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Influence of Plant Invasion on Seed Chemistry of Winterfat, Green Rabbitbrush, Freckled Milkvetch, Indian Ricegrass and Cheatgrass

Robert R. Blank[1], Tye Morgan[1], and Fay Allen[1]

ABSTRACT

Plant invasions have proven detrimental to numerous ecosystem processes; however, limited information exists on how plant invasions affect seed nutrients. We quantified nutrients in seeds of Indian ricegrass (Achnatherum hymenoides)*, green rabbitbrush* (Chrysothamnus viscidiflorus)*, winterfat* (Krascheninnikovia lanata)*, freckled milkvetch* (Astragalus lentiginosus)*, and cheatgrass* (Bromus tectorum) *in sites invaded about 10 years by cheatgrass and in nearby sites with only widely scattered plants of cheatgrass. Seed chemistry differed significantly among the species tested. Overall, seeds of shrubs and freckled milkvetch had greater concentrations of N, P, and K, and lower C:N ratios than the grass species. On areas invaded by cheatgrass for 10 years, seeds trended towards decreased nutrients relative to seeds from non-invaded areas. Statistically, however, only winterfat, whose seeds from invaded areas had greater N and significantly lower C and C:N ratios, and cheatgrass, whose seeds from invaded areas had less P, were significantly different from non-invaded areas. Complimentary data suggests that cheatgrass invasion increases the availability of N, which explains an increase for seeds of winterfat; however, invasion also fosters high winterfat mortality. We suspect that high density of cheatgrass and cheatgrass litter on sites invaded for 10 years essentially ties-up large quantities of P, K and Mg, thus reducing amounts available for plant uptake. Overall, our data suggests declining nutritional value of seeds with plant invasion.*

INTRODUCTION

One of the most researched invasive plant species in western rangelands has been cheatgrass (*Bromus tectorum* L.). Extensive information has been published concerning this species and how it has irreversibly changed plant communities (Mack 1981; Stewart and Hull 1949; Young and Evans 1973; Young and Blank 1995). Despite the immense pool of research that has been conducted on cheatgrass autoecology, there is an absence of literature concerning if cheatgrass invasion can alter seed nutrition of native plants. Invasive plants are known to alter Soil nutrient availability, which often facilitates their invasion (Ehrenfeld 2003). Moreover, invasive plants may alter biogeochemical cycling relative to native species such that the vertical distribution of soil nutrients is affected (Jobbágy and Jackson 2001). Modification of the vertical distribution of soil nutrient availability will affect root competition and efficacy of nutrient uptake and seed chemistry. The purpose of this study was to quantify the effect of cheatgrass invasion of a native winterfat (*Krascheninnikovia lanata* ((Pursh) A.D.J. Meeuse and Smit) landscape on seed nutrition of the dominant species. The working null hypothesis posits that seed chemistry of several common plants in this community will not be affected by the degree of cheatgrass invasion.



Figure 1—Photographs of the study area. Top photo shows area invaded for about 10 years by cheatgrass. After 10 years of invasion cheatgrass density is incredibly high, occupies all microsites, and causes considerable mortality of winterfat (taller plant in photo). Bottom photo shows a relatively non-invaded area with healthy winterfat plants. Interspaces among winterfat are only sparsely occupied by forbs and native grasses such as squirreltail (*Elymus elymoides*), needle-and-thread (*Stipa comata*), and Indian ricegrass (center foreground in photo).

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MATERIALS AND METHODS

The study site is in the Honey Lake Valley of northeastern California (40°08.18'N, 120°04.39'W). Yearly precipitation averages 230 mm (9 inches), the average maximum temperature is 18°C (64°F) and average minimum temperature is 1°C (34°F). The soil is classified as a coarse-loamy Xeric Haplocalcid. The winter-spring of 2005 to 2006, precipitation was relatively normal and provided ample moisture for the vegetation to produce an abundant source of seed. In the summer through fall of 2006, seeds were obtained when ripe from the dominant plants in a winterfat community and included cheatgrass (*Bromus tectorum* L.), winterfat (*Krascheninnikovia lanata* (Pursh) A. Meeuse and Smit), Indian ricegrass (A*chnatherum hymenoides* (Roem. and Schult.) Barkworth), green rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.), and freckled milkvetch (*Astragalus lentiginosus* Douglas ex Hook.). Seeds were collected from 4 replicate areas (several plants per area) in two cheatgrass invasions zones: 1) invaded for 10 years by cheatgrass, and 2) only sparsely invaded in shrub canopies (figure 1). Collected seeds were allowed to air-dry in paper sacks for several months. Seeds were then hand-picked from chaff and plant material, and oven-dried at 60°C (140°F) for 48 hours. Seeds from each replicate were homogenized and a subsample was analyzed for total C and N using a LECO Tru-spec analyzer. Another subsample was ashed in a muffle furnace at 500°C (932°F) or 6 hours and treated with HCl and HNO_3 to solubilize the ash. Calcium, Mg, Na, K, Fe, and Mn were quantified by atomic absorption spectroscopy. Solubilized P was quantified using flow-injection methodology. Data were analyzed using ANOVA with categorical variables invasion class and species. Means were separate using Tukey's Honest Significant Difference at the $P \leq 0.05$ level.

RESULTS AND DISCUSSION

Overall, invasion status had minimal effects on seed chemistry (figure 2). For most species tested, the data trended towards lower nutrient concentration in areas invaded for about 10 years by cheatgrass. Seeds of winterfat were most affected by invasion status; seeds from cheatgrass invaded areas had significantly more N and significantly less C and C:N ratios than seeds from non-invaded areas. We suspect that elevated seed N in winterfat may be due to more N availability in soil beneath invaded areas facilitated by greater mineralization of organic-N (Blank 2008). Alternatively, winterfat plants in invaded areas are less dense due to die-off, which may allow greater N uptake per plant. Seeds of cheatgrass taken from areas invaded for over 10 years have significantly less P than seeds taken from relatively non-invaded areas. Explanation of lower seed P may involve a decrease of soil P availability due to far greater cheatgrass biomass on invaded areas. In addition, the invaded sites have far greater surface litter that may sequester phosphorus from newly growing plants.

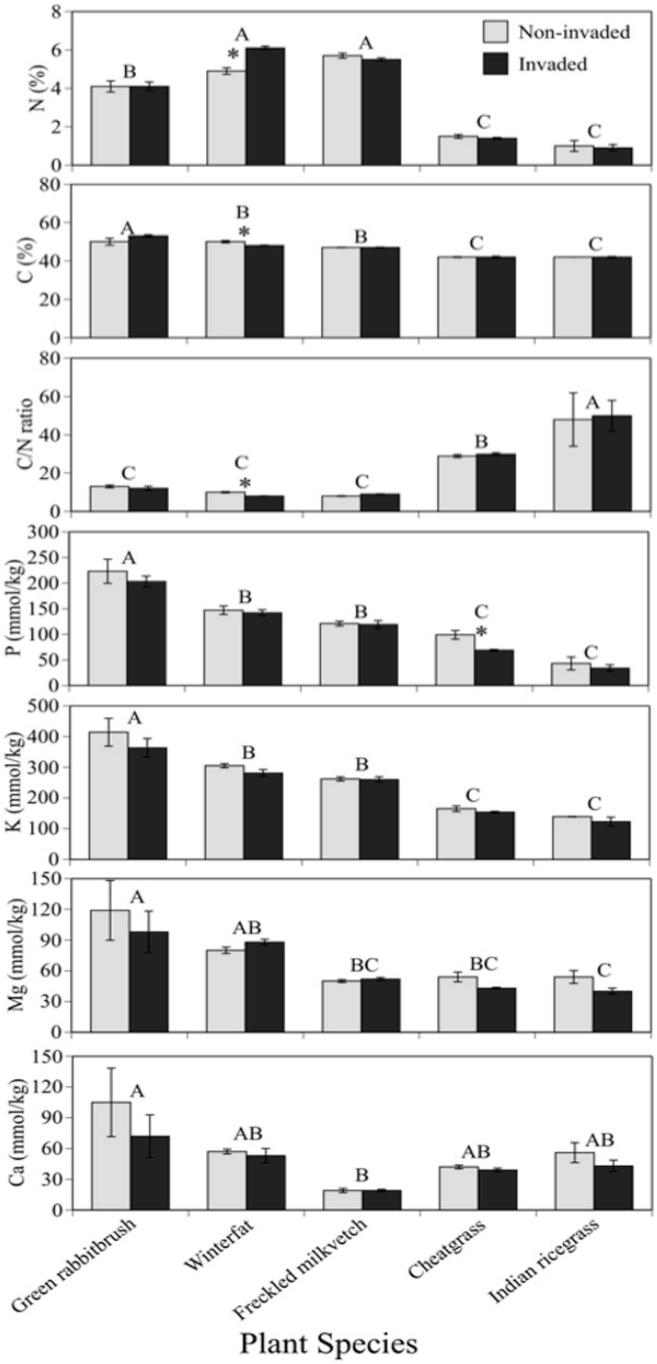


Figure 2—Nutrient concentrations in seeds of green rabbitbrush, winterfat, freckled milkvetch, cheatgrass, and Indian ricegrass as affected by invasion status. For each panel, letters denote significant differences ($P \leq 0.05$) among plants and an asterisk denotes a significant difference between non-invaded and invaded treatments.

Seeds from green rabbitbrush, winterfat, and freckled milkvetch had greater concentrations of N, P, and K and much lower C:N ratios than seeds from the grasses cheatgrass and Indian ricegrass (figure 2). At a first approximation, these data suggest seed foraging would be more efficient and profitable on a per unit weight basis.

Many other factors, however, such as caloric density and levels of secondary compounds affect foraging behavior.

SUMMARY AND IMPLICATIONS

We conclude that, in a year of slightly above normal precipitation, cheatgrass invasion had only a slight effect on nutrients in seeds of several native plants. Invasion by annual grasses such as cheatgrass and meduashead (*Taeniatherum caput-medusae* L.) has altered landscape-level vegetation dynamics and has feed-back into the population structures from the soil microbial community to terrestrial fauna. Changes in biogeochemical cycling brought about by annual grass invasion has and will continue to alter the vertical distribution and availability of soil nutrient pools. Native grasses, forbs, and shrubs, which are critical forage species, will face not only competition from cheatgrass but altered nutrient niches. Ultimately, we simply lack sufficient knowledge to predict the effects of these processes on forage and seed quality for individual plant species.

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