Report: Soil biota in abandoned agricultural fields limits restoration of native forbs in southern California

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**Summary**

Biotic and abiotic constraints on the re-establishment of native plant communities in old fields or abandoned agriculture may be due to strong soil legacy effects. Agricultural practices such as tilling, fertilization, and monocultures all contribute to soil degradation. Little is known about how soil-borne pathogen legacies affect the re-establishment of native plant species during restoration. Previous experiments revealed oomycete hyphae infecting the roots of native forb species (Hilbig and Allen 2015). *Peronosporales* contains oomycete pathogens that are the cause of foliar blight, such as grape downey mildew, but also contains soil borne pathogens of the genera *Phytophthora* and *Pythium* that are common agricultural pests.

We examined the effects of a fungicide (fludioxonil) and an oomycetecide (metalaxyl) on the growth of the invasive annual grass *Bromus diandrus* and associated native forbs *Amsinckia menziesii*, *Layia platyglossa*, and *Lasthenia californica* growing in mixture. Due to exceptional drought in California in 2014-15 growing season, native coastal sage scrub forb species and *Bromus diandrus* were seeded in 4 gallon mesocosms (15.25 x 11.5 x 7.25 in.) in controlled greenhouse conditions. Plants were grown under 4 different soil conditions including sterile, control (contains all soil biota), metalaxyl soils, and fludioxonil soils. Seeds of the five native forbs and *Bromus diandrus* were added at a density of 6 viable seeds per species per mesocosm. Mesocosms contained a constant density of 24 plants across all treatments. Plants were harvested after five weeks for aboveground biomass and root biomass. Biomass was determined after drying at 60 ̊C for 48 hours.

**Results**

The application of Fludioxonil increased aboveground biomass of the native forb *Layia platyglossa* (P=0.005, Fig 1) and the invasive grass *Bromus* (P=0001, Fig 1). *Bromus* had the highest biomass in sterile soil than all other treatments, whereas native forbs had reduced biomass in sterile soils compared to control soils. There was no significant change to *Amsinckia menziesii* and *Lasthenia californica* biomass across soil treatments (Fig1). Preliminary root colonization observations revealed that neither metalaxyl nor fludioxonil killed arbuscular mycorrhizal fungi, but fludioxonil did reduce septate hyphae in roots. A high incidence of ascomycetous hyphae was observed in *Bromus diandrus* and *Lasthenia californica*. High colonization by coarse arbuscular mycorrhizal fungi (AMF) was observed in *Layia platyglossa*. Field collected samples had as high as 49% coarse AMF colonization in *Layia platyglossa*.

Culturing and subsequent isolation of potential oomycetes using PARP-H media resulted in 5 morphologically unique cultures. Sequences of our cultures matched known sequences of one oomycete, (*Pythium heterothallicum*)*,* three ascomycetous fungi (*Fusarium equiseti, Fusarium pseduograminerarum, Penicillium brevicompactum*),and one zygomycete (*Mortierellales sp*)within GeneBank.

**Conclusions**

Increased biomass in the native plant *Layia platyglossa* in soils treated with Fludioxonil is most likely due to a reduction in infection by soil-born root pathogens while having no effect on coarse AMF. The use of this fungicide might result in increased establishment and growth of *Layia platyglossa* during restoration. However, *Bromus diandrus* also benefitted from the application of Fludioxonil and sterile soils suggesting that soil-borne pathogens reduce the growth of the invasive grass. Alleviation from these pathogens might result in an increase in establishment and growth. We have identified and cultured five agricultural pathogens including *Fusarium equiseti* and *Fusarium pseduograminerarum* which cause root-rot and crown rot, respectively, in wheat. These pathogens may be negatively affecting the growth of the invasive annual grass *Bromus diandrus* in this system, and therefore applications of fungicides, such as Fludioxonil, might actually benefit the invasive species at the same time it benefits some natives.



Fig 1. Aboveground biomass of native forbs and *Bromus diandrus* when grown under different soil conditions, harvest after five weeks, and dried at 60 C for 48 hours. Significance was determined at α=0.05.