



Germination and selfing rates in natural and horticultural *Echinacea* taxa

Christina Andruk^{1,2}, Jennifer Ison^{1,3}, Kay Havens¹

1- Chicago Botanic Garden, 2- University of Connecticut, 3- University of Illinois at Chicago



INTRODUCTION:

*Horticulture selection can change basic characteristics such as germination and selfing rates in plants. From a conservation standpoint, it is important to understand what changes occur when plants are brought into horticulture and how this could effect natural populations if there is cross pollinate. The genus *Echinacea* is used extensively in horticulture and can be used as a model to analyze the differences between natural and horticultural populations.

*The **temperature and timing germination** experiments will examine natural and horticultural taxa's response to variations in germination temperature through germination rate and timing.

*It is estimated that around 60% of all angiosperms are self-incompatible (SI). Domesticating self-incompatible plants may affect their selfing rates. *Echinacea*, like many members of the Asteraceae, has a sporophytic self-incompatibility system (SSI), in which, the two S alleles on the diploid pollen coat control pollination. Self-incompatibility is not always completely effective. It has been documented that in *Senecio squolidu* the rate at which plants self pollinate 3.1% (Brennan 2005). The **selfing rate** experiment will provide information on the conservation of fragmented habitats. As habitats decrease in area, plants may have to rely more on self pollination to reproduce.

RESEARCH QUESTIONS:

1. What is the effect of temperature on germination rate and timing in the 6 *Echinacea* taxa?
2. How does the selfing rate vary among 6 *Echinacea* taxa?

GENUS CHARACTERISTICS:

*Asteraceae *Perennial *Self-Incompatible
*Limited seed dispersal *Reproduces by seeds

TAXA ANALYZED:

Nat.pop.ang: *E. angustifolia* (from natural populations in Minnesota) (Fig. 1)

Nat.pop.pur: *E. purpurea* (natural population near Hot Springs, NC)

Cultivar.pur: *E. purpurea* 'Bright Star Improved' (horticulture cultivar)

Hybrid 1: [*purpurea* "Alba" x *paradoxa*]

Hybrid 2: [*purpurea* "Alba" x [*tennesseensis* x *angustifolia*]]

Hybrid 3: [[*purpurea* x *purpurea* "Alba"] x [*purpurea* x *paradoxa*]]
x [[*purpurea* "Alba" x [*purpurea* x *purpurea* "Alba"]]



Figure 1: *Echinacea angustifolia*

METHODS:

*Summer 2003: 10 individual plants with at least two flowering heads from each taxa were chosen at random. Flowering heads were assigned one of two treatments:

-Open pollinated -Pollinator excluded

*Seed were collected in the fall, cleaned, dried with silica gel and stored at -20°C.

***Pregermination treatment** (14 days): Seeds were cold stratified in a 4°C fridge with a 24-h/day low levels of light. Florel solution was used maintain moisture and provide ethylene (Ferghahati and Reese 1994).

***Germination treatment** (14 days):

-For the **temperature and timing experiments**, 30 seeds per seed head were placed in each temperature category: 17, 21, 25, 29, and 33°C at 16-h/day light on the thermogradient table.

-For the **selfing experiment**, 100 seeds per plant were incubated at 25°C at 16-h/day light. (Fig. 4)

*Seeds were considered germinated when the radicle was visible.

*Number of seeds with embryos that did not germinate was recorded at the end of the experiments.

TEMPERATURE AND TIMING GERMINATION:

DATA ANALYSIS AND RESULTS:

Temperature Experiment

*Generalized linear model

***Predictors:** taxa and temperature ***Response:** germination rate (binomial distribution)

*Taxa and temperature significant predicted germination rate ($p \approx 0.0$ AIC = 289.15)

Timing Experiment

*Generalized Linear Model

***Predictors:** taxa, temperature ***Response:** germination timing (poisson distribution)

*Taxa and temperature significant predicted germination timing ($p \approx 0.0$ AIC = 12291)

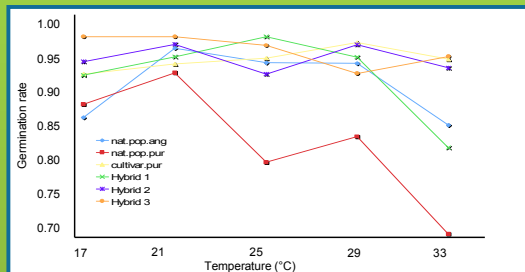


Figure 2: Germination rate for each taxon by temperature

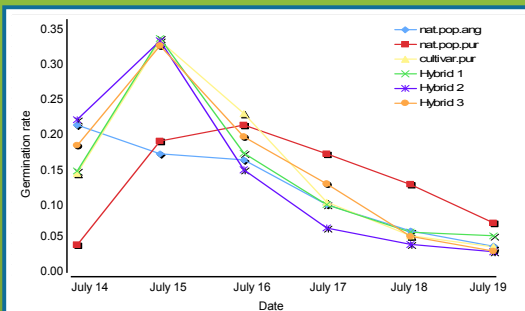


Figure 3: Germination rate for each taxon by date of emergence

DISCUSSION:

Temperature Experiment

*Seeds from horticulture and cultivar taxa germinated at a higher rate (95%) than the natural taxa (89%).

*The hybrid and cultivar seeds tolerated a wider range of temperatures than the natural seeds (Fig. 2)

*Horticulture and cultivar taxa could have a selective advantage if they were to compete with natural populations in the wild in terms of the number of viable seeds produced, and the range of temperatures at which they can germinate.

Timing Experiment

*Hybrids and cultivar seeds all had peak germination on the same day while the natural populations had more varied distributions (Fig. 3).

*Hybrid and cultivar taxa may have lost genetic diversity in terms of the timing of germination due to selection for a uniform germination temperature. This may have been accomplished by eliminating one of the dormancy stages (Qu 2005).

*Natural taxa have more variation in the timing of their germination which could prevent an entire population from being destroyed by stochastic events.

SELFING RATE EXPERIMENT:

DATA ANALYSIS AND RESULTS:

*Generalized linear model

***Predictor:** taxa ***Response:** fertilization rate (binomial distribution)

*Taxa significant predicted the number of selfed seeds that germinated ($p = 0$ AIC = 128.55)

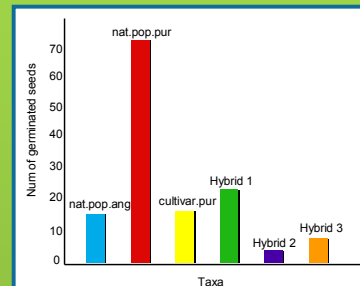


Figure 4: Number of selfed seeds that germinated out of 1000 seed per taxon



Figure 5: Seeds in petri dish

DISCUSSION:

*Nat.pop.pur had many more germinates than any other taxa -7.3% of its seeds germinated (Fig 4).

*Two nat.pop.pur plants had significantly higher germinates, 35 and 21 ($p \approx 0$) than other plants in that taxon.

*This indicating there could be a maternal effect of selfing and these plants may have a leaky self incompatibility system.

*The plants could be responding to the negative aspects of growing in a pollen-limited environment.

*There is an evolutionary tradeoff between avoiding inbreeding, and maximum reproductive output. If a population is fragmented, it could become pollen-limited and the selfing rate may increase. This has also been documented to occur during population bottleneck events (Brennan, 2005).

FURTHER RESEARCH:

*Further study the variation in germination rates between natural and horticulture populations of *Echinacea* with other conditions such as: storage time, ethylene treatments, and changes in cold stratification.

*DNA fingerprinting to determine if those seeds that selfed were truly selfed seeds or if contamination occurred.

*Study selfing rates in SSI species in natural fragmented populations in order determine the effect of pollen limitation on inbreeding depression.

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