Site-Specific Herbicide Applications for Improved Weed Management

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Soil Residual Herbicides

Introduction

Soil residual herbicides are a critical component of best management practices for herbicide-resistant weeds. The residual activity of these herbicides is influenced by several soil properties (clay content, organic matter, pH, moisture, etc.). Therefore, applying the appropriate herbicide rate based on the fields soil properties is critical for optimal herbicide efficacy (Table 1). However, many fields in Indiana have spatially variability of these soil properties extensive enough to require more than one residual herbicide rate, which can be applied using site-specific management practices. However, an accurate method for documenting the spatial soil variability is necessary to develop management zones for variable-rate residual herbicide applications.

Table 1: Recommended rates for s-metolachlor and metribuzin based on soil texture and organic matter (OM) levels present in within a field.

Herbicide	Texture Class	Herbicide Rate (g ai ha^{-1})		
s-metolachlor		<3% OM	≥3% OM	Muck
	Coarse	1071-1424	1424	Do Not Use
	Medium	1424-1788	1424-1788	
	Fine	1424-1788	1788-2142	
metribuzin		<2% OM	2-4% OM	≥4% OM
	Coarse	Do Not Use	400	400
	Medium	400-533	533-666	666-799
	Fine	533-666	533-932	1065

Research Objectives:

1. Determine the accuracy of four data sources to document spatial soil variability
2. Develop management zones (i.e. prescription maps) for variable-rate applications of soil residual herbicides.

Sources for Management Zone Development:

1. Web Soil Survey (WSS)
   - Publicly available soil surveys provided by USDA-NRCS
2. Soil Samples Only (SS)
   - 60 soil cores per field in a stratified random sampling pattern
3. Soil Samples + Electrical Conductivity data (SS + EC)
   - Manually collected soil samples combined with electrical conductivity data.
4. Soil Samples + SmartFirmer OM data (SS + SF)
   - Soil samples coupled with organic matter data from SmartFirmer sensors (Figure 1).

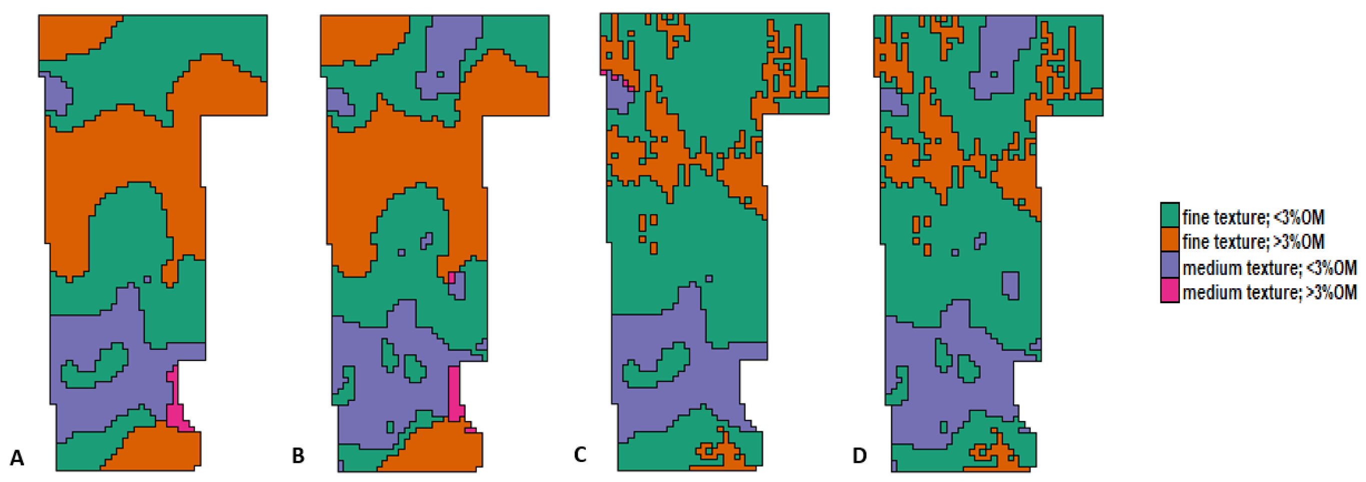

Figure 1: Management zones for a Rush County field using **A)** Soil samples alone, **B)** Soil samples + EC, **C)** Soil Samples + SmartFirmer, **D)** Soil Samples + EC + SmartFirmer for variable-rate applications of pendimethalin, flumioxazin, acetochlor, dimethenamid, and s-metolachlor

Conclusions

1. WSS does not provide reliable prediction for soil texture and OM
2. Soil Sample Only and Soil Samples + Electrical Conductivity maps can be used for VR residual herbicide applications since the accuracy ratings are similar for soil texture, OM, and management zones.

References

1. López-Granados F. 2011. Weed detection for site-specific weed management: mapping and real-time approaches. Weed Research. 51: 1-11

Foliar-Applied Herbicides

Introduction

General Process for Site-Specific Applications of Foliar-Active Herbicides

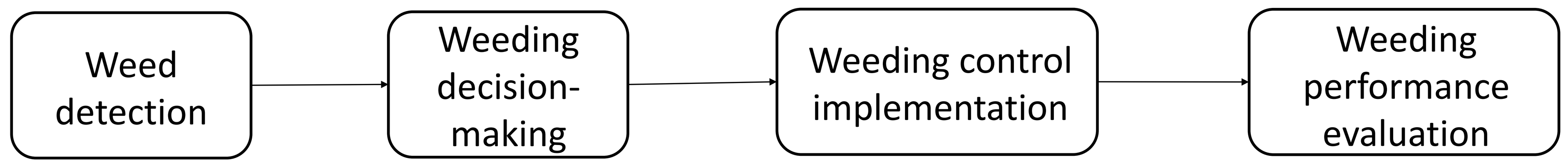

Figure 2: Process used for site-specific weed management (López-Granados 2011).

Sensing Methods for Weed Detection

Sensing methods used for distinguishing between weeds and crops can be categorized into two groups:

1) Airborne remote sensing (planes, UAVs, and satellites)
2) Ground-based real-time sensors (RGB-NIR, spectrometric, and optoelectronic sensors) (López-Granados 2011).
   a) Spray boom-mounted sensors collect images to differentiate the crops from the weeds (Figure 3).
   b) The accuracy of differentiating between crop and weeds relies on the travel speed, crop stage, and time of day.

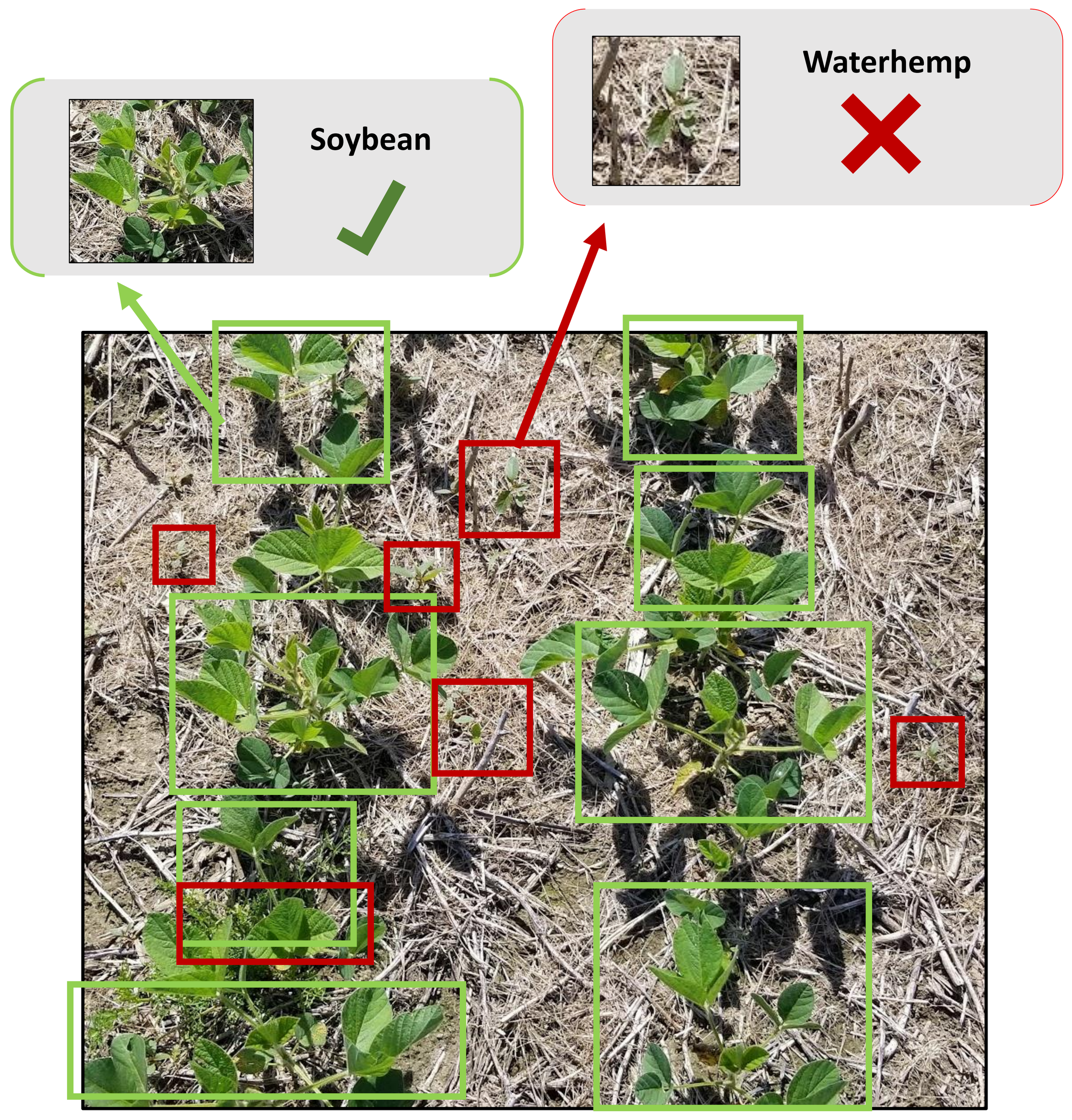

Figure 3: Crop and weeds differentiation using image processing with four steps: pre-processing, vegetation segmentation, feature extraction, and classification.

Dual Tank and Boom Spray Systems

Separate solution tanks and booms on a single sprayer allows for simultaneous applications of broadcast herbicides with one boom and site-specific applications based on weed presence with the second boom. This system also provides two different spray configurations to optimize the herbicides in each tank instead of forcing combinations that are not compatible.

Advantages:

1. Reduce non-residual herbicide use leading to cost savings
2. Avoid herbicide antagonism
3. Help combat herbicide resistant weeds
4. Reduce the herbicide loading in the environment

Figure 4: Blue River Technology Agronomic Testing Machine equipped with a dual tank delivery for site-specific applications.

Research Objectives

1. Comparing the accuracy of spray systems under different variables:
   - Time of day (solar noon/ dusk)
   - Crop stages
   - Travel speeds
   - System sensitivity for weed detection (Figure 5)
2. Evaluating single and dual tank 'See & Spray' applications for systemic and contact herbicides vs broadcast applications
3. Potential for dual-tank system for resolving negative herbicide interactions.

Performance Evaluations

1. Documenting the efficiency of the 'hits' and 'misses' of the spray application on target weeds
   - Location of the missed weeds (row middle vs in-row)
2. Determining the number of false positives (sprays when no weeds are present)
3. Reductions in pesticide use versus broadcast applications
4. Overall herbicide strategy effectiveness

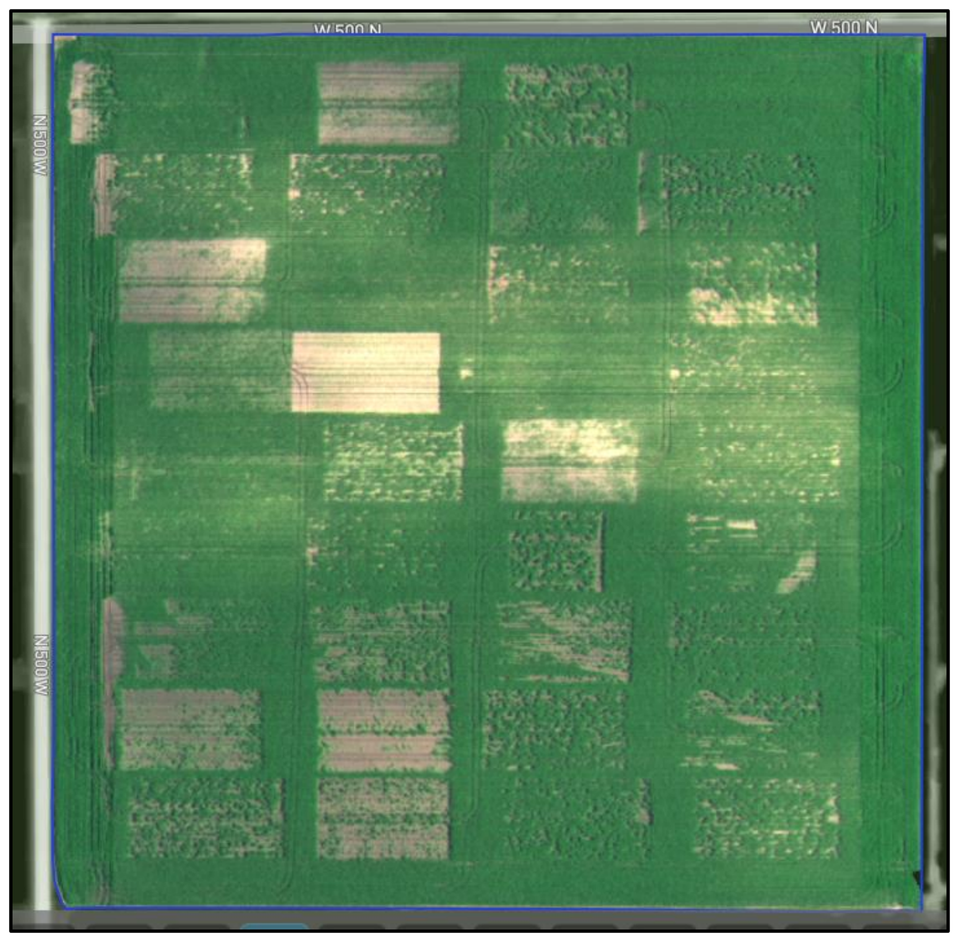

Figure 5 Aerial image of corn trial comparing accuracy and efficiency of herbicide application under multiple experimental factors (time of day, cop stage, travel speeds, and spray system sensitivity). (Image taken July 12th, 2022).

Limitations and Improvements

1. Ability to identify weeds in narrowly spaced crops or past canopy closure.
2. Reducing the number of false positives