Compost May Encourage Native Grasses and Discourage Forbs

Honors Thesis

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Abstract

Farmers and land managers have used compost as a beneficial amendment to improve soil health and increase plant yield for centuries. This study analyzes the effects of compost on native plant establishment in the presence of a non-native species, *Bromus inermis* (smooth brome). In a replicated greenhouse study, I applied four compost treatments to pots containing native plant species and smooth brome: a control group with no compost added, and three other treatments in which compost was added at 10%, 20%, and 30% by volume. After 7 weeks of growth, I compared the dry weight of the aboveground biomass and the abundance of each species across treatments. As the compost increased, 4 grass species reacted positively and increased in biomass. However, forb species did not follow this trend, and their biomass decreased as the compost levels increased.

Introduction

Smooth brome is a perennial C3, cool-season grass native to Europe. It was deliberately introduced to North America from Hungary and used for forage and rangeland improvements because it is especially cold-hardy and drought-tolerant (Palit and DeKeyser, 2022). Additionally, smooth brome is a rhizomatous species that can grow roots up to 1.4 meters deep, making it difficult to remove from a system once it has established (Palit and DeKeyser, 2022). This study was undertaken to determine if compost could be a valuable addition to management options for this invasive species, especially for restoration projects. Compost can change the biochemical environment of soil by increasing soil microbe activity, arbuscular mycorrhizae persistence, and

numerous beneficial nutrients (Ohsowski et al., 2012). Additions of compost can also increase water retention and improve structural stability, but results widely vary across climates (Leger et al., 2022). However, the benefits of compost do not occur in a vacuum reserved for native plants to utilize. Compost addition could encourage invasive species, as well (O'Dell and Claassen, 2006; Blumenthal et al., 2017). This study was conducted to find out if smooth brome, in particular, would outperform other native grasses and forbs in northern Colorado grassland soil with the addition of compost.

Methods and materials

This study was completed in a greenhouse to control for weather, herbivory, and other variables. I collected 60 gallons of native soil from a field in northern Fort Collins. The soil had a sandy clay texture, low organic matter, and a pH of 7.9. I also gathered 20 gallons of compost from the CSU compost facility. The compost consisted of horse bedding and food scraps from the CSU dining hall.

I split the soil into 4 treatments with varying levels of compost. The first treatment was the control, so only the native soil was present. The second treatment involved native soil and 10% compost by volume, the third treatment used 20% compost, and the fourth treatment used 30% compost. I used 1-gallon-sized pots, and planted a mixture of 9 species (Table 1) in each ~~pot~~ with 15 replicates for each treatment. For each species, I counted 5 seeds and set them aside in an envelope.

Species	**Forb/grass**	**Introduced/native**
Bromus inermis (smooth brome)	Grass	Introduced
Helianthus annus (common sunflower	Forb	Native
Thelesperma filifolium (stiff greenthread)	Forb	Native
Linum lewisii (wild blue flax)	Forb	Native
Asclepias speciosa (showy milkweed)	Forb	Native
Pascopyrum smithii (western wheatgrass)	Grass	Native
Cleome serrulata (Rocky Mountain beeplant)	Forb	Native
Bouteloua curtipendula (sideoats grama)	Grass	Native
Elymus trachycaulus (slender wheatgrass)	Grass	Native

Table 1) Nine species used in this study, sorted by forbs/grasses and introduced/native.

I poured the soil into a larger bin to break up any large clumps and remove rocks. Once mixed and worked through, I scooped out the soil and filled the first 15 1-gallon pots in the control group until there was only an inch and a half left at the top.

I used a ruler to measure the depth of a smaller bucket and measured out the compost treatments based on volume. 1 inch of compost correlated to 10% and 9 inches of soil correlated to the other 90%, and so on. The compost was thoroughly mixed with the soil before being added to the 1-gallon pots. The method was repeated with each subsequent treatment of varying levels of compost.

Once the pots were filled, they were watered for 2 days until the soil was saturated and water was dripping out of the bottom of the pots. Next, I scraped back the top layer (about 1 cm) of soil, sprinkled the prepared packages of seeds evenly across the pot, and recovered them with the 1 cm of soil. 5 seeds from each species were planted for a total of 45 seeds per 1-gallon pot. Once planted, the pots were randomized and watered. I watered them once a day for 6 minutes for 7 weeks. I randomized them daily after I watered them, as well. In the greenhouse, the plants received natural sunlight and some synthetic light.

After those 7 weeks, I clipped each plant at soil level and put them in labeled bags according to their pot number, treatment, and species. They were dried for 4 days in an oven at 55 **°C** and weighed.

Results

The grasses and the forbs had somewhat of an opposite reaction to the compost additions. While almost all of the grasses increased in weight (Figure 1) and abundance (Figure 2) as the compost increased by volume, the forbs decreased in weight and abundance (Figures 1 and 2). Although as the treatment changed from 10% to 30% compost, the forbs did not decrease by more than 5 individuals per pot, and showy milkweed even increased.

Only sideoats grama exhibited a fairly neutral response to the compost treatments. However, smooth brome total dry weight increased over threefold with 30% compost compared to the control group, where half of the native species outperformed the smooth brome in total abundance and dry weight.

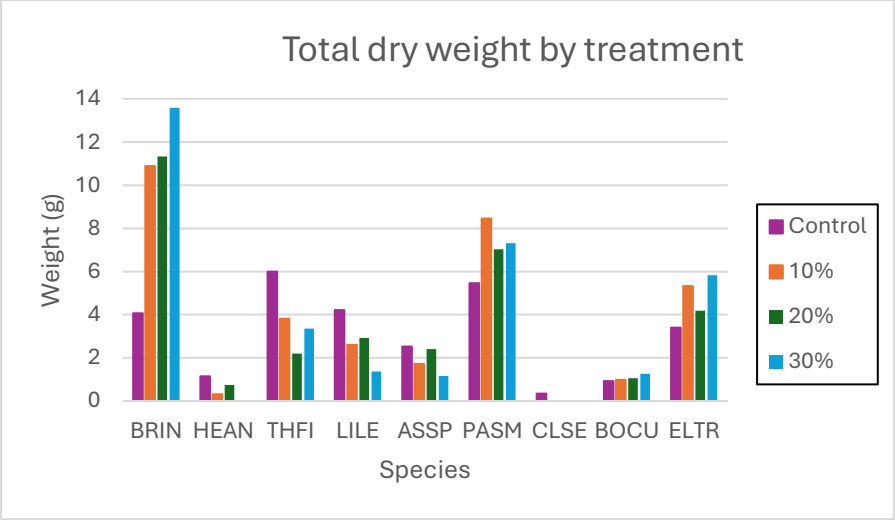

Figure. 1) Total dry weight of 9 species growing in pots with varying levels of compost (n=x). The grasses generally reacted positively to the compost additions, while the forbs decreased.

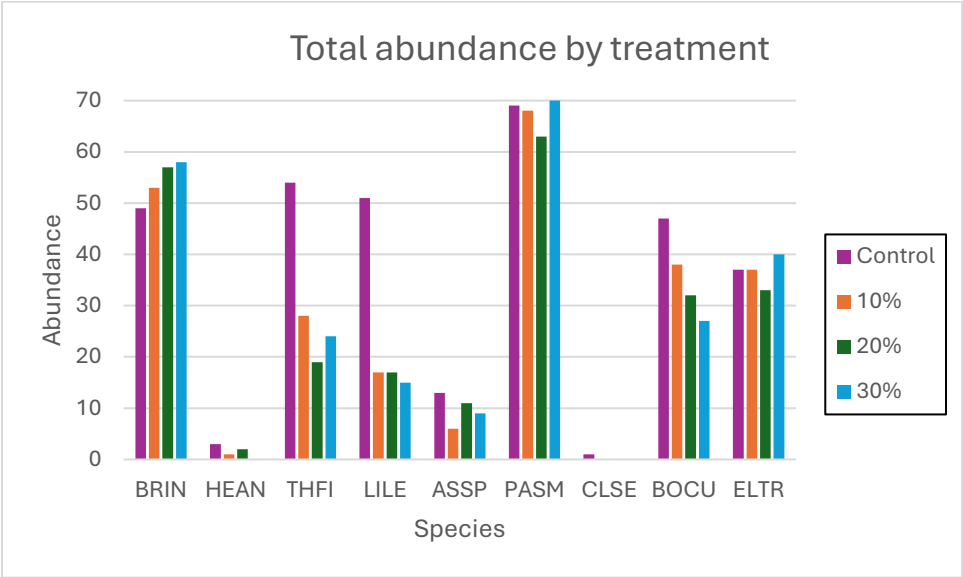

Figure 2) Number of individuals of each plant species per pot (n=X). The compost additions did not correlate as much with the abundance, except for a few key species such as stiff greenthread, wild blue flax, and sideoats grama. Those 3 showed a significant decrease as compost was added.

Discussion

Compost changes the soil's nutrient content (Ohsowski et al., 2011), microbiology (Ringer, 2016), physical structure (Ohsowski et al., 2011), and more (Leger et al., 2022). However, it is impossible to know what specific aspect of the compost affected plants in this study without further experiments. Additionally, this experiment occurred in a greenhouse, and results may differ in the field. Outside of a controlled environment, seed predation, drought, and fluctuating temperatures could alter how the competition between these species takes place.

This is only a prediction of how compost could affect the outcome of grassland restoration work. Yet, certain species such as western wheatgrass, wild blue flax, and the stiff greenthread show promising results, with total abundance and weight higher than the smooth brome when compost was not added. Perhaps, compost additions will not be the solution to the problem of invasive species, but it did increase the biomass of all the grasses and the abundance for some of them. If you didn't have invasive species to take care of, compost could be a valuable addition to restoration projects.

Ringer's dissertation showed that adding compost could increase native species density in a disturbed roadside area in Rocky Mountain National Park (2016). However, other treatments, such as mulch or a mulch/compost mixture, worked significantly better (Ringer, 2016). They also studied native and nonnative plants in the greenhouse (including smooth brome), where they found that incorporating compost increased the biomass of all species (Ringer, 2016). This was a contrast from my study, in which increasing compost led to a general decrease in forb biomass.

Other than Ringer's dissertation, I could not find a study in northern Colorado specifically examining the effects of compost on native plant establishment in the presence of smooth brome.

Yet, a 2005 article studying biosolid amendments to soils in a Colorado sagebrush steppe found that seeded grasses dominated over shrub species (Paschke et al.), aligning more with my findings of grasses performing better with increased compost.

Finally, there were a few outlying variables that could have affected the results of the study. The soil I collected was left over from a construction project and had been sitting in a pile for months. All sorts of seeds could have blown in from the surrounding fields. There were a few plants I could not identify, and that could have caused additional competition between the 9 species I did plant. Additionally, the soil contained lots of shale chunks from lower soil layers dredged up by the construction, but the plants would not naturally be growing in these layers if propagated in the field.

I would give careful thought to using compost in a land restoration strategy. While compost can be a helpful tool, it can also encourage invasive species that could persist for decades (Blumenthal et al., 2017). Land managers should think about what species they want to revegetate a site, what nonnative or invasive species are present, and how they might benefit if nutrients are increased by compost or other organic additions.

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