Cedar afforestation of prairie alters soil properties on a decadal time scale

Michelle R. Busch and DeAnn Ricks Presley*

Dept. of Agronomy, Throckmorton Hall, Kansas State University, Manhattan, KS 66506-5501

Introduction

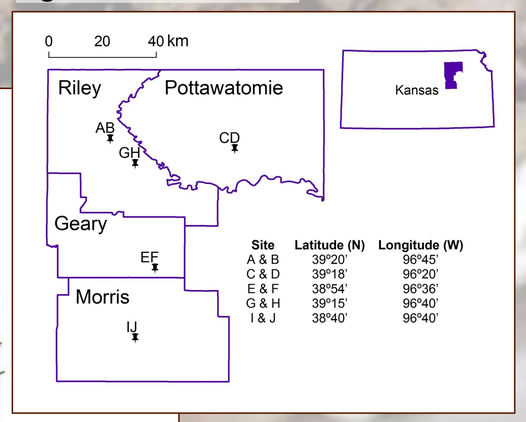
Eastern red cedar (*Juniperus virginiana*) encroachment on native grassland rapidly alters the ecosystem, but the resulting effect on soil properties has not been fully evaluated. The goal of this project is to identify the extent to which soil properties, including properties related to soil-forming processes, have been transformed after approximately 50 years or less under eastern red cedar establishment.

Site and Methods

Comparative studies were conducted at five native rangeland sites in the tallgrass prairie in Kansas, within the Bluestem Hills Major Land Resource Area (Fig. 1). Ten sites were sampled using a truck-mounted hydraulic soil probe to extract four individual cores of 3.9 cm diameter at each pedon location along the transect. Cores were extracted to a depth of approximately 1.2 m or refusal, and the vertical soil profile morphology was described. A three-pedon transect (near the tree's stem, at the canopy edge, and grassland) was completed at each tree (Fig. 2), generating 30 pedon descriptions and a total of 163 soil samples, separated by genetic horizons.

Laboratory analyses included: pH, cation exchange capacity, total C, and wet aggregate stability. Data were analyzed using the PROC MIXED procedure of the SAS software version 9.2, which was used for analysis of variance and mean separation differences .

Figure 1. Site locations



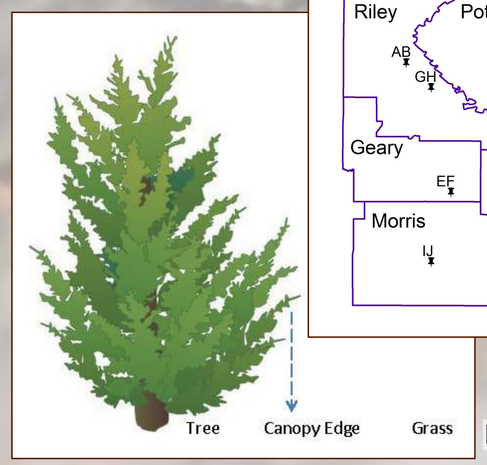


Figure 2. Sampling Diagram

Results and Discussion

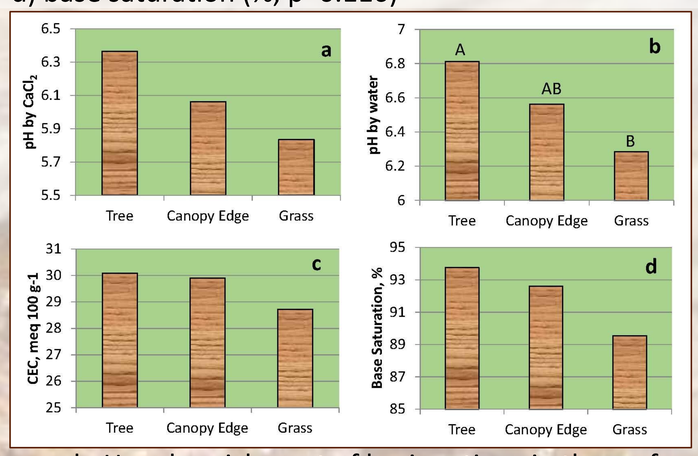
Figure 3. Effect of vegetation on base cations in soil surface horizon as reflected in:

a) pH by $CaCl_2$ (p=0.0733)

b) pH by water (p=0.013)

c) cation exchange capacity, meq 100 g^{-1} (p=0.491)

d) base saturation (%, p=0.116)



Increased pH and enrichment of basic cations in the surface soil horizon is a common finding, and is attributed to the high Ca and Mg content observed of the litter of plants from the *Juniperus* genus (Hart and Parent, 1974. Am. Midl. Nat. 92: 191-201.).

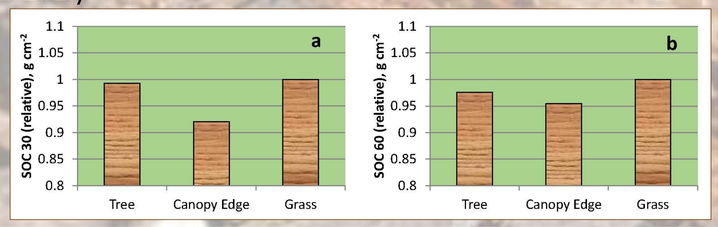


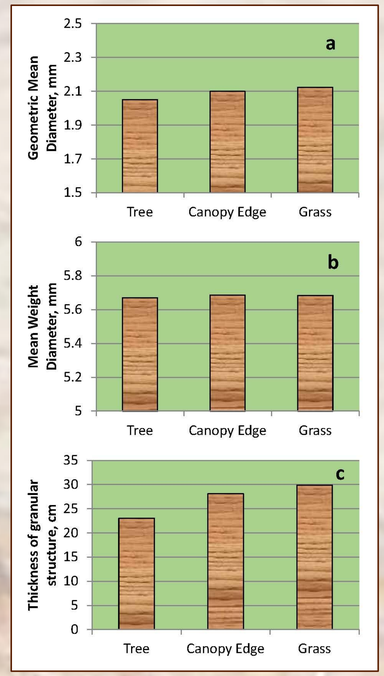
Figure 5. Effect of vegetation of soil organic carbon (SOC) indicated by a) SOC 30 relative to grass and b) SOC 60 relative to grass.

Figure 4. Structure and aggregate stability in soil surface horizons as reflected in:

a) geometric mean diameter (mm) of aggregates,

b) mean weight diameter of aggregates (mm), and

c) thickness/depth (cm) of granular structure in soil profiles.



Eastern red cedar litter enriches surface soils in Ca, and since Ca flocculates clay, the decline in aggregation is a bit surprising, however, the surface horizons were generally low in clay (commonly ≈20% clay, Fig. 4). Organic matter is another very important factor in aggregate stability, therefore, a reduction in organic matter might trump a simultaneous increase in Ca with respect to wet aggregate stability. Also, there are fewer fine roots in the surface horizon beneath the trees, and this might lead to reduced aggregation.

Another potential reason for the decrease in aggregate stability beneath the tree could be because the SOC content is slightly lower for both the tree and canopy edge pedons (Fig. 5). Smith and Johnson (2003. Global Biogeochemical Cycles. 17(2): 1062.) recorded no changes in total SOC under cedar tree cover; but rather, through isotopic analyses, they determined that SOC shifted from grassland to forest C.

Conclusions

- Degradation of soil structural properties of the tree pedons relative to the grassland pedons
- Addition of an O horizon and concomitant decrease in SOC to depths of both 30 and 60 cm under cedar vegetation
- Enrichment of surface soil horizons with base cations under the tree cover

Acknowledgements

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