Testing the Soil Preferences of Erect Knotweed (*Polygonum erectum*) in a Common Garden Experiment

Megan E. Belcher[1], Daniel R. Williams[2], and Natalie G. Mueller[3]
University of Tennessee at Knoxville[1], Ohio State University[2], Washington University in St. Louis[3]

Introduction

Long before the widespread cultivation of maize, a unique crop system of plants was cultivated and domesticated by past farmers in eastern North America (ENA) called the Eastern Agricultural Complex (EAC). Evidence of EAC domestication is found only archaeologically in ENA[1]. Questions about how these lost crops were grown, consumed, and shared among past peoples remain largely unanswered.

Ideal environmental conditions for the cultivation of different EAC crops is unknown. Preferences for certain soil types by these crops could have played a large role in where and how past peoples interacted and moved on the landscape. We can infer what environments would have been suitable for EAC crop cultivation through growth experiments.

This poster aims to explore cultivation practices favored by one crop species, Erect Knotweed (*Polygonum erectum*). We hypothesize that populations of *P. erectum* grown in rich, well-drained soils will be more productive and higher in yield than those in clay-rich soils. This experiment aims to sheds more light on the type of environmental conditions favored by *P. erectum* and the circumstances in which *P. erectum* is most productive.

Figure 1a (left): Specimen PE007 collected from the Kentucky River Valley. Figure 1b (right): Specimen PE005 collected from Courthouse Rockshelter. Both images courtesy of N.G. Mueller.

Methods

Two populations of *P. erectum* were used in this study, referred to as PE005 and PE007 (figure 1a and 1b). Seeds from population PE005 were collected from the Red River Valley, near Courthouse Rockshelter. Seeds from population PE007 originate from the Kentucky River Valley in Henry county. Specimen samples were then collected and harvested for their seeds. These seeds were germinated in a greenhouse and then transplanted into a common garden. A common garden experiment takes a species from its native environment and places it in a common environment as a control[2]. PE005 and PE007 were placed in two different soil types: a raised bed with augmented soils and clay soils lacking in abundant organic matter.

Height, radial extent, longest branch, and phenological growth stage[3] of each plant were measured (figure 2a). Each population was measured on a weekly basis during an eight-week period. Soil color, and texture were also determined for each plot (figure 2b). Measurements of each population were both analyzed using linear modeling and Principal Component Analysis (PCA) to identify intra- and intergroup patterns.

Results

- When planted in clay-rich soils, PE005 and PE007 grow similarly.
- Differences between PE005 and PE007 emerge when they are both planted in rich, well-drained soils ($P \leq 0.001$).
- Differences between PE005 and PE007 are also significant based on Linear Regression Modeling (LRM) ($P \leq 0.001$) (figure 5).
- There is a clear difference in growth between populations based on PCA analysis (figure 4).

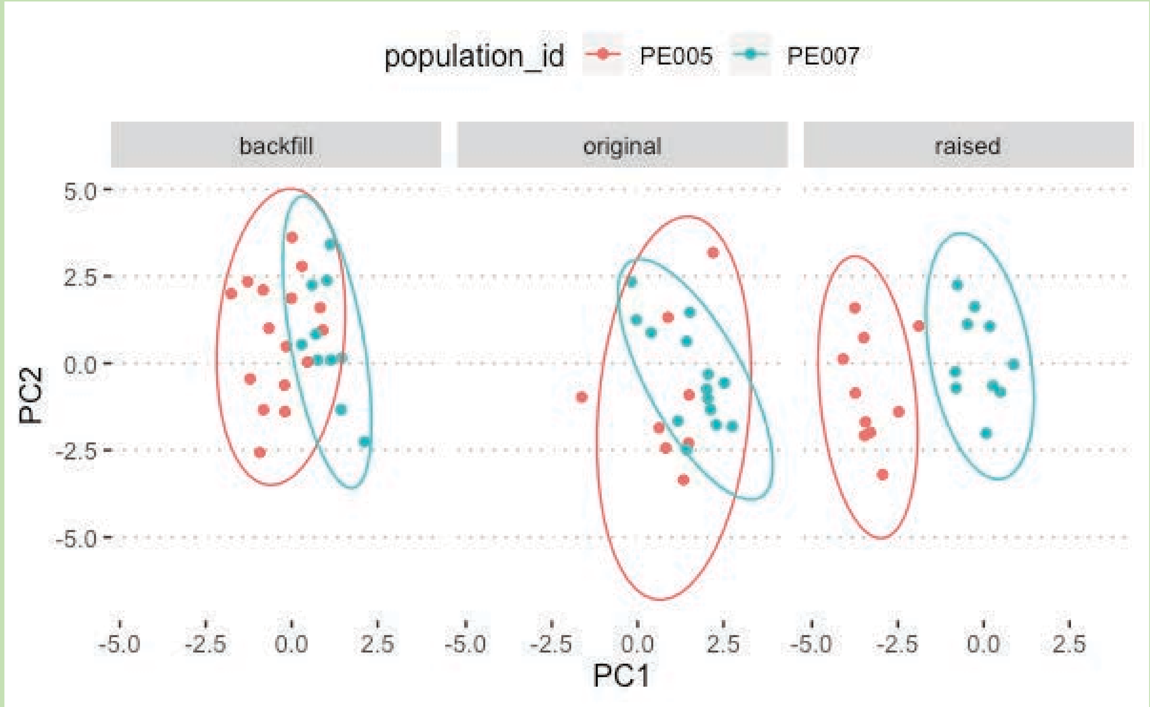
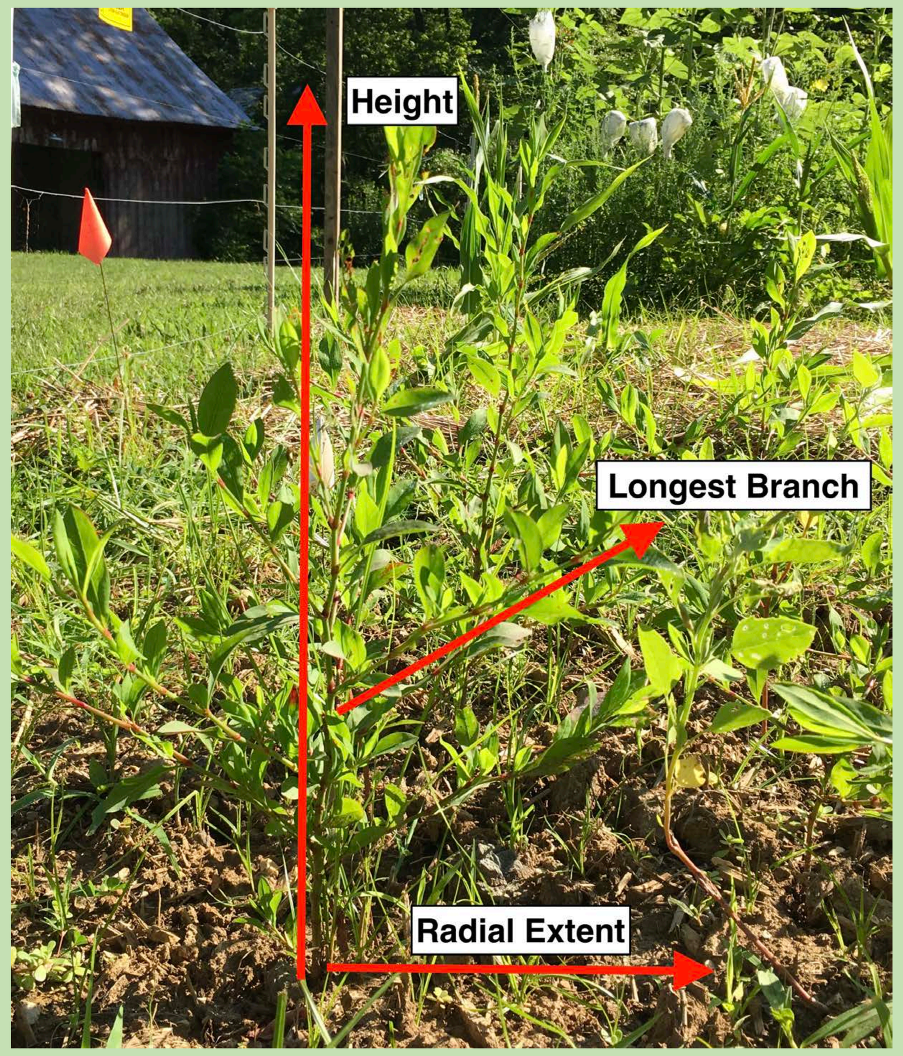


Figure 4 (left): PCA analysis graph showing differences between erect knotweed populations planted is different plots. PC1 describes plant height and PC2 describes height versus radial extent and longest branch length. Radial extent and branch length are highly correlated while height is less correlated with these variables.
In raised bed populations, there is a distinct difference between PE005 and PE007 in PC1. PE005 is noticeably larger in size than PE007.

Figure 5 (left): LRM graph showing trends in plant height organized by date. There is a clear difference between PE005 and PE007 in the raised bed plot. PE005 is significantly bigger in size than PE007. Both populations do not vary in size in the backfill and original plots.



Plot	Plot Soil Type	Taxon	Soil Color	Soil Texture
15	Original	PE007	2.5 Y 4/4 (olive brown)	Clay
13	Original	PE007	2.5 Y 3/2 (very dark grayish brown)	Clay
17	Original	PE005	10 YR 4/2 (dark grayish brown)	Clay
4	Backfill	PE005 and PE007	10 YR 3/3 (dark brown)	Clay
7	Backfill	PE005	2.5 Y 4/4 (olive brown)	Clay
11	Raised Bed	PE005 and PE007	10 YR 2/2 (very dark brown)	Clay loam

Figure 2a (left): diagram displaying each measurement collected on each plant: height, radial extent, and longest branch. Figure 2b (above): table displaying data from soil tests of each plot.

Discussion

The results indicate that *P. erectum* is more productive for each tested variable in rich, well-drained soil than in dense, clay soils. Populations of P. erectum in clay-rich soils still grew and developed at a lesser rate, pointing to erect knotweed's versatility in growing in various soil types. However, this disparity between populations in differing soil types is substantial enough to place soil type as an important factor in the cultivation of erect knotweed.

Population PE005 is more productive than PE007, no matter the soil type. This may point to PE005's origins from Courthouse Rockshelter, a rockshelter archaeological site where several uncarbonized EAC crops, including erect knotweed, were recovered from a cache dating between 2500 and 3000 B.P[4]. PE005 was collected right below the rockshelter, possibly indicating this population is feral based on its high productivity and overall plant size. Though, genetic evidence would be necessary to confirm this. It also displays characteristics of apical dominance as the central stalk on PE005 plants takes precedence over adjacent stems. PE007 was substantially outgrown by PE005.

Several EAC crops, including erect knotweed, are floodplain species. Advantageous for creating clearings and replenishing soil nutrients, past farmers relied heavily on annual floods for crop production[5]. Erect knotweed crop yield is vulnerable to flooding. Many archaeologists suggest that past peoples moved plants upland and out of the floodplain in order to have a more stable reliance on EAC crops, especially *P. erectum*[4,5]. Thus, increasing the range of *P. erectum*'s habitat and exchanging seed stock resulted in unintentional domestication. Furthermore, in communities where erect knotweed cultivation continued to occur in the floodplain, with unreliable harvests based on flooding, domesticated erect knotweed was not developed.

These communities could have supplemented their diets with other EAC crops and gathered plants. Did ancient farmers prioritize staying in the lowland, so floodplain species thrived on nutrient-rich soil but risking flood damage, or did they move higher upland where some amount of yield would be guaranteed? These factors could have had an effect on ancient farming practices as well as settlement patterns.

Conclusion

- Erect knotweed grows faster in rich, well-drained soils.
- Differences between PE005 and PE007 emerge when they are both planted in rich, well-drained soils based on LRM.
- Variation in erect knotweed populations is evident in the traits seen in PE005 and could be displaying feral characteristics.
- Soil preferences are just one factor in the cultivation and domestication of erect knotweed and could have influenced ancient farming practices and settlement patterns.
- Phenotypic and genotypic traits of PE005 and PE007 should be better investigated to explore the high productivity of PE005.
- Information about soil preference of erect knotweed can help in future experimental studies of the species.

References and Acknowledgements

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