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Does disturbance similarly facilitate weed invasion within grass , forb , and shrub plots ?

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Key words : growth form , soil resources , safe sites , *Bromus tectorum* , *Isatis tinctoria*

Introduction Big sagebrush communities (*Artemisia tridentata* Nutt.) in the Great Basin have been degraded by the synergistic consequences of chronic disturbance and annual weed invasion (Young and Evans 1978). Repairing ecosystem function is an overarching goal of restoration efforts, but it remains unclear which species most effectively resist weed invasion and how disturbance mediates weed invasion. We evaluated whether disturbance similarly facilitates invasion in single-species grass, forb, and shrub plots.

Materials and methods Experiments were conducted at Millville, UT (41°39'44" N, 111°48'88" W, 1402 m). The soil is a gravelly loam series. Plots (1.5 m × 1.5 m, 1 m aisles) were established in May 2003 from transplants reared in a greenhouse, and consisted of 24 plants in a 5 × 5 square arrangement equally spaced (30 cm apart), with the center plant absent. Three plot-types were randomly located with 30 replicates: grass (*Agropyron cristatum* [L.]), forb (*Achillea lanulosa* [Nutt.] Piper), and shrub (*Artemisia tridentata* var. *wyomingensis* [Beetle & A. Young] Welsh). A disturbance treatment was applied in mid-November 2004 to 15 replications by removing four plants from the 1 m² center of plots with a shovel to potentially increase above and below-ground resources and create safe seed sites for the two invasive species. Plots were seeded an invasive annual grass (*Bromus tectorum* L.) and an invasive forb (*Isatis tinctoria* L.) autumn 2004 and 2005 (400 seeds per species). Total weed seedling density was determined in summer 2005 and 2006. Total (non-weed) shoot dry mass, soil nitrate and solar radiation (400-700 nm) at the soil surface was determined for plots in summer 2006.

Results Disturbance significantly increased weed density for all three growth forms except for *Agropyron* in 2006 (Figure 1). Within a treatment, weed density was less variable in 2005 than 2006. Weed density also sharply increased between 2005 and 2006 in all plots except *Agropyron*. In fact, weed density declined within disturbed *Agropyron* plots during the study. In contrast, *Achillea* and *Artemisia* plots had 2-3 fold greater weed density than *Agropyron*. Total plot non-weed shoot dry mass (g) of *Achillea* (1957 ± 542) was lower ($P < 0.01$) than *Agropyron* (4608 ± 542), which was lower ($P < 0.01$) than *Artemisia* (14,594 ± 542). The disturbance treatment did not consistently increase soil nitrate (mg kg⁻¹ soil) or solar radiation at the soil surface (mol m⁻² s⁻¹). However, *Achillea* plots had significantly greater ($P < 0.01$) mean soil nitrate and solar radiation (5.2 ± 0.05 and 382 ± 50) than *Agropyron* (1.3 ± 0.05 and 355 ± 50) and *Artemisia* (0.9 ± 0.05 and 155 ± 50) plots, respectively.

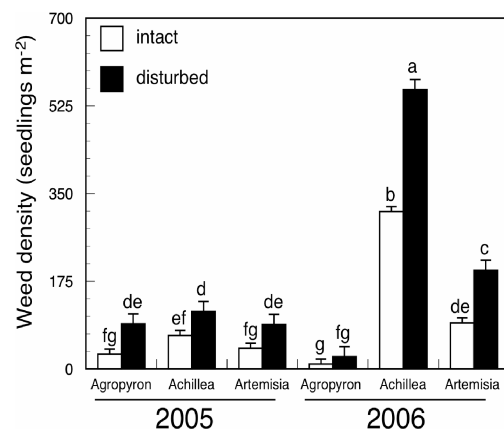


Figure 1 Mean (+ 1 SE) weed density in autumn. (Lowercase letters indicate differences ($P < 0.01$)).

Conclusions The importance of disturbance to mediate weed invasion is clearly corroborated by our results. The capability of the long-lived perennial grass (*Agropyron*) to resist invasion appears to be associated with greater biomass productivity. In contrast, high susceptibility to weed invasion of *Achillea* plots was due to significantly greater amounts of underutilized above and belowground resources (Davis et al., 2000). Our results agree with the general contention that disturbance events increase available resources or safe sites for weed invasion. Perennial grasses appear to be a necessary component of minimizing underutilized resources. Our results also emphasize that managerial efforts to reduce the recurrence of disturbance events should be a primary goal to reduce the impacts and prevent continual dominance of invasive annual species in the sagebrush-steppe ecosystems of the Great Basin.

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