Has yellow starthistle (*Centaurea solstitalis*) recently adapted to serpentine soils?

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Abstract

Yellow starthistle (*Centaurea solstitalis*) is a highly invasive noxious weed that has caused widespread environmental and economic damage in California and the western United States. However, in the past, starthistle has not invaded serpentine soil habitats as it has invaded otherwise similar non-serpentine soil habitats. Serpentine soils, which present chemical and physical difficulties for plant growth, are relatively common in California, have produced large numbers of endemic species, and have largely not been invaded by non-native plants. However, in recent years, yellow starthistle has been noted increasingly often on California's serpentine soils. The purpose of this experiment is to test if some yellow starthistle populations have developed genetic-based adaptations that allow them to grow and successfully compete in serpentine habitats. Three pairs of otherwise similar serpentine and non-serpentine sites with starthistle present from a wide geographical area within California were identified and soil and seed samples were collected from each site. Germination tests at different water potentials were performed on seeds from all populations. Seeds from the serpentine samples tended to have higher germination than seeds from non-serpentine populations.

Introduction

*Starthistle (*Centaurea solstitalis*) is a highly invasive noxious weed that has decimated rangeland, grassland, farmland, and wildland in the Western United States
*Species invasions often follow the same pattern: introduction, followed by a "lag period", followed by exponential increase in species abundance, followed by a slowed expansion as the species nears its biological potential.
*Starthistle has displayed a classic invasion pattern from its introduction to California to the present.
*Serpentine soils are derived from ultramafic rock and are characterized by a low Ca:Mg ratio and often also have high concentrations of heavy metals such as Fe, Ni, Cr, and Co and low levels of plant nutrients including N, P, Ca, and K. They tend to have a patchy distribution and, although not geographically separated from other habitats, the serpentine soils' distinctive characteristics result in extremely different growing conditions.
*Because of these challenging conditions, serpentine soil habitats often are composed of a high number of endemic species and many plants (including invasives) cannot grow/compete on serpentine soils.
*Starthistle has not historically been an especially concerning weed on serpentine soils.
*Plants in the same family have traits in common. Starthistle is a member of the Asteraceae family which contributes the second greatest number of the worst weed species worldwide

Objective

Determine if seeds from yellow starthistle populations growing on serpentine soils perform differently than yellow starthistle populations growing on non-serpentine soils.

Materials and Methods

*Identified potential "twin" serpentine and non-serpentine sites using Web Soil Survey, geology maps, and land-manager expertise.
*Collected seed and soil samples from "pairs" of serpentine and non-serpentine sites.
*Tested the percent germination of seeds collected from each population at 5 water potentials.
*Fit hydro-time model to percent germination data.

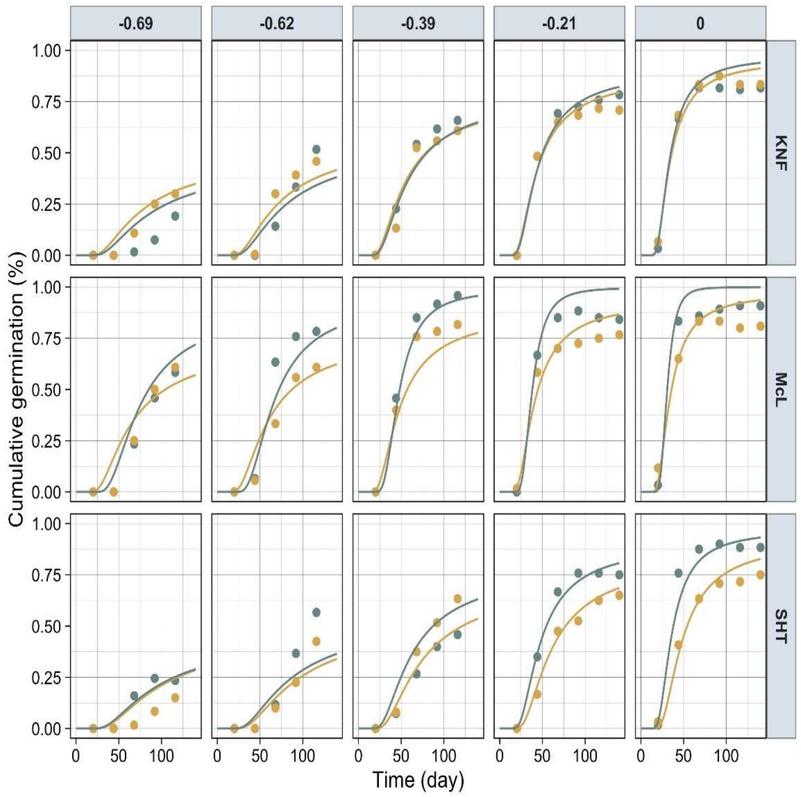

Figure 1. Cumulative percent germination over time (hours). Seeds from serpentine populations tend to have a higher percent germination than seeds from non-serpentine populations.

Results and Discussion

*Seeds from serpentine populations tend to have a higher germination than seeds from non-serpentine populations.
*These trends suggest that serpentine populations may have genetic differences from non-serpentine populations.
*Alternative explanations include small sample size, damaged seed, and small number of sites.

Conclusions

Further experiments are required to test this hypothesis

Future Work

*Test soil samples for "Serpentine Character".
*Conduct a reciprocal common garden experiment and measure the fitness of plants from different populations.
*If there are significant differences in performance of the serpentine and the non-serpentine populations, genetic testing will be performed.
*Identify and conduct experiments on more serpentine/non-serpentine pairs.

References

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