Enhancing Soybean Production with Differential Soil Drainage and Residue Management in Minnesota

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INTRODUCTION

Highly intensive agricultural systems require changes in practices to enhance the efficiency of resource use. Corn (*Zea mays* L.) and Soybean [*Glycine max* (L.) Merr.] are the dominant crops on the landscape in the midwestern United States. Soybean has shown the potential to produce respectable yields in full no-till scenarios under heavy corn residue, however, little is known about early-season growth and development.

Early spring vigor and growth rates are affected by weather and soil factors and are generally strong indicators of yield potential. Weather factors such as rainfall patterns have shifted significantly; very heavy rainfall events are more frequent. Therefore, research is needed to quantify the effect of drainage, tillage, and crop residue.

Objectives

- Examine drainage and tillage effects on spring soil conditions affecting planting, emergence and vigor.
- Investigate the effects of residue level on all aspects of both early-season and season-long soybean growth, as well as mineral nutrition.

MATERIALS AND METHODS

- The field study was established at The University of Minnesota Drainage Site near Wells, MN, USA (Fig. 1) on a Marna silty clay loam and Nicollet silty clay loam soil.
- Tile drainage was installed in 2011 in eight blocks; four blocks have been open, and the others closed to create drainage treatments (Drained and Undrained).

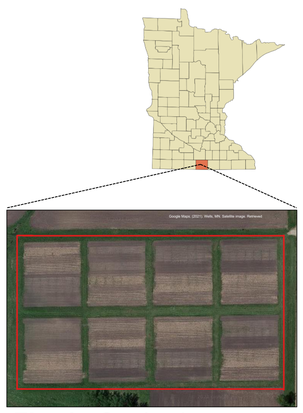

Fig. 1 - Study site located near Wells, MN,

Data Acquisition for the 2021 growing season

- The site has been planted each year in a corn-soybean cropping system in ~9 m by 3 m plots, with four 0.76 m wide rows each.
- Soybean belowground biomass was collected at the beginning of flowering (R1) stage.
- Soybean stand counts were taken at emergence (VE) and full maturity (R8) stage, and plant heights was measured at R8 stage.
- Soil compaction was measured between and on rows 2-4 at a 25 cm depth, in average of 48 plots with different tillage and drainage interactions.
- Corn and soybean grain yield was obtained using a research-scale combine equipped with a yield monitoring device and adjusted to 130 kg^{-1} moisture content.

RESULTS AND DISCUSSION

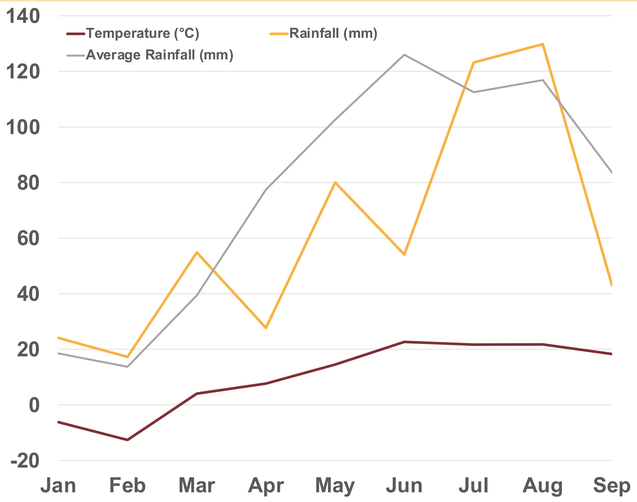

Fig. 2 Monthly average temperature (°C) and monthly average rainfall (mm) data for the study area (National Centers for Environmental Information, 2021). Yellow line represents the measured mean monthly precipitation during the 2021 growing season. Grey line shows the long-term mean monthly.

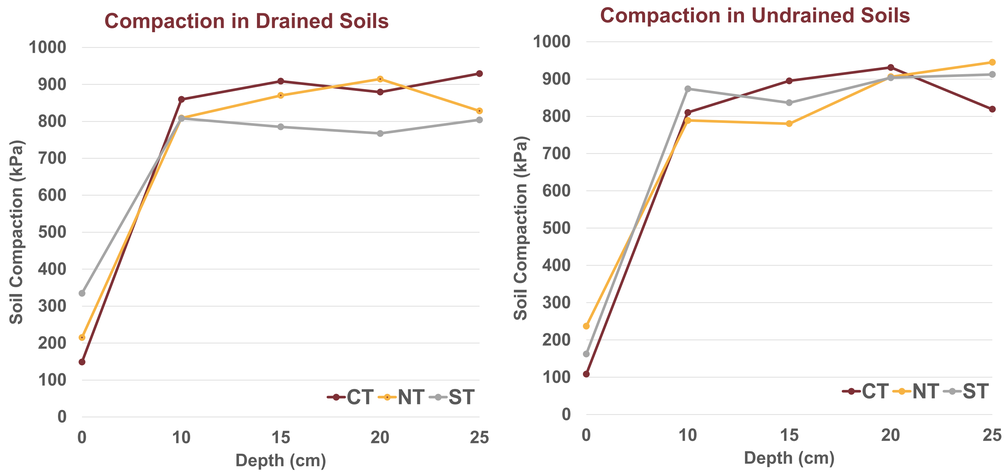

Fig. 3 Average soil compaction measured in drained (left) and undrained (right) soils. Soil compaction prevents moisture penetration, reduces fertilizer and chemical uptake and hinders plant root growth.

Fig. 4 Middle-season soybean growth (R1) differences between Drained (D) and Undrained (U) systems.

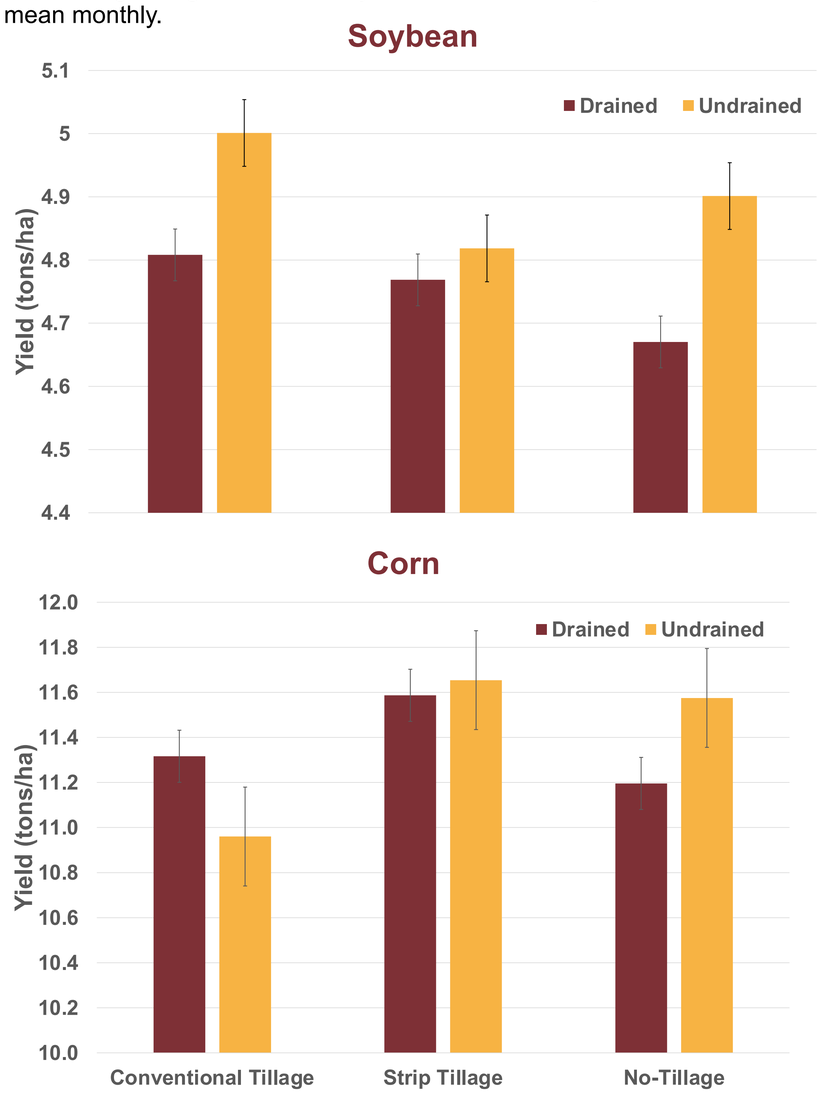

Fig. 5 Average soybean (top) and corn (bottom) grain yields during 2021 growing season.

- Conventional and strip tillage enhanced soybean growth starting early and continuing throughout the season.
- Plants in conventional tillage and in undrained soils had longer roots.
- Soybean grain yields under conventional and no-tillage treatments were higher in undrained soils than in drained soils.
- The average corn grain yields were inconsistent, but drainage had a smaller effect on yield and strip tillage tended to perform better than the conventional tillage treatment.
- Significant interactions between drainage and tillage during an unusually dry growing season suggests a need for additional years of research.

SUMMARY

- Corn grain yields were similar between Drained and Undrained soils due to low rainfall at the site.
- Average soybean grain yields were higher under undrained conditions, but conventional tillage tended to yield most.
- The greatest root length in soybean was obtained using conventional tillage and under drained conditions.
- One-year preliminary data show yield improvement as the result of tillage and drainage interaction; highlighting the need for additional years of data collection.

ACKNOWLEDGMENTS

Research Funding Provided by the Minnesota Soybean Research and Promotion Council and the University of Minnesota. Thanks to the Soybean Production And Physiology Research Project field crew for their help.