Assessing Soil Variability in Commercial Fields and the Potential Impact on Weed Management

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Introduction

- ❖ Site-specific management practices continue to be adopted by growers by documenting spatial variability at the field level with yield maps and grid soil sampling for variable rate technology (VRT).
- ❖ Herbicide applications are still being conducted uniformly across a field.
- ❖ Over 40 soil residual herbicides labeled for corn and soybean cropping systems have rate restrictions based on organic matter (OM) and/or soil texture (Table 1) (Loux et al. 2020).
- ❖ Crop injury and/or poor weed control can result from uniform applications of soil residual herbicides across non-uniform fields.
- ❖ Soil electrical conductivity (EC) can be measured by electrical resistivity sensors (ER) (Figure 1) as an indirect measure of variability for cation exchange capacity (CEC), soil texture and OM (Barnes et al. 2003).
- ❖ Soil EC sampling methods using ER sensors have moderate to strong correlations to soil texture and OM (Doolittle et al. 2002; Kweon et al. 2013; Mertens et al. 2008).
- ❖ Minimal research has been conducted to document the potential use of soil EC sensors for directing soil residual herbicide applications.

Table 1. Example of three soil residual herbicide use rates based on soil texture and organic matter (OM).

	Soil Texture Class	**Use Rate (pt/A)**		
		<3% OM	**>3% OM**	
s-metolachlor	Coarse	1.0-1.33	1.33	
	Medium	1.33-1.67	1.33-1.67	
	Fine	1.33-1.67	1.67-2	
	Soil Texture Class	**Use Rate (oz/A)**		
		<1% OM	**1-3.0% OM**	**> 3% OM**
sulfentrazone	Coarse	4.5-6	6.0-8	8-10.1
	Medium	6.0-8	8-10.1	10.1-12
	Fine	8	10.1	12
	Soil Texture Class	**Use Rates (oz/A)**		
		<2% OM	**2-4% OM**	**>4% OM**
metribuzin	Coarse	Do Not Use	12	0.75
	Medium	0.75-1	1-1.25	1.25-1.5
	Fine	1.1.25	1-1.75	2

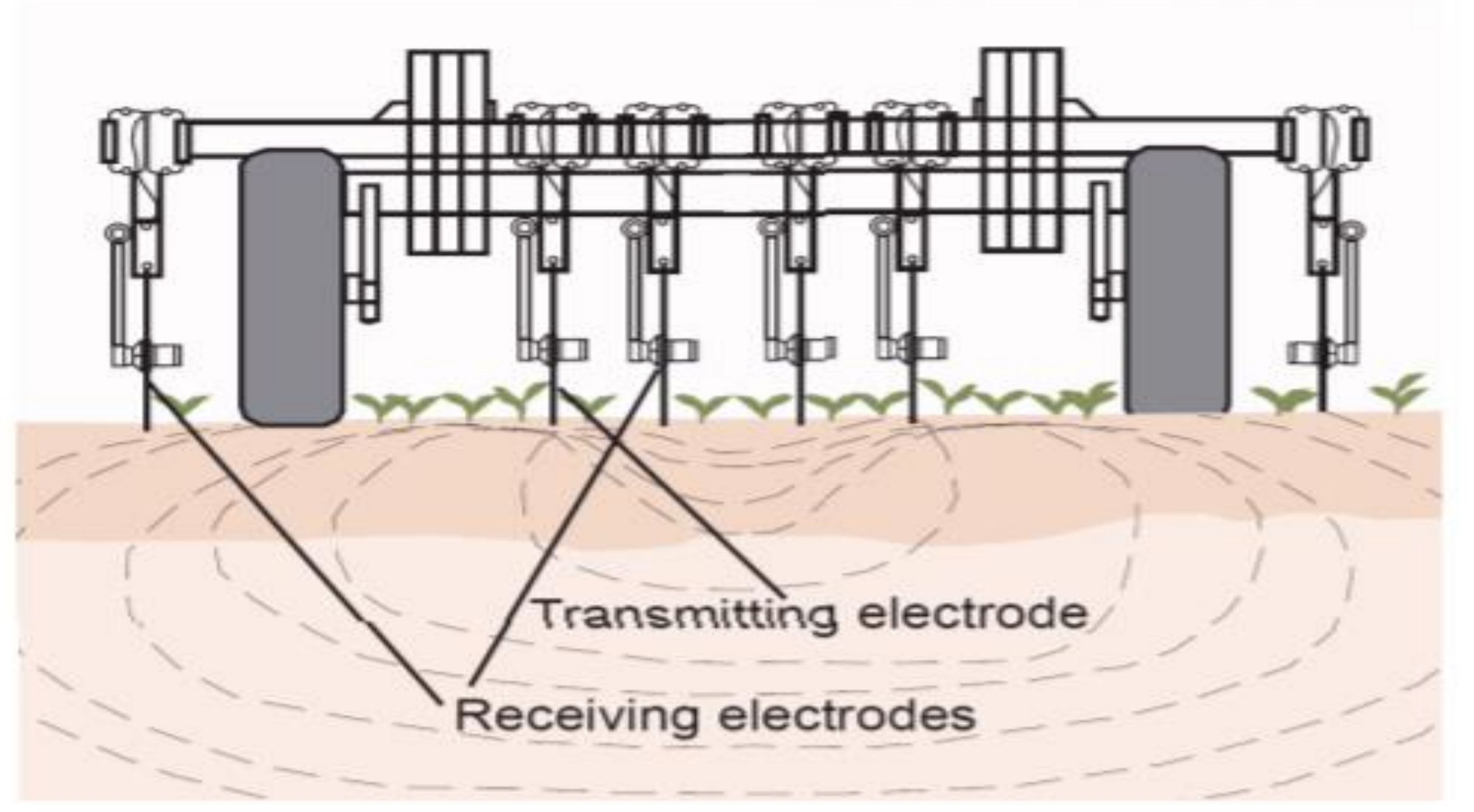

Figure 1. Operation of electrical resistivity sensor. Transmitting electrodes emit an electrical current (grey dashed lines) directly through the soil. The different in current flow is read by receiving electrodes and measured in mS/m. (Image from Grisso et al. 2009)

Hypothesis

1. Commercial field variability is extensive enough to justify the use of variable rate applications of soil residual herbicides
2. The use of soil EC, combined with traditional soil sampling, provide a sound basis to generate an accurate prescription maps for variable rate soil residual herbicides.

Objectives

1. Assess the extent of variability of soil properties to justify site-specific soil residual herbicide applications.
2. Determine if accurate prescription maps based on soil EC and other soil properties can be generated for variable rate soil residual herbicide applications.

Material and Methods

- ❖ Soil EC, OM, and texture data will be collected from commercial fields across the state of Indiana (Figure 2A).
- ❖ Soil electrical conductivity data will be collected by a vehicle mounted, direct contact soil electrical resistivity sensor. (Figure 1).
  - 50ft passes guided by lightbar AB lines.
  - Measurements taken every second at a shallow depth up to 25-cm (e.g. Figure 2B &C).
- ❖ Soil texture, OM, and pH collected in a stratified random sampling pattern.
  - Soil EC results separated into 3 strata (Figure 3A & B)
  - 20 samples per strata (Figure 3C & D)
  - Soil samples collected at a 15 cm depth.
- ❖ Soil samples are paired with GPS coordinates from collection location and entered into a geographic information system (GIS) software.

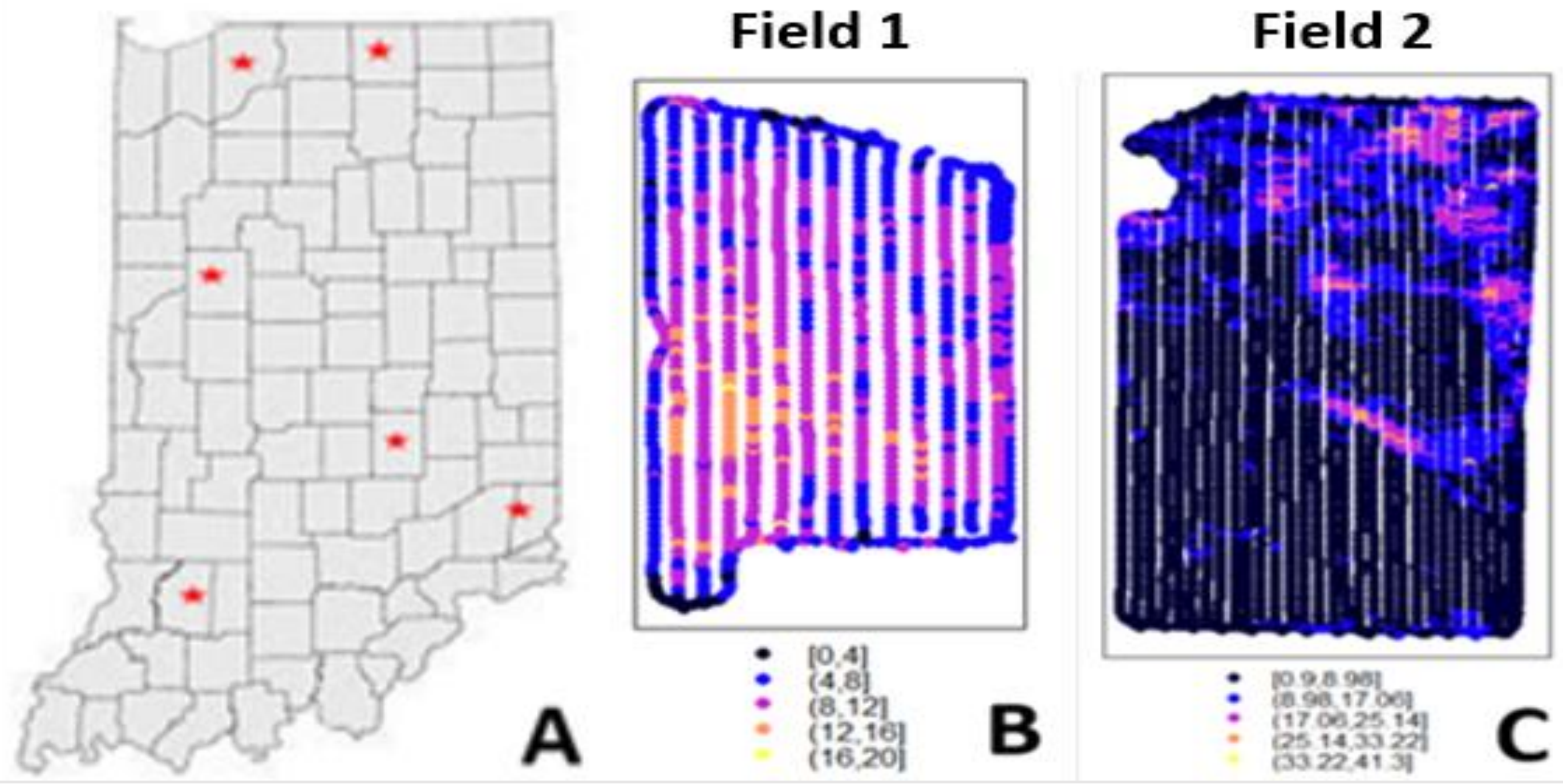

Figure 2. (A) Locations of fields where soil electrical conductivity will be sampled. **(B &C)** Spatial variability of unfiltered soil EC measurements (mS/m) at a shallow depth up to 25-cm in a 20-acre field **(B)** and 88-acre field **(C).**

Statistical Analysis

- ❖ R packages sp, raster, gstat, and rgdal used for statistical analysis of spatial data.
- ❖ 1% percent of unfiltered data points are removed from the tails of the distribution to eliminated extraneous values caused by poor soil contact with the equipment
- ❖ Data fitted to a spherical semivariogram model to complete ordinary kriging to interpolate area between samples.

Results and Discussion

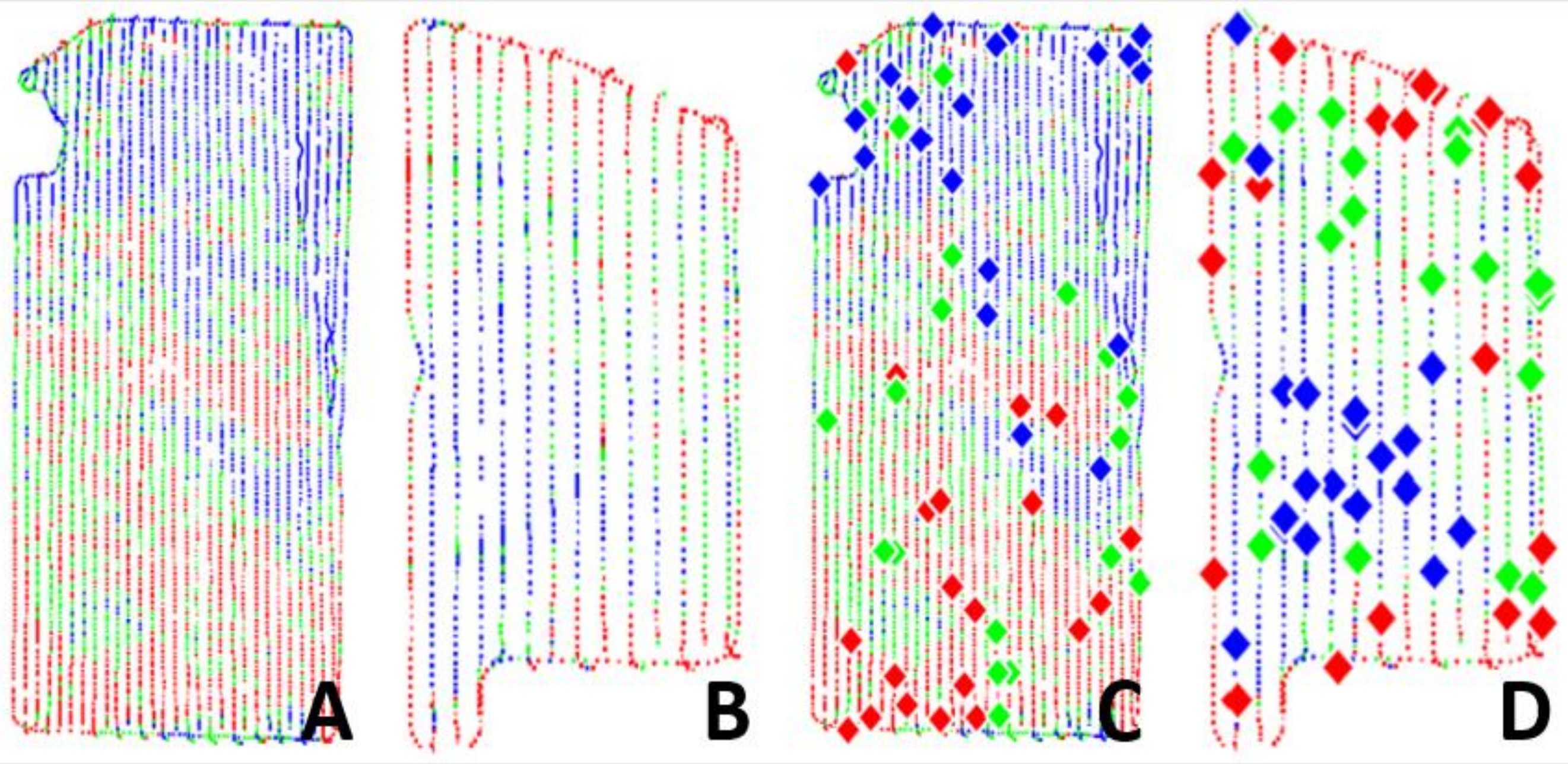

Figure 3. Data layers of the filtered soil EC sample points separated into three strata **(A & B)** and sampling points used for stratified random sampling **(C & D)**

- ❖ The filtered soil EC results from two standard fields in north central Indiana display a 4- and 9-fold difference in variability in Field 1 and Field 2, respectively.
- ❖ Variability could be attributed to multiple soil properties like salinity, soil saturation, bulk density, clay content, and organic matter (Corwin and Lesch, 2005).
- ❖ Apparent EC has been shown to have strong correlation to clay content (r^2=0.76) and organic matter (r^2=0.80) in the soil (Mertens et al. 2008; Kweon et al. 2013).

Conclusion

- ❖ Once the soil sampling and analysis for all proposed fields has been conducted, sound conclusions will be synthesized. The limited data available currently suggest the presence of field variability to justify variable rate residual herbicide applications.

Future Research

- ❖ Collect soil in a stratified random samplings pattern to generate soil texture, OM, and pH maps with ordinary kriging.
- ❖ Determine whether the prescription zones generated by the spatial EC data and soil samples are reliable for variable rate applications of soil applied herbicides.

Additional Research

- ❖ Future research will be conducted to fit soil residual herbicide application rates to the zone layers of prescription maps generated by spatial soil EC and soil samples.

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