This project will take three months to complete. Each trial will take between 1.5 and 2 weeks to gather data and will be done once a month for June, July, and August.

*Reina’s spin-off project:*

This project will take about three months to complete. Each trial will take 2 days to measure and will be repeated three times across the development span of Echinacea angustifolia.

**References**

Arntz AM and Delph LF. 2001. Pattern and process: evidence for the evolution of photosynthetic traits in natural populations. Oecologia 127:455–467.

Hogan KP, García MB, Cheeseman JM, and Loveless MD.1998. Inflorescence photosynthesis and investment in reproduction in the dioecious species *Aciphylla glaucescens* (Apiaceae). New Zealand Journal of Botany 36(4): 653-660.

Ridley CE, Hangelbroek HH, Wagenius S, Stanton-Geddes J, Shaw RG, 2011. The effect of plant inbreeding and stoichiometry on interactions with herbivores in nature: Echinacea angustifolia and its specialist aphid. PLoS ONE 6(9): e24762.

Wagenius, S., H. H. Hangelbroek, C. E. Ridley, and R. G. Shaw. 2010. Biparental inbreeding and interremnant mating in a perennial prairie plant: fitness consequences for progeny in their first eight years. Evolution 64:761-771.