Soil and Soybean Responses to Planting into Terminated Prairie Strips

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Introduction

- Prairie strips (PSs) are a diverse perennial plant community, generally comprised of native plants from the Midwest US, that have disproportional benefits to the amount of land they occupy.
- Previous research has shown overwhelming benefits to water quality, soil health, and wildlife/pollinator populations when converting just 10% of a field to a contour PSs [1] (**Figure 1**).
- According to the Iowa State University STRIPS website, over 11,000 acres of prairie strips are planted across 14 states [2]. Prairie strips are also a part of the USDA CRP's CLEAR initiative.
- However, with the disproportional benefits to soils concentrated under the prairie strip, growers and researchers alike have wondered how rotating PSs affect these benefits across a field or watershed. In other words, the idea is to 'spread the soil benefits' under PSs with long rotations of crop-PS throughout the watershed at 10-15 year intervals.
- RESEARCH QUESTIONS: how will crop yield and soil be affected by cultivating a former PS? More specifically we asked 1) how does land previously under PS affect new crop health (measured as SPAD), 2) how does land previously under PS affect the quantity and size of soybean nodules, and 3) how prior land, previously under PS but now cropped, affect soil health?

Methods

- Site & Experiential Design: A paired watershed experimental design located in Jasper County, IA at Neal Smith Wild Refuge with three paired water sheds (control with no PS and PS), three sampling locations in each watershed (psuedoreplicates), and three positions from terminated PS (3m Above or uphill, within prior PS, 3m Below or downhill).
  - All cropland is maize-soybean rotation, with no-tillage.
  - PS were terminated with glyphosate then tilled with chisel plow to 10 cm; control strips were also tilled
- Plant Sampling and Analyses: Six plants were sampled in each watershed. Aboveground biomass was oven dried at 50℃ and weighed
  - SPAD measured on soybean at R2/R3 with Minolta SPAD-502
  - Nodules count and size were analyzed using SNAP pipeline software [3]
- Soil Sampling and Analyses: Composite soil samples collected at 0-15 cm depth on 22 June 2021 (49 days after tillage and termination).
  - Nitrate and ammonium concentration extracted with 0.5 M K_2SO_4 and analyzed using colorimetric microplate method [4,5]
  - Microbial Biomass C and N (MBC and MBN) was measured using the Fumigation method and a Shimadzu TOC-L Total Organic Carbon Analyzer [6]
- Soil Erosion Measurements: Mesh pad method (15×15 cm) [7]

Results & Discussion

- Planting into former PS reduced soybean stand counts by 36% (**Figure 2**), but had no effects on SPAD (**Figure 3**) nor soybean nodule count or size (figure not shown). Likely due to poor seed to soil contact after tilling PS.
- Soils sampled 49 days after PS termination had…
  - 60% greater MBC (, 123% greater MBN, 29% lower MBC:MBN than the control (**Figure 4**). Likely due to prairie vegetation altering soil physical properties, and greater above- and belowground inputs from prairie plants.
  - 419% greater ammonium-N but 37% lower nitrate-N concentrations than the control (**Figure 5**). Likely due combined greater mineralization
- Soil from prior PS reduced soil erosion by 66% and 88% compared to tilled and no-tilled cropland (**Figure 6**).

Conclusion

- Our findings suggest that terminated PSs
  - Reduced soybean stand counts.
  - Increased soil microbial biomass.
  - Increased concentrations of 'less mobile' forms of N (ammonium-N and MBN).
  - Reduced soil erosion compared annual cropping systems temporarily
- More research is needed to estimate how long this stability and resistance will last
- Our findings show that the PSs benefits have a minimal trade-off, reduction of soybean stand counts

Acknowledgements

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Rotating prairie within cropland has persistent positive effects on soils, but lowers soybean stand count.

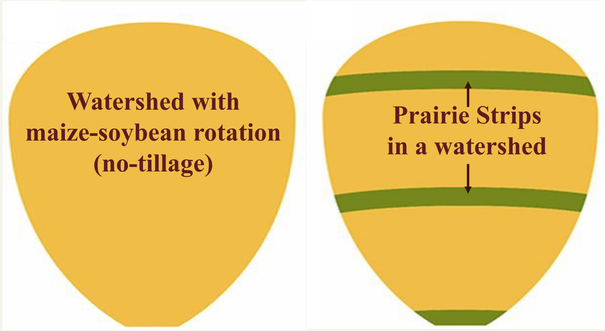

Figure 1. Paired-watershed experimental design. The left figure is the control cropland watersheds that contained no prairie strip (but both tillage treatments – CT and NT). The right figure is the design of the prairie strip (PS) watersheds before termination (herbicide and tillage). The green areas represent the former PS.

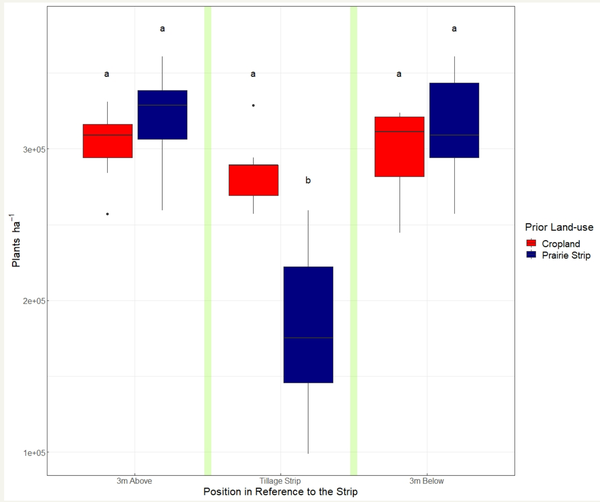

Figure 2. Soybean stand counts at R2/R3 stage. Counts are reported in plants per hectare (n = 9). There is no significant difference among treatments. The tillage strip in the prairie strip treatment has a stand count reduction of 36% compared to the cropland.

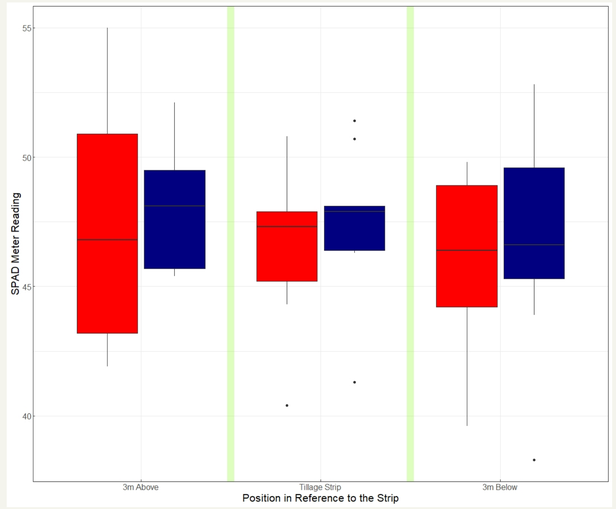

Figure 3. SPAD meter readings, proxy for chlorophyll content, at the soybean R2/R3 stage. Ten plant readings were averaged to a single value for each sample location in each watershed (n=9). There is no difference between treatments.

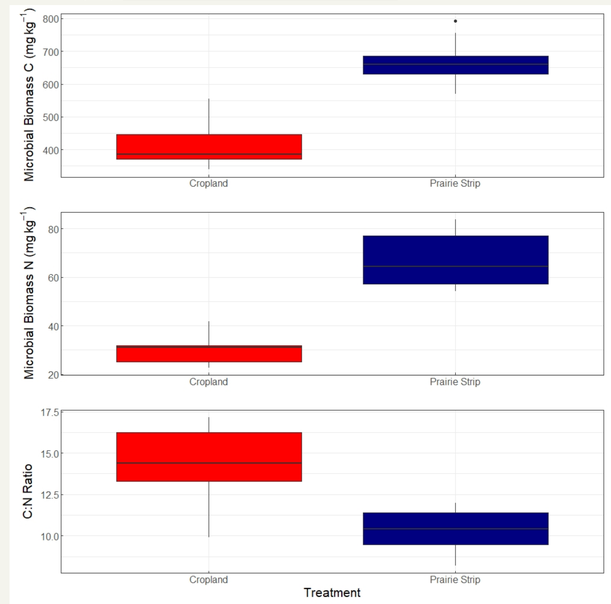

Figure 4. Microbial biomass carbon, biomass nitrogen, and ratio (n = 9). Microbial biomass C and N are elevated in the terminated prairie strip compared to the cropland. Microbial biomass C is 60% and microbial biomass N is 123% greater in former PS soils compared to the tilled cropland. Microbial Biomass C:N ratio is decreased 29% in former PS soils compared to the cropland.

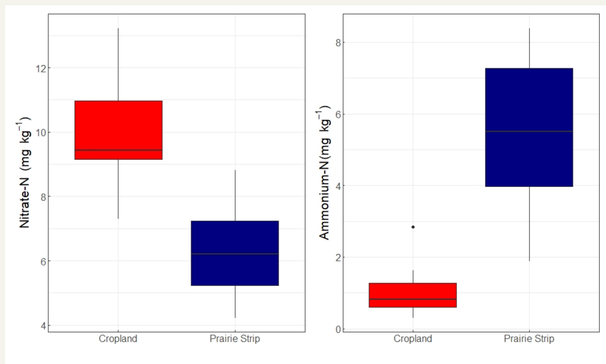

Figure 5. Nitrate-N and ammonium-N in tilled control (cropland) and terminated, tilled former PSs (n=9). Former PS soil had 37% lower nitrate-N than the tilled control, cropland. Former PS soil increased ammonium-N by 416% compared to the tilled control, cropland.

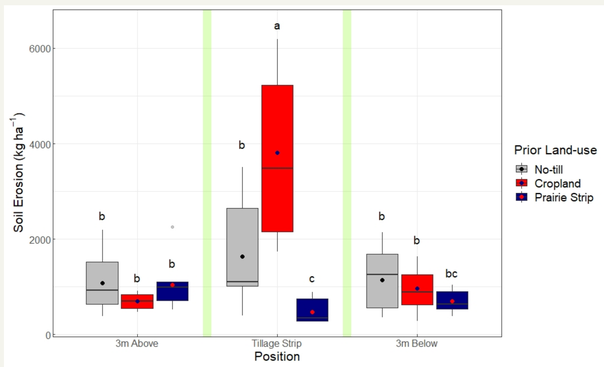

Figure 6. Mean soil erosion measured by mesh pads from May 12th to July 26th (n=9). Treatments include: 1) a treatment that was never tilled (No-Till), 2) a cropland strip that was previously no-till but tilled in 2021 (Cropland), and 3) a PS that was terminated and tilled in 2021 (Prairie Strip). PS decreased soil erosion by 88% compared to tilled, cropland strips and even decreased soil erosion by 66% compared to no-tillage at all.

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