Relationship of Soil Properties and the Spatial Distribution of Weed Seedbanks

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Introduction

- Weeds are known to infest fields in clustered patterns across an agricultural field. Depending on field location, the distribution of the clusters can vary in species, densities, and developmental patterns with potential for a single field to have multiple clusters of different weeds present (Clay and Dille 2020).
- Weed species tend to localize in areas favorable for their survival (Cardina et al. 1996).
- Many studies have interpreted the spatial heterogeneity of weed seedbanks using numeric distributions parameters that are limited to a single numeric value (Mortensen et al. 1993; Cardina et al. 1997).
- Limited research has been conducted to document the spatial correlation of various weed seedbank characteristics and field soil properties such as clay content, organic matter content, pH, cation exchange capacity (CEC), and electrical conductivity.

Hypothesis

Weed seedbank abundance and species richness is influenced by spatial variability of soil properties in commercial fields.

Objectives

1. Document the spatial variability of weed seedbank characteristics within four commercial fields in Indiana.
2. Determine the relationship of the seedbank characteristics with the clay content, organic matter content, pH, cation exchange capacity (CEC), and electrical conductivity.

Methods

Sampling Collection:

- Four Indiana commercial fields were selected based on suspected spatial variability of weed seedbank characteristics (Figure 1).
- 60 soil samples paired with GPS coordinates collected at a 8-cm depth with a 6-cm diameter probe in a stratified random sampling pattern for particle size and standard soil analysis.

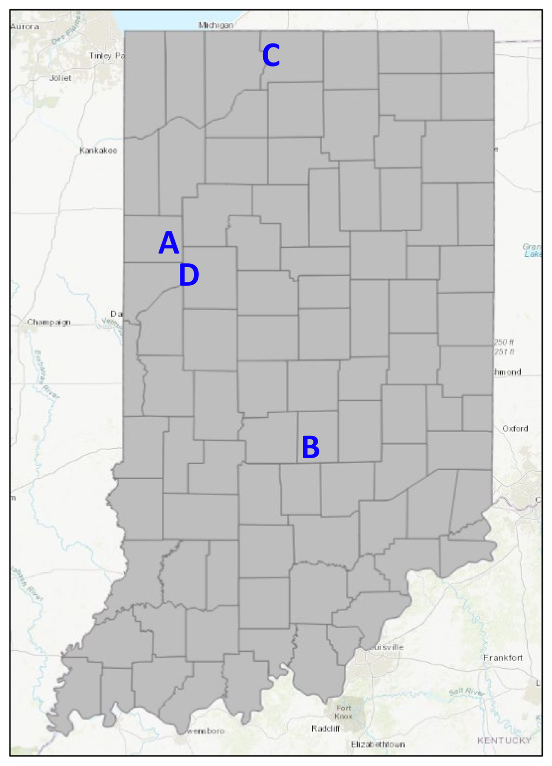

Figure 1: Location of the **A)** Benton County, **B)** Johnson County, **C)** St. Joseph County, and **D)** Warren County Fields.

Weed Seedbank Grow-out

- Samples were stored at 4 C for 6 weeks, thawed, fragmented, and dispersed across a 1.27-cm vermiculite layer in a 25- by 25-cm plastic flats.
- Samples were allowed three separate grow-out periods of 4 weeks. The samples were dried and mixed.
- At the end of each grow out period, weed seedlings were identified and enumerated.

Statistical Analysis

- The correlation analysis of weed seedbank characteristics to sampled soil properties was determined with Pearson's correlation coefficient.
- Clustering was determined using Moran I statistic with inverse weighted distance (IDW) with p=2 using the spdep and ape packages in R.
- Values for the unknown sampling space was determined using ordinary kriging fitted to Stein's parameterizations with automap, raster, rgeos, gstat, sp, and sf packages.

Results

Most Prevalent Weed Species

- 36 total weed species identified across all fields.
- Waterhemp (*Amaranthus tuberculatus*) was the most prevalent weed species (Figure 2).

Relationship between Weed Seedbank Characteristics and Soil Properties

- Clay content had an inverse relationship with weed seedbank total abundance, species richness, and broadleaf abundance in three out of four fields, respectively (Table 1).
- Organic matter content explained between 10% to 24% of broadleaf weed seedbank abundance variation in three of the four fields (data not shown).
- Up to 26% and 45% of the variation in total weed seedbank and broadleaf species abundance, respectively, was explained by the combined effects of clay content and organic matter for three fields (data not shown).

Relationship between Weed Seedbank Species and Soil Properties

- Waterhemp abundance was correlated to clay content in three fields and organic matter in two fields .
- Carpetweed (*Mollugo verticillate*) abundance was explained by organic matter at St. Joseph and Benton Co. fields (r^2= 0.19 and 0.16, respectively).

Spatial Distribution of Weed Seedbank Abundance and Species Richness

- Total weed seedbank clustering present in Johnson Co. field only (Figure 3A).
  - Weed seedbank abundance was correlated to clay content.
- Species richness clustering present in Benton (Figure 3B) and Johnson Co. fields .
  - Species richness was inversely correlated to clay content in both fields
- Spatial distribution of monocots seedbank abundance explained by soil pH at St. Joseph Co. field (data not shown).

Spatial Distribution of Individual Weed Species

- Waterhemp and common lambsquarters (*Chenopodium album)* clustering was present in Johnson Co. and St. Joseph Co. field, respectively (Figure 3C).

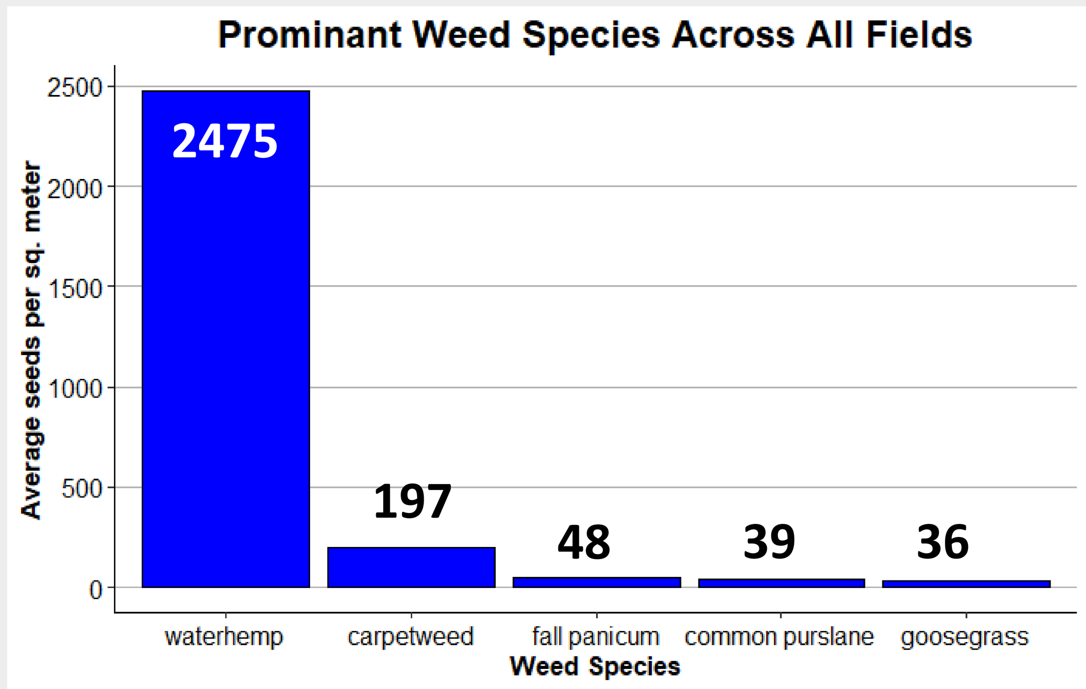

Figure 2: The most prevalent species (average seeds per m²) across studied fields included waterhemp, carpetweed (*Mollugo verticillate*), fall panicum (*Panicum dichotomiflorum*), goosegrass (*Eleusine indica*), and common purslane (*Portulaca oleracea*).

Table 1: Relationship of weed seedbank total abundance, broadleaf abundance, and species richness to percent clay content using Pearson correlation coefficient (r).

	Total abundance	Broadleaves abundance	Species richness
Benton	-0.35*	-0.44*	-0.33*
Johnson	-0.27*	-0.27*	-0.26*
St. Joseph	-0.19	-0.18	-0.13
Warren	-0.36*	-0.36*	-0.26*

*Significant relationship with clay content at α=0.05.

Spatial Distribution of Weed Seedbank Characteristics

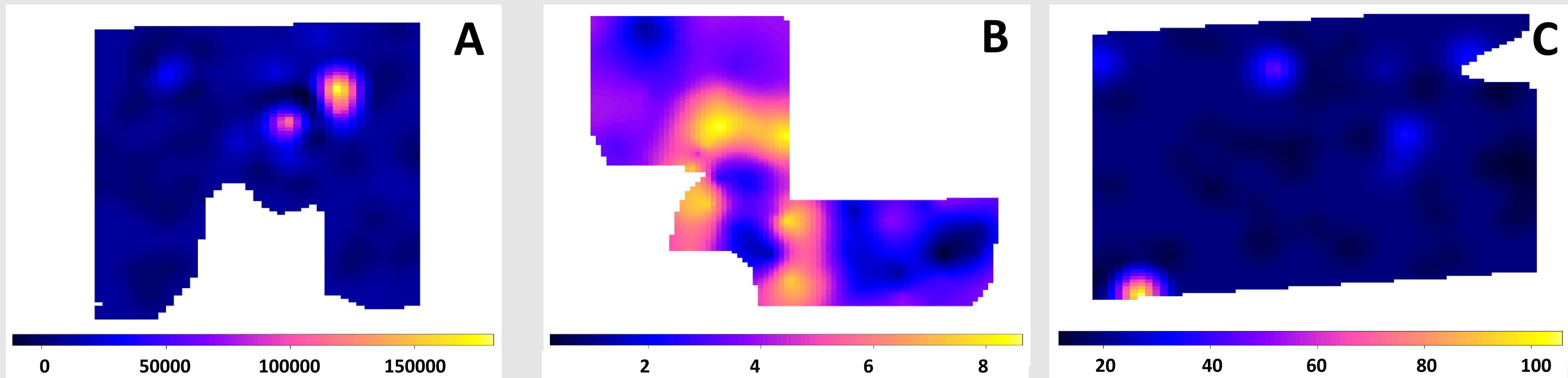

Figure 3: : Spatial distribution of **A)** Total weed seedbank abundance (count per m²), **B)** Species richness (species per m²), and **C)** common lambsquarters abundance (count per m²) in Johnson, Benton, and St. Joseph Co. fields, respectively.

Conclusions and Future Research

Conclusions

- No soil property provided a consistent prediction for weed seedbank distribution, abundance, diversity, or richness.
- Clay and organic matter were the most reliable factors related to waterhemp seedbank and may be useful for building prescription maps for applications of variable rate, soil residual herbicides.

Future Research

- Soil seedbank samples will be subjected to elutriation to confirm quantification of all viable seeds.

References

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