

Soil pH influences the growth of *Phalaris arundinacea*

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Abstract

In an effort to discover the impact that soil characteristics have upon the growth of the wetland species Phalaris arundinacea, we compared soil in wetland and forest regions of the Conard Environmental Research Area for pH levels, soil temperature, water percentage, total Carbon percentage and total Nitrogen percentage. We also conducted a greenhouse study to compare total biomass produced by Phalaris arundinacea planted in both wetland and forest soil. We found significant differences in the pH, soil moisture, and soil temperature between locations. No significance differences were found in Carbon and Nitrogen percentage. Our greenhouse study produced Phalaris arundinacea seedlings in both types of soils, but those growing in the wetland soil had significantly greater biomass. Since temperature and moisture were kept constant in the greenhouse, we conclude that soil pH influences the growth of Phalaris arundinacea.

Introduction

Prairie wetlands are unique ecosystems that contain distinctive soil, close proximity to a major body of water, and an abundance of distinct plant species (Gosselink and Mitsch 1986). One species, *Phalaris arundinacea* or Reed Canary Grass, is a very aggressive grass most commonly found in wetland communities (Christiansen and Müller, 1999). *Phalaris arundinacea* possesses a strong root system and is able to tolerate prolonged periods submerged in flooded regions (Flocker et al., 1988). When prairie restorers are considering reconstruction of a wetland area, they need to know whether soil conditions are those which promote and stifle the growth of the aggressive *Phalaris arundinacea*.

Studies have shown wetland areas to be able to hold water very successfully after a flood or heavy rain, thus allowing plants in that region greater access to water (Thompson, 1992). Other studies have shown that woody debris does not allow great amounts of water to penetrate into the forest soil, thus limiting plants access to water (Schlesinger and Waring, 1985). We expect to see a much greater amount of moisture present in the wetland region. Also, the forest region is sloped, and this does not allow it to collect water as easily as the flat wetland region. In the forest region, dense trees cover the soil, not allowing much sunlight to warm up the soil as a result of thick branches and leaves. Since the wetland region is not protected by trees from the sun, we believe that a higher soil temperature will be found in the wetland region as a result of the better access to the sun's rays.

In general, *Phalaris arundinacea* is tolerant

of pH levels in soil as low as 6.1 and as high as 7.5 (Finn et al., 1990). Since pH levels in wetland soil have been found to generally be around neutral or 7, we hypothesize that the soil collected at CERA's wetland will fall within this range (Gosselink and Mitsch, 1986). We observed 0% cover of *Phalaris arundinacea* in forest plots, therefore we believe that the forest area will contain pH levels not within the range at which *Phalaris arundinacea* grows most efficiently. Since we do not believe the forest soil to have pH levels which are within the range needed for successful growth of *Phalaris arundinacea*, we anticipated pH will be a factor that encourages the development of greater biomass in wetland soil.

Wetland soil has been found to divert nutrients from the water source and to use these nutrients in the soil (Galatowitsch and van der Valk, 1994). Thus, we believe that there will be a higher percentage of both Nitrogen and Carbon found in the wetlands. We hypothesize that through our greenhouse study, we will show significantly greater biomass in seeds grown in the wetland soil, as a result of increased nutrient availability. We anticipate minimal growth from the seeds planted in the forest soil as they will be hindered by low nutrient availability and pH levels which stifle growth.

Methods

We performed research at the Conard Environmental Research Area over the course of ten days in the months of October and November, 2003, in both the wetland area bordering Perry Pond and the upland wooded

area, which is called “second growth” near the pond (<http://www.grinnell.edu/academic/biology/cera/trailmap/>). We created two transects, one 130m and the other one 120m, that ran perpendicular to the pond, and extended through the wetlands as well as the woods. The plots located in the woods were on a slope while those in the wetland area were flat. A small stream runs through the transects about 45 meters from the pond. In the first transect, eight of the plots were located in the wetland area while only five were located in the upland wooded area. In the second transect, seven of the plots were in the wetlands and five in the wooded area. We placed a marker every ten meters along the transects, separating them into 13 and 12 sections respectively from which we can take samples. The plots located in the wetland area had 100% cover by *Phalaris arundinacea*; the plots located in the forest area had 0% cover by *Phalaris arundinacea*.

On October 27th, 25 Core samples were taken from the CERA wetlands and forest regions. The soil samples were immediately weighed, and dried for 48 hours. After the 48 hour period, the samples were weighed, and the percent loss of water was calculated. pH levels were tested by first creating a solution which

contained 5g of soil and 5 ml of water. An electronic pH calculator was submerged in the solutions, thus determining the pH levels in the soil at each plot. We recorded the soil temperature at a depth of 4 cm at each individual plot at CERA on November 12th, using a thermometer. Finally we tested the percentage of Carbon and Nitrogen in a C/N analyzer using the same core samples as were used previously. The mean values of the various soil characteristics in the two areas were compared using T-tests.

The second stage of our experiment was to perform a greenhouse study in which we planted *Phalaris arundinacea* seeds in different types of soil. Soil samples were taken from CERA on October 27th from eight locations, four in the wetland and four in the forest. On October 29th seeds were planted in the soil from the eight locations, with three samples for each location, and placed into an incubator tray. The seeds were incubated at a constant temperature of 25 degrees Celsius, and watered every other day. Another tray of seeds was planted on November 3rd using the same methods. Plants were harvested on November 17th, dried for a 48 hour period and weighed. An ANOVA general linear model test was used to test for significant effects of soil type and day planted on plant biomass.

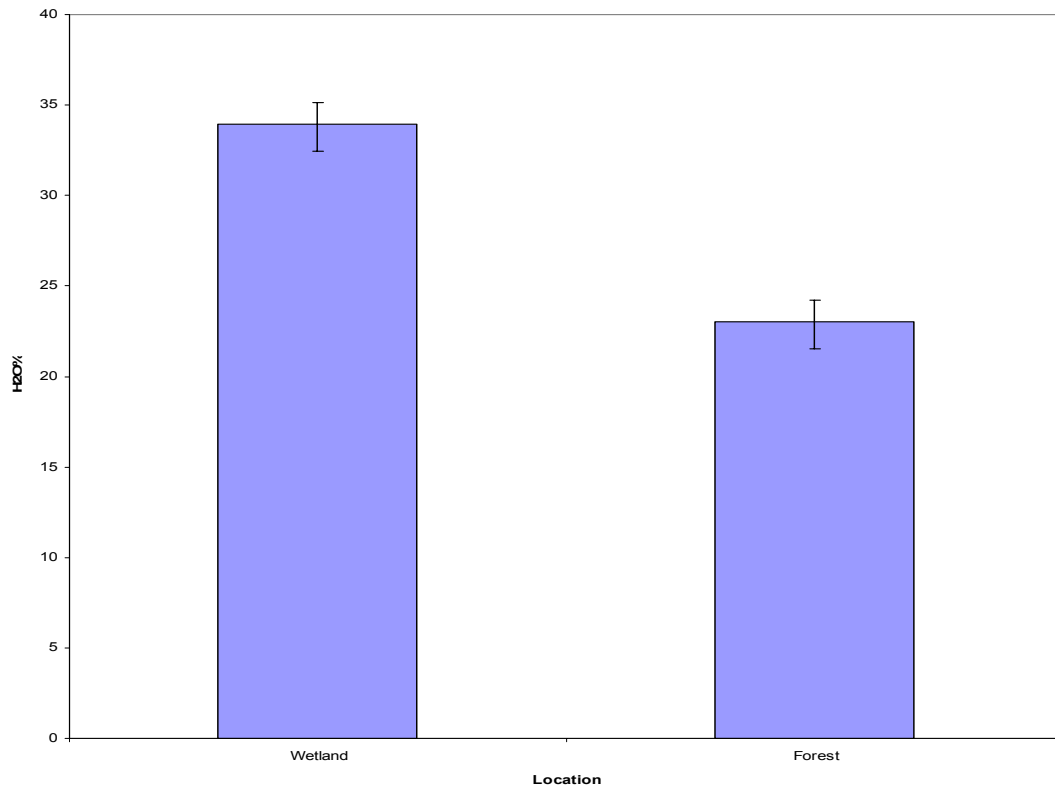


Figure 1. Water content (mean \pm SE) in wetland and forest soils.

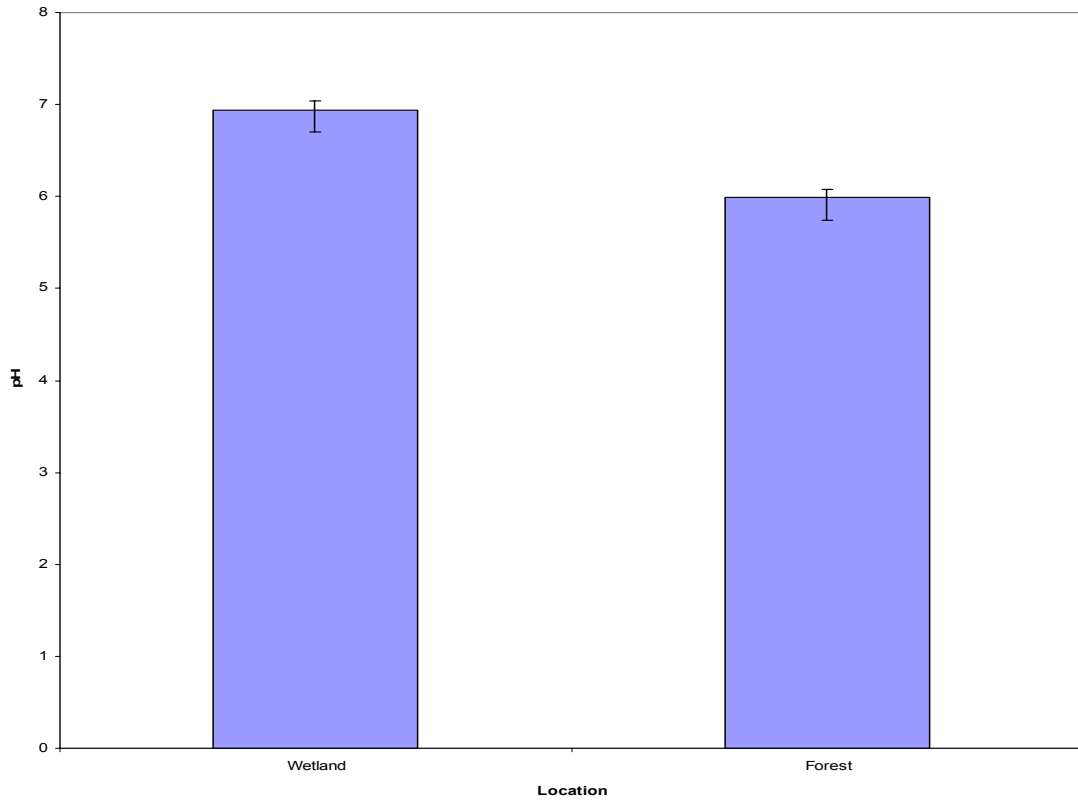


Figure 2. Mean soil pH (\pm SE) in wetland and forest soils.

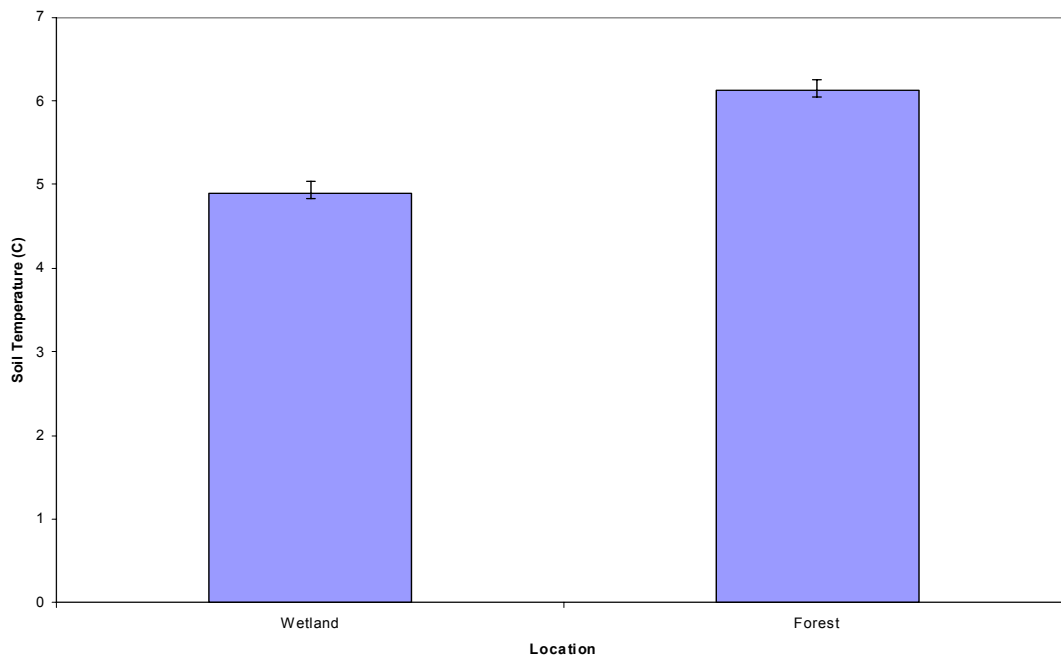


Figure 3. Mean soil temperature (\pm SE) in wetland and forest soils

Results

We found similarities as well as differences between the soils collected in the wetland and forest regions. Figure 1 shows that the mean percentage of water found in the wetland region soil was significantly higher than in the forest region soil ($t=7.68$, $p=0.000$). Figure 2 shows that the mean wetland pH level was significantly higher than that in the forest region ($t=3.67$, $p=0.004$). Figure 3 shows that the mean wetland temperature of the soil at the two locations was significantly different ($t=-7.90$, $p=0.000$). The

percentage of Nitrogen found in the soil was greater in the wetland area, but the difference was not statistically significant ($t=.76$, $p=.455$). We found the mean Carbon percentage in the wetland region was higher, but the difference was not significant ($t=.99$, $p=.334$). In the greenhouse study, the wetland soil produced *Phalaris arundinacea* significantly larger in biomass when compared to the *Phalaris arundinacea* produced in forest soil on both days planted (soil effect, $F=8.73$, $p=0.005$).

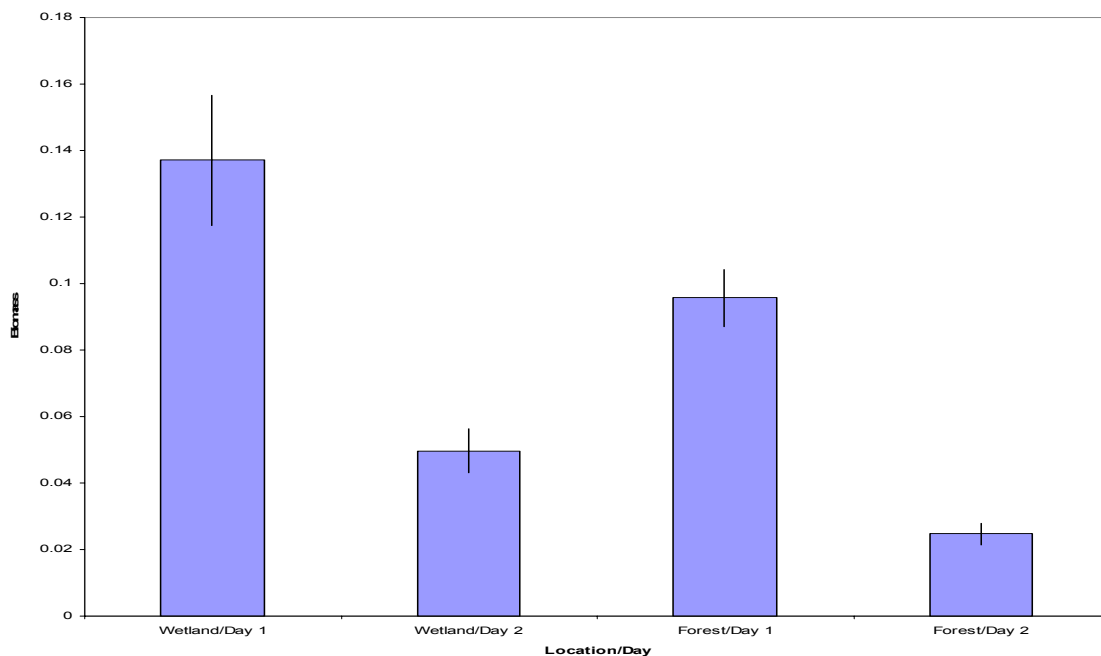


Figure 4. Mean biomass (\pm SE) for plants grown in wetland and forest soils ($n=12$).

Discussion

Our study illustrates the impact that soil can have on the successful growth of *Phalaris arundinacea*. Since the soil in CERA's wetland region had 100% coverage of *Phalaris arundinacea*, and the forest had 0% coverage, we hypothesized that characteristics of wetland soil promoted growth of this particular species. The testing of these two regions illustrated the differences in the soil's characteristics. Soil temperature, water percentage, and pH levels were significantly different in the two locations. Since water percentage and soil temperature were kept constant throughout our experiment, the statistically larger biomass found in the

plants grown in wetland soil during our greenhouse experiment, show pH to be the leading component that impacts the growth of this species. Since Carbon and Nitrogen showed no significant differences in the two soil types, it is unlikely that they had an impact upon the growth of *Phalaris arundinacea*.

Studies have shown *Phalaris arundinacea* to grow most efficiently when planted in soil whose pH level is within the range of 6.1 to 7.5 (Finn et al., 1990). Other studies have shown that wetland soil tends to possess a pH that is near 7 or neutral (Gosselink and Mitsch, 1986). As expected, the mean pH level found at CERA's wetland soil is 6.944, which is within the range at which *Phalaris arundinacea* grows most successfully.

Meanwhile, the mean pH level found at CERA's forest soil is 5.988, outside of the range which is optimal for growth. This allows us to conclude that pH most influenced the growth of *Phalaris arundinacea* compared to all other characteristics tested because it was the sole significant characteristic that was not held at a constant throughout the greenhouse study.

Wetlands, when compared to forest areas, possess a higher percentage of water in their soil because of frequent flooding (Gosselink and Mitsch, 1993). *Phalaris arundinacea*, because it possesses a strong system of roots, is able to thrive in extremely wet conditions (Flocker et al., 1988). At the start of the greenhouse study, seeds planted in the wetland soil had more water available to them as a result of a significantly higher percent of water found in wetland soil. The germination of the seeds occurred more rapidly, giving wetland seeds a distinct advantage. However, over time as watering occurred and water percentages in both soils became equal, forest soil seeds were able to have growth similar to the growth experienced by wetland seeds. This allowed some growth of *Phalaris arundinacea* to occur in forest soil. We also found that soil temperature differed significantly in the two locations. The greenhouse study forced us to keep soil from both sites at the same temperature, in essence eliminating that variable from affecting the growth. Since the growth was as we hypothesized, we believe that soil temperature does not strongly influence the growth of *Phalaris arundinacea*.

Since *Phalaris arundinacea* clearly grows well under the conditions found in the wetland soil, limiting its growth in wetland areas may be extremely difficult. However, soil conditions set natural limitations as to how vastly this species can expand. If soil conditions are not optimal for the growth of *Phalaris arundinacea* its growth will be stifled, and thus not be a problem to prairie restorers.

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