A Comparison of *Bromus tectorum* Growth and Mycorrhizal Colonization in Salt Desert vs. Sagebrush Habitats

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A Comparison of *Bromus tectorum* Growth and Mycorrhizal Colonization in Salt Desert vs. Sagebrush Habitats

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Abstract

Cheatgrass (*Bromus tectorum*) has recently invaded marginal low-elevation salt desert habitats across the Great Basin. We tested the hypothesis that cheatgrass seed produced in populations from the more stressful salt desert vs. upland sagebrush habitats should grow differently in salt desert soils compared to adjacent upland sagebrush soil, and vice versa. We evaluated growth, incidence of flowering, and arbuscular mycorrhizal fungi (AMF) colonization of plants grown in the soils from which their seeds were collected vs. in the reciprocal soils from the nearest sagebrush or salt desert site in three large basins in northern Nevada. Simultaneously we measured nutrient cations, available nitrogen and phosphorus, percent carbon and nitrogen, texture, and dry-down characteristics in all soils. We found that salt desert soils were generally more nutrient poor and more saline than their upland (sagebrush) counterparts; salt desert soils also generally had a higher percentage of sand compared to their upland counterparts and were consistently drier. The most dramatic plant responses to soil and seed source were 1) lower aboveground biomass of mature plants in most salt desert soils compared to sagebrush soils, or lower biomass in plants grown from salt desert seed; 2) lower root:shoot ratios in plants grown in salt desert soil across two of three basins, irrespective of seed source; 3) a higher percentage of flowering individuals from salt desert seed sources at harvest, irrespective of soil source; 4) depressed AMF colonization of plants in salt desert soils; and 5) strong influence exerted by seed source on AMF, whereby sagebrush-originating plants grown in sagebrush soils had greater AMF colonization compared to salt desert soils but salt desert-originating seedlings had very low AMF colonization rates irrespective of soil source. These results suggest that both population level and soil-based controls are important as this widespread weed moves into marginal habitat.

Key Words: AMF, invader, maternal effects, seed source soil nutrients

INTRODUCTION

Plant invaders may expand their range into a broad array of sites by undergoing local adaptation (Parker et al. 2003) or by having broad environmental tolerances (e.g., the all-purpose genotype, Baker 1965). Most predictions of range expansions of invading species have been based on climate matching or climate envelope modeling, although the predictive power of this approach is low (Williamson 2006). Much less attention has been paid to the role of soils in the invasion and range expansion of introduced plants. Yet studies of plants on serpentine soils, for example, have demonstrated the important role of edaphic conditions in influencing species evolution and population persistence (Batten et al. 2006). Variation in soil nutrient availability (e.g., Huenneke et al. 1990) and soil microbial communities (as reviewed by Inderjit and van der Puttten 2010) have been shown to strongly influence invasion.

Cheatgrass (*Bromus tectorum* L.) is a primarily selfing annual grass introduced to western North America from Eurasia and northern Africa in the 1800s (Mack 1989). Its invasion into salt desert (SD) shrub communities, however, has been observed only since the late 1980s (Young and Tipton 1990; Hunter 1991). Novak and Mack (1993) argue that cheatgrass shows little genetic variation across its North American range, whereas others (Ashley and Longland 2009; Leger et al. 2009; Scott et al. 2010) have suggested that cheatgrass has developed genetic variation within and among invasive populations, particularly in marginal compared to more central habitats. Its presence in marginal SD habitats has been noted for three decades; it can become abundant enough to fuel large wildfires with negative and long-term impacts on the native vegetation (Haubensak et al. 2009). The degree to which invasion into SD habitats has selected for adaptations to that habitat is unknown, as is the extent to which mycorrhizal associations are present in cheatgrass populations across habitats and soil types. It is a facultative host of arbuscular mycorrhizal fungi (AMF), demonstrates little growth response to AMF presence (Allen 1984), and can reduce AMF in soils (Hawkes et al. 2006). Considered a poor host for AMF, its invasion and site dominance may affect recolonization and growth of resident species that may be AMF-dependent (Vogelsang and Bever 2009; Busby et al. 2012).

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