Should Variable Soil Residual Herbicide Rates Be Determined by Soil Type, Weed Seedbank Densities, or Both?

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Uniform Herbicide Applications

- Soil residual herbicides applied uniformly
  - Single dose selected based on average soil test results, most limiting soil parameter, or local practice

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- Fields with high variability of soil parameters may result in over- or under-application
  - Over-application: Potential crop injury and unnecessary cost
  - Under-application: Early weed escapes

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Uniform Herbicide Applications

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- Fields with high variability of soil parameters may result in over- or under-application
  - Over-application: Potential crop injury and unnecessary cost
  - Under-application: Early weed escapes
- Best management practices (BMP)
  - Residual herbicides
  - Full label rates

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Metribuzin Labeled Rates

Metribuzin Rates (g ai ha^{-1})			
% OM	Coarse	Medium	Fine
<2	DO NOT USE	400 – 533	533 – 666
2 – 4	400	533 – 666	533 – 932
≥4	400	666 – 799	1065

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Mapping

- Non-uniform soil residual herbicide applications require accurate soil classification mapping.

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Mapping

- Non-uniform soil residual herbicide applications require accurate soil classification mapping.

- Previous research indicates electrical conductivity data and grid soil sampling produces most accurate maps. (Vagedes et al. 2023)

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Variable Rate Herbicide Applications

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- Variable rate application of soil residual herbicides could improve weed control while reducing crop injury

- Grain sorghum research (Gundy et al. 2022)
  - Reduced overall herbicide applied
  - Reduced overall weed control

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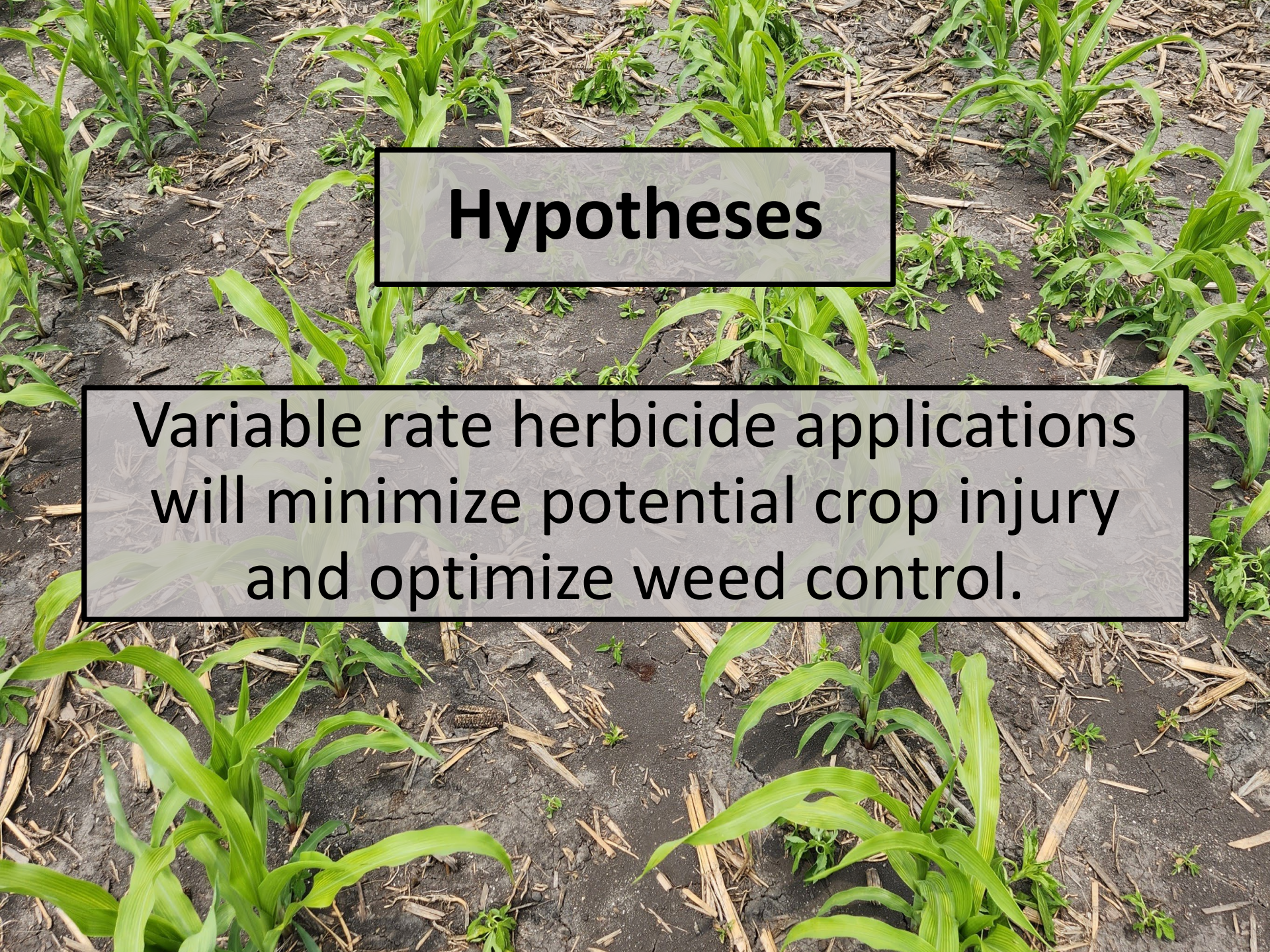

Hypotheses

Variable rate herbicide applications will minimize potential crop injury and optimize weed control.

Objective

Quantify the influence of variable rate applications of soil residual herbicides in corn and soybean production in terms of crop injury, weed control, and crop yield.

Materials and Methods

- Field trials established 2023
  - Two previously mapped fields
    - (EC + grid sampling)
  - Giant ragweed major concern

Materials and Methods

Soybean

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  - Two previously mapped fields
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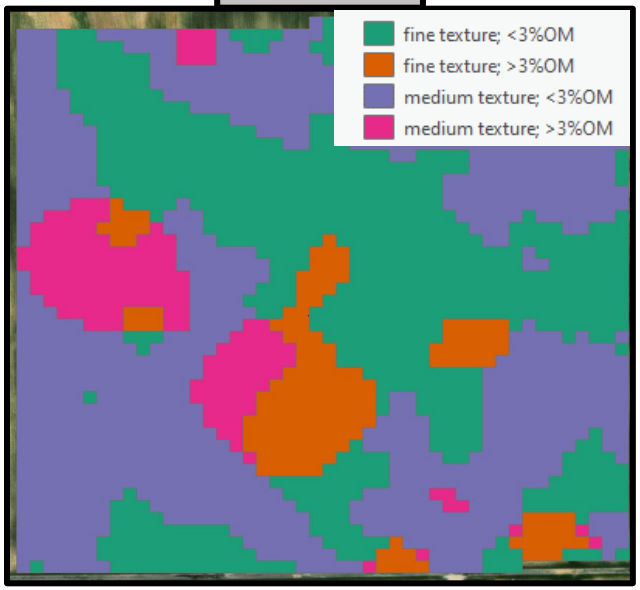
Corn



Materials and Methods: Application

- Grower selected herbicides and base rates
- Variable rates: median of label recommendation range

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Labeled Herbicide Rates

Clopyralid + Flumetsulam Rates (g ai ha^{-1})		
% OM	Coarse	Medium - Fine
<3	139 + 52 (191)	139 + 52 (191) - 174 + 65 (239)
>3	139 + 52 (191) - 174 + 65 (239)	174 + 65 (239)

Sulfentrazone Rates (g ai ha^{-1})			
% OM	Coarse	Medium	Fine
<1.5	158 – 210	210 – 280	280
1.5 – 3	210 – 280	280 – 354	354
>3	280 – 354	354 – 420	420

Cloransulam Rates (g ai ha^{-1})	
% OM	All Soil Textures
<3	35
>3	44

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Materials and Methods: Application

- Grower selected herbicides and base rates
- Variable rates: median of label recommendation range

Soybean

Rate Levels	Cloransulam	Sulfentrazone
	g ai ha^{-1}	
Base	18	175
Low	31	314
Medium	35	354
High	42	420

Corn*

Rate Levels	Flumetsulam	Clopyralid
	g ai ha^{-1}	
Base	33	87
Low	59	156
High	65	174

*Atrazine applied at fixed rate: 1681 g ai ha^{-1}

-Applied using ATV sprayer calibrated to apply 140 L ha^{-1}

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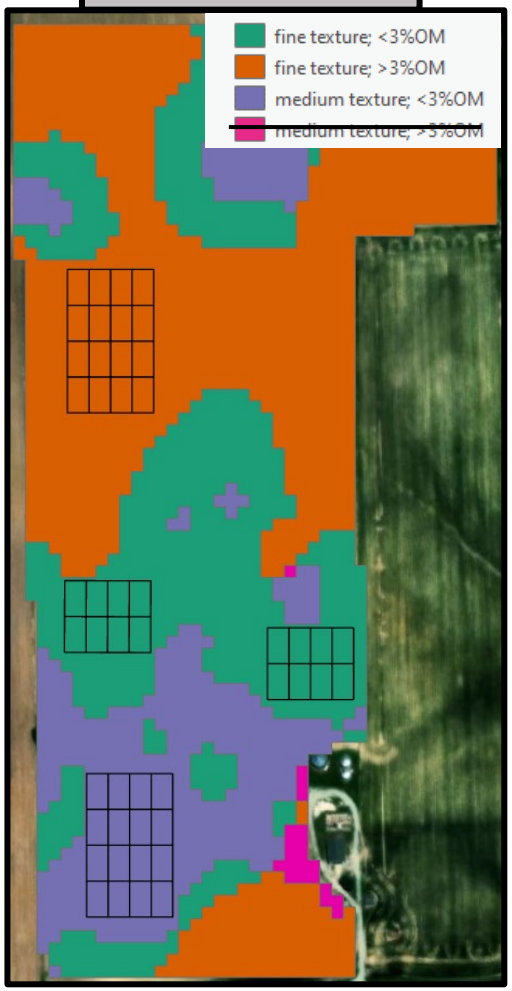
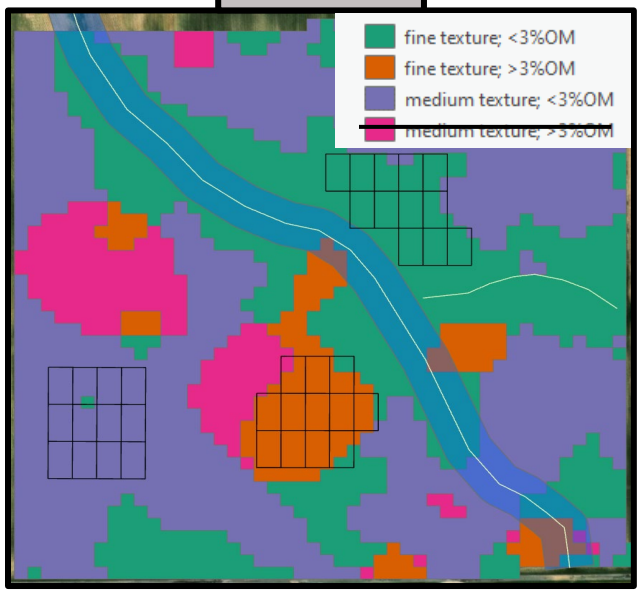
Materials and Methods

Soybean

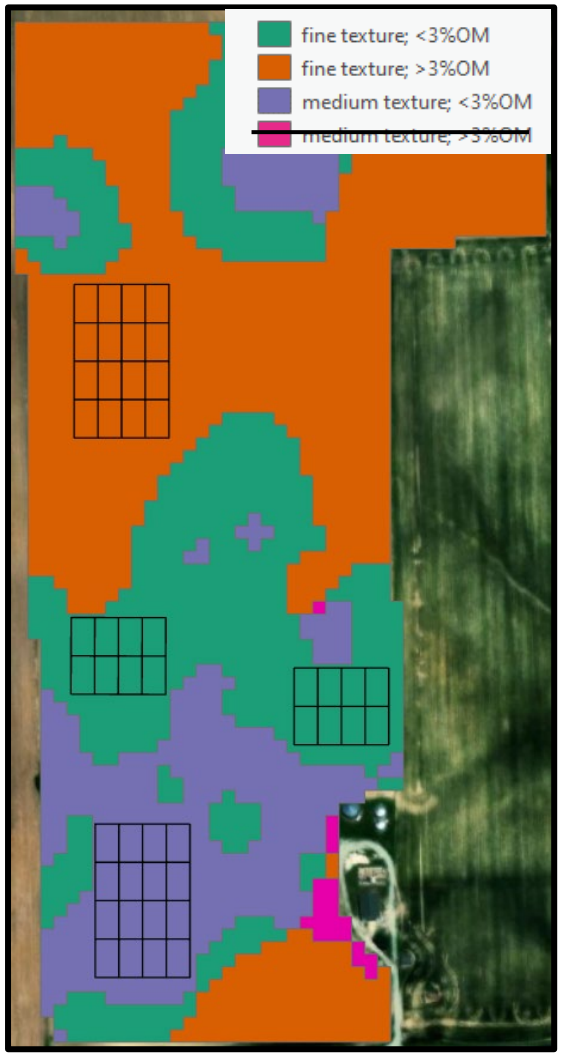


- Field trials established 2023
  - Two previously mapped fields
    - (EC + grid sampling)
  - 18 x 30 m plots
  - Giant ragweed major concern

Corn



Materials and Methods: Soil Sampling



- Seedbank grow out
  - 6 cores
  - 7 x 8 cm each (0.042 m^2 surface area/plot)

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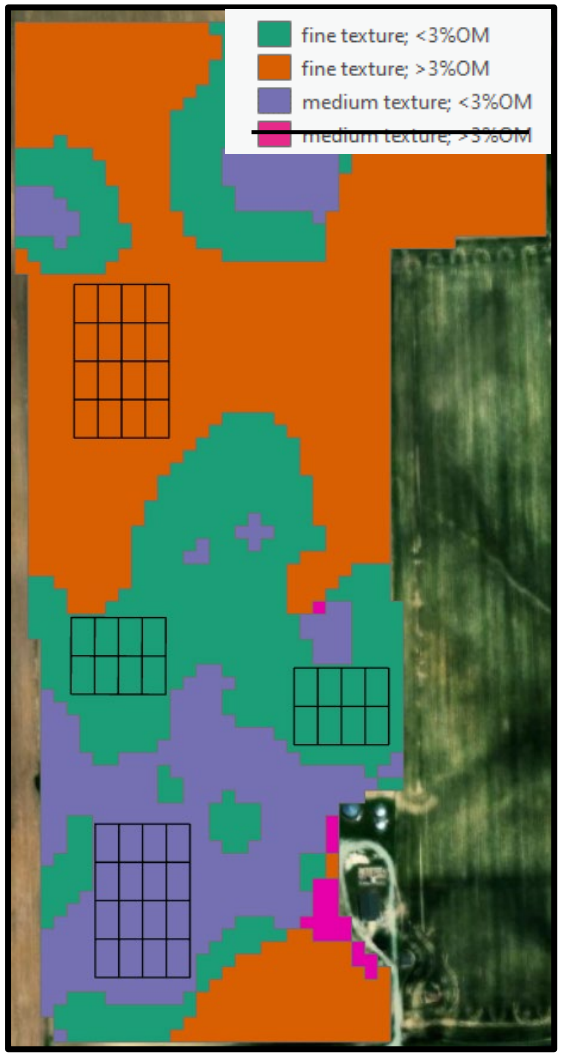
Materials and Methods: Soil Sampling



- Seedbank grow out
  - 6 cores
  - 7 x 8 cm each (0.042 m^2 surface area/plot)
- Soil type confirmation
  - 3 cores

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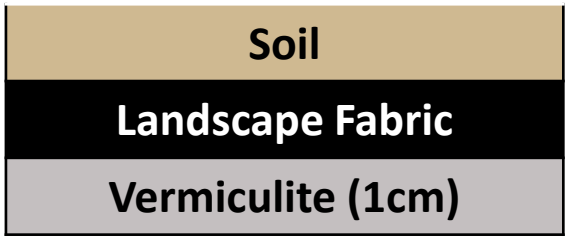
Materials and Methods: Soil Seedbank

- Grow out method (Wilson et al. 2011)
  - 1 month/ run
  - 3 runs – dried between each
- 50x25cm flat (1)/plot
- Sub-irrigated
- Weeds counted by species as they emerged



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Materials and Methods: Experimental Design and Analysis

- Three-factor factorial
  - Factor 1: Soil Residual Herbicide Rate
  - Factor 2: Soil Texture Class
  - Factor 3: Species seedbank abundance
- RCBD with 4 replications
- Data Collection
  - Crop stand counts(14 DAP and prior to POST)
    - 2m row/plot
  - Weed counts (14 DAP and prior to POST)
    - 8 m^2/plot
- Analysis via 3-way ANOVA (R studio 4.3.1)
  - Tukey adjustment ($\alpha = 0.05$)

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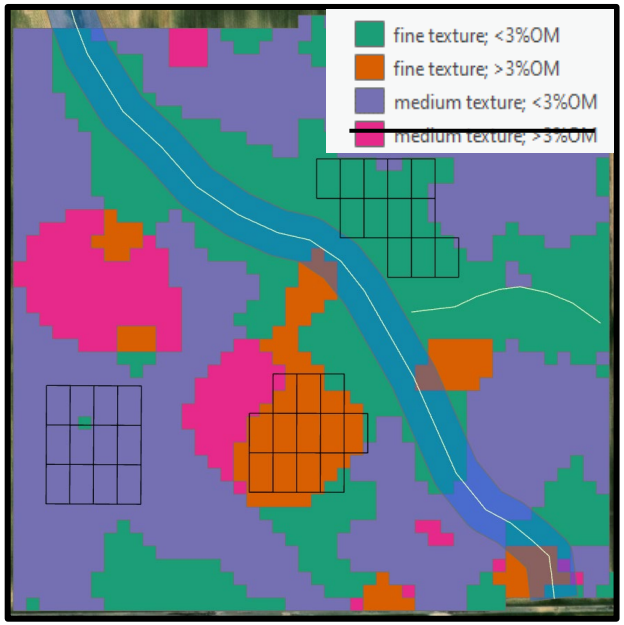
Results

Results - Corn

- Predominant weeds included:
  - Eastern black nightshade (*Solanum ptycanthum*)
  - Velvetleaf (*Abutilon theophrasti*)
  - Burcucumber (*Sicyos angulatus*)
  - Ivyleaf morningglory (*Ipomoea hederacea*)



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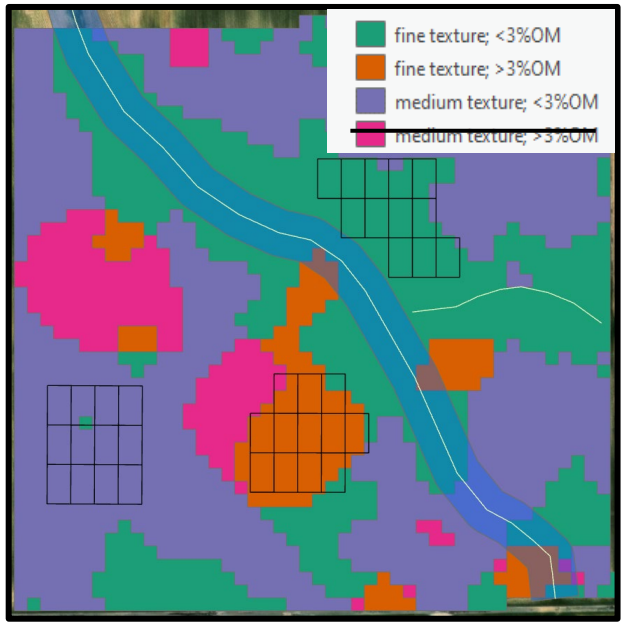
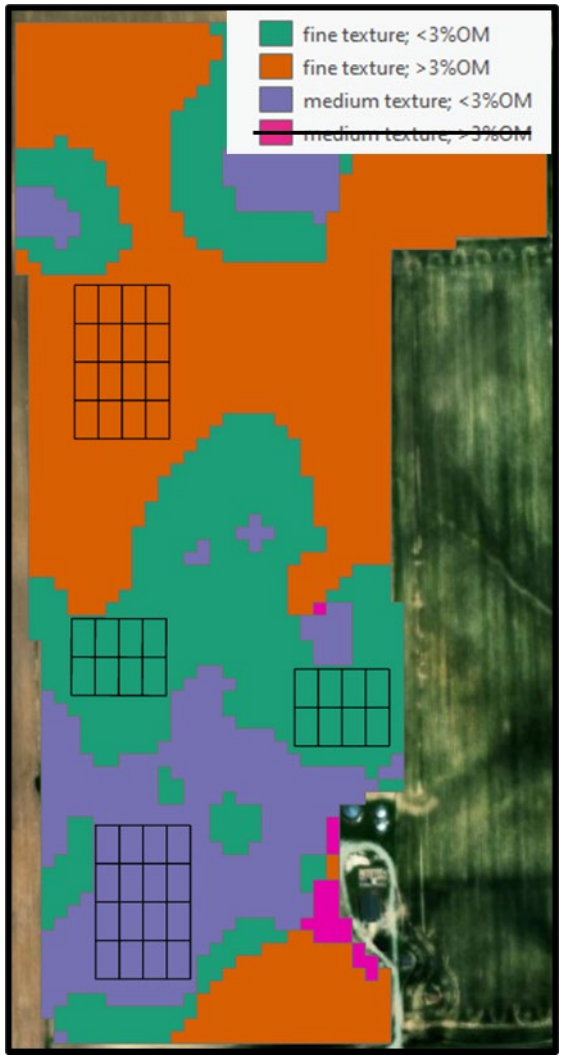
  - Burcucumber (*Sicyos angulatus*)
  - Ivyleaf morningglory (*Ipomoea hederacea*)
- Weed emergence at both timings were not influenced by herbicide rate, soil type, or seedbank densities.
- Overall low weed abundance



Results - Soybean



Predominant species included:

- ❖Giant ragweed (*Ambrosia trifida*)
- ❖Prickly sida (*Sida spinosa*)
- ❖Ivyleaf morningglory
- ❖Annual grasses
  - Barnyardgrass (*Echinochloa crus-galli*)
  - Large crabgrass (*Digitaria sanguinalis*)
  - Fall panicum (*Panicum dichotomiflorum*)
  - Giant foxtail (*Setaria faberi*)
  - Yellow foxtail (*Setaria pumilla*)

Results - Giant Ragweed

Factor	F value	P value
Seedbank Abundance	F 1, 34 = 164.13	<0.001 ***
Herbicide Rate	F 1, 34 = 1.74	0.178
Soil Type	F 1, 34 = 9.87	<0.001 ***

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Results - Giant Ragweed

Giant ragweed emergence prior to POST influenced by soil seedbank abundance and soil type individually rather than herbicide rate.

Factor	F value	P value
Seedbank Abundance	F 1, 34 = 164.13	<0.001 ***
Herbicide Rate	F 1, 34 = 1.74	0.178
Soil Type	F 1, 34 = 9.87	<0.001 ***

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Results - Prickly Sida

Factor	F value	P value
Seedbank Abundance	F 1, 29 = 56.67	<0.001 ***
Herbicide Rate	F 3, 29 = 3.35	0.032 *
Soil Type	F 3, 29 = 1.47	0.243
Rate : Soil Type	F 6, 29 = 5.23	<0.001 ***
Rate : Abundance	F 2, 29 = 2.98	0.066
Soil Type : Abundance	F 2, 29 = 5.16	0.012 *
Rate : Soil Type : Abundance	F 1, 29 = 37.66	<0.001 ***

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Results - Prickly Sida

Emergence prior to POST influenced by the interaction of weed seedbank abundance, herbicide rate, and soil type.

Factor	F value	P value
Seedbank Abundance	F 1, 29 = 56.67	<0.001 ***
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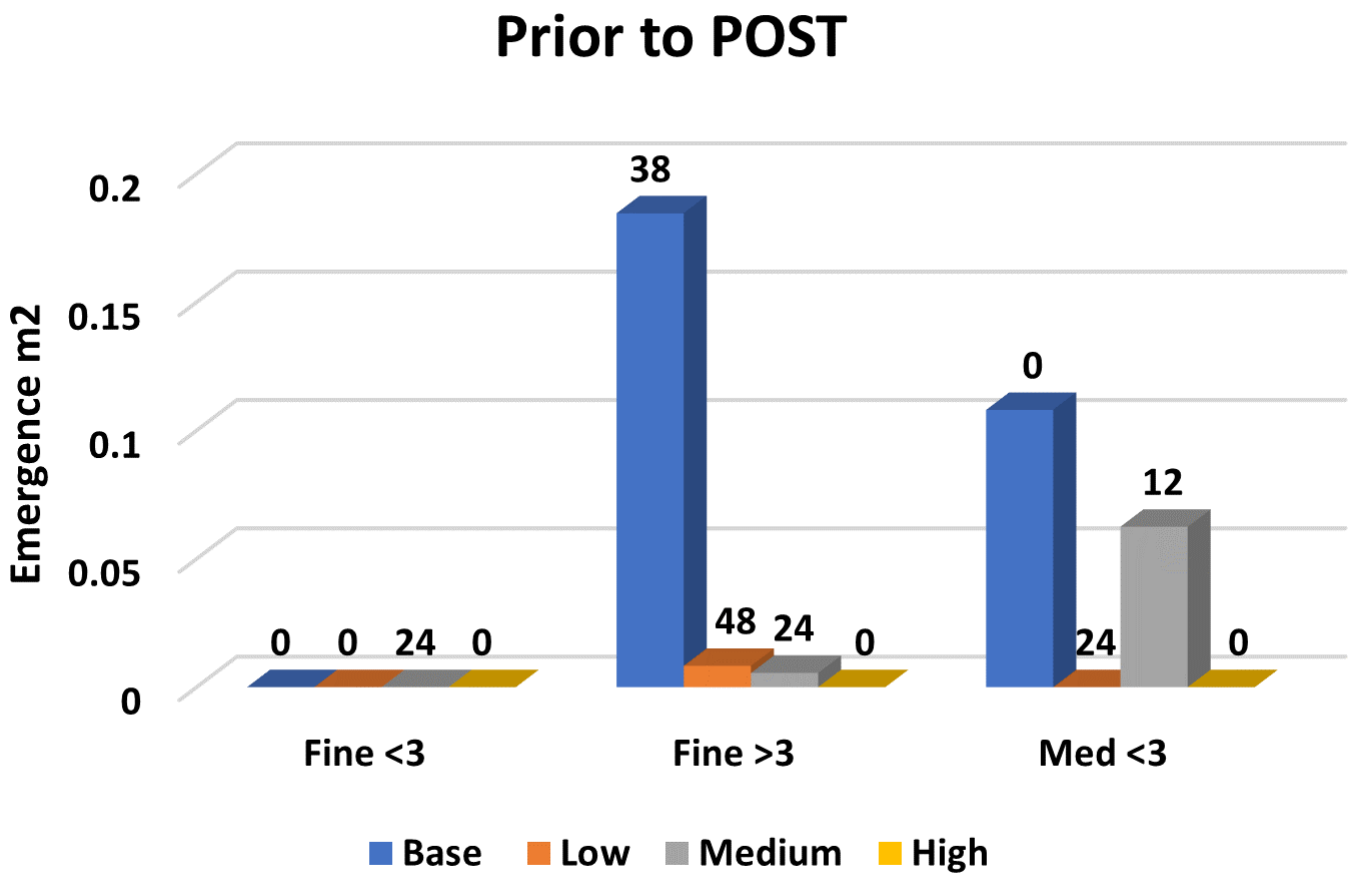

Numbers over bars indicate species seedbank abundance (m^{-2})

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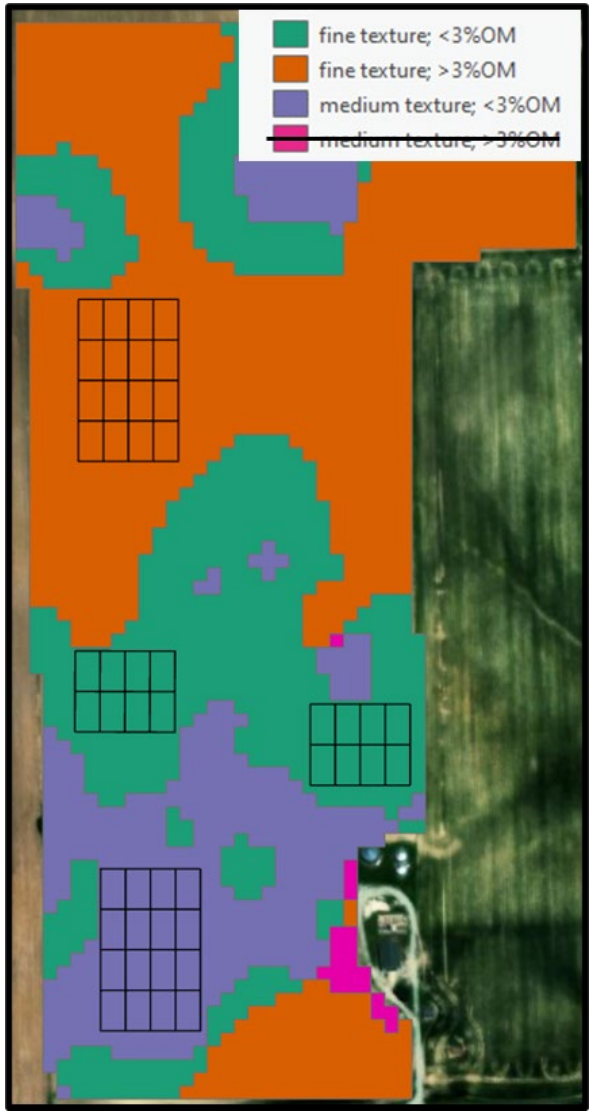
Prickly Sida Seedbank Abundance



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Results - Annual Grasses

Factor	F value	P value
Seedbank Abundance	F 1, 24 = 37.44	<0.001 ***
Herbicide Rate	F 3, 24 = 8.95	0.002 **
Soil Type	F 3, 24 = 6.79	<0.001 ***
Rate : Soil Type	F 6, 24 = 3.17	0.020 *
Rate : Abundance	F 3, 24 = 5.53	0.005 **
Soil Type : Abundance	F 2, 24 = 8.29	0.002 **
Rate : Soil Type : Abundance	F 5, 24 = 5.55	0.002 **

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Results - Annual Grasses

Emergence prior to POST influenced by the interaction of weed seedbank abundance, herbicide rate, and soil type.

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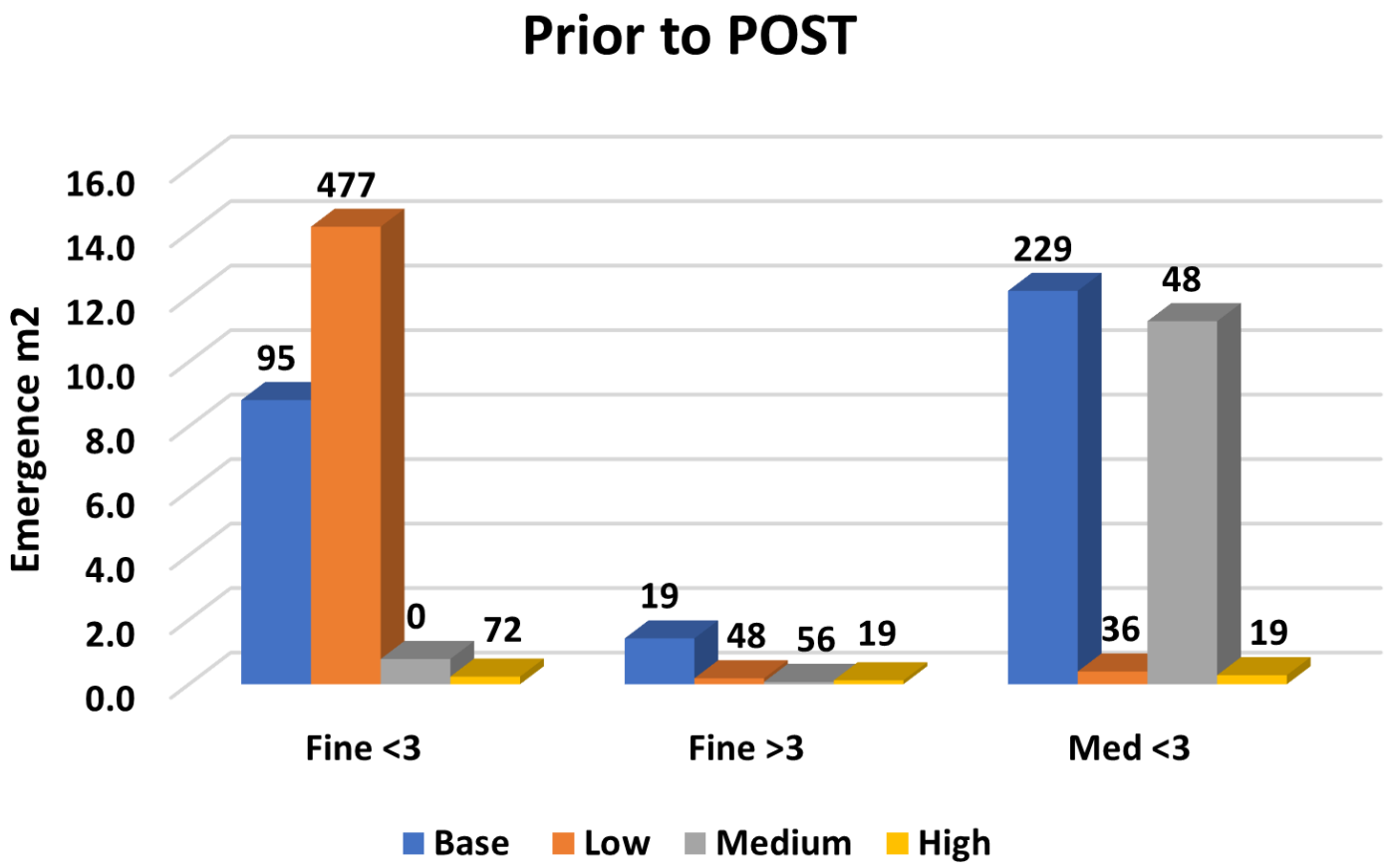
Results - Annual Grasses



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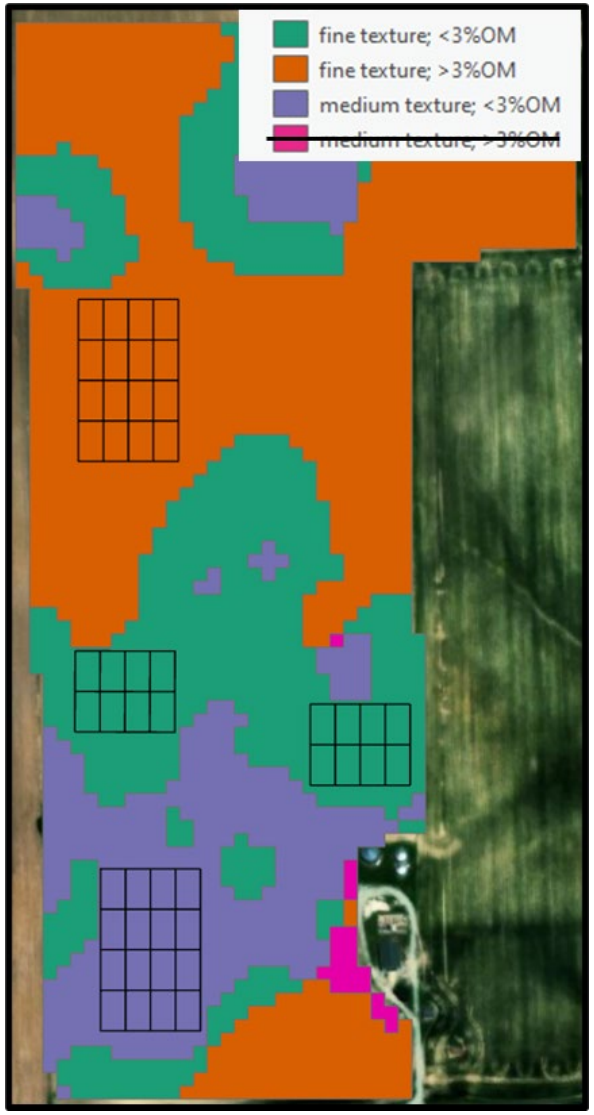
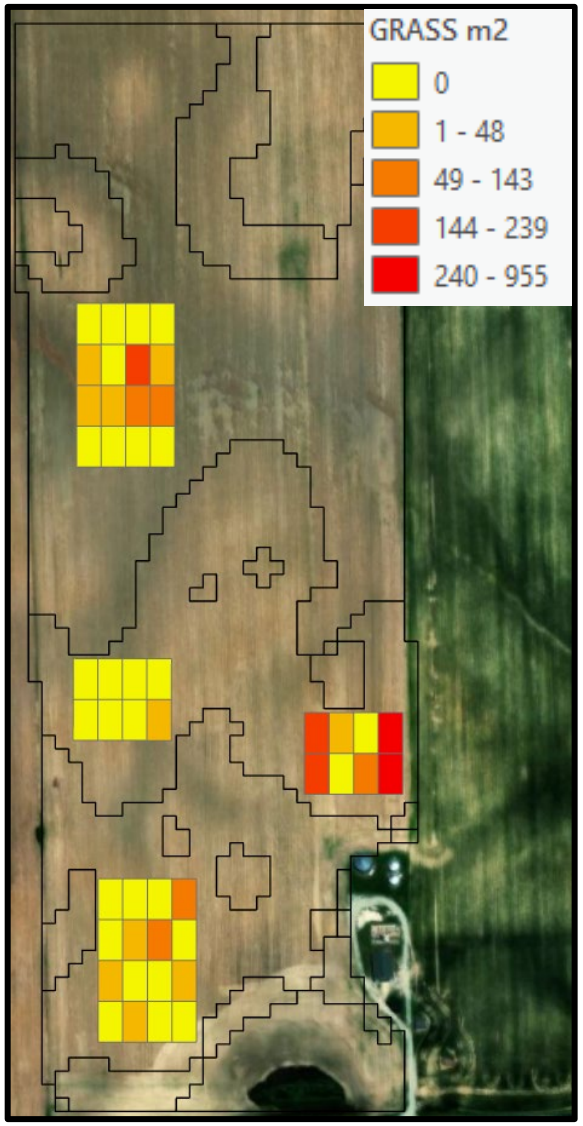
Annual Grasses Seedbank Abundance





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Conclusion

Variable rate applications of soil residual herbicides may need to consider both soil type and the spatial variability in the abundance of the soil weed seedbank to provide a valuable benefit for farmers.

Future Research

- Greenhouse bioassays on herbicide treated soils to quantify herbicide in soil solution from variable rate application.

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Future Research

- Greenhouse bioassays on herbicide treated soils to quantify herbicide in soil solution from variable rate application.

- Determine economic value of variable rate application.

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Acknowledgements

- Funding by Indiana Soybean Alliance and Indiana Corn Marketing Council
- Farm cooperator
- Purdue Weed Science group

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Questions?