Effect of Fertilizer and Residue Management for Maize (Zea Mays L.) on Soil Water Status and Yield

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INTRODUCTION

- The supply of adequate water and nutrients, especially nitrogen (N), is critically important for maize production.
- The interaction of water, N, and crop residue influence biogeochemical processes that may ultimately effect plant growth and yield.
- Water in humid regions, characterized by deep and medium to heavy textured soils, store substantial amounts of water. This however may not provide crops with an adequate supply of water during drought periods potentially limiting yield.

OBJECTIVES

- To quantify the impacts of different residue management strategies on soil water status.
- To evaluate the combined effect of nitrogen fertilizer and residue management on maize grain yield.

MATERIALS AND METHOD

Location

The experiment was conducted near Redwood Falls, in southwest Minnesota, USA on a Canisteo soil (Fine-loamy, mixed, superactive, calcareous, mesic typic endoaquolls) during the 2014 and 2015 growing seasons (Fig. 1).

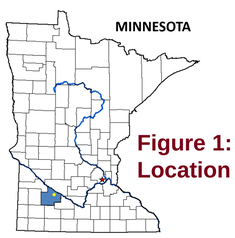


Figure 1: Location

The experiment

- Continuous corn rotation, randomized complete block design with four replications, main plots as residue treatments, subplots as nutrient treatments. Plot size was 12.2 m long and 3 m (Fig. 2).
- Residue was raked, baled and removed after grain harvest for the Low Residue Returned (LRR) treatment while all residue was returned to the plot area after harvest for the Full Residue Returned (FRR) treatment (Fig. 3).
- A disc-ripper was employed as a primary tillage in the fall after residue management.
- Fertilizers were applied and incorporated before planting.
- Two nutrient management regimes: a) control with No Fertilizers (NF) and b) fully fertilized (FF) as; N (urea) 224 kg N ha^{-1}, 112 kg P_2O_5 ha^{-1}, 16.8 kg S ha^{-1} and potassium (K) fertilizers applied at the recommended rates for optimum corn yield.
- Planting dates: May 5th of 2014, and April 30th of 2015.

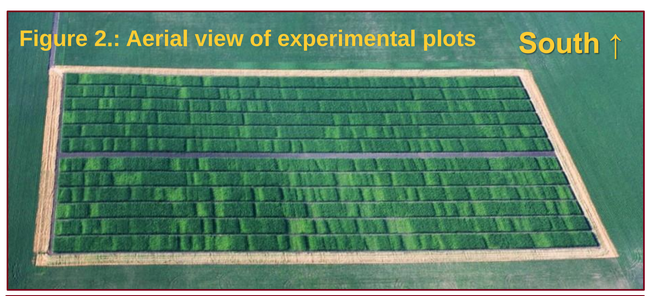


Figure 2.: Aerial view of experimental plots

Figure 3.: Residue Treatments

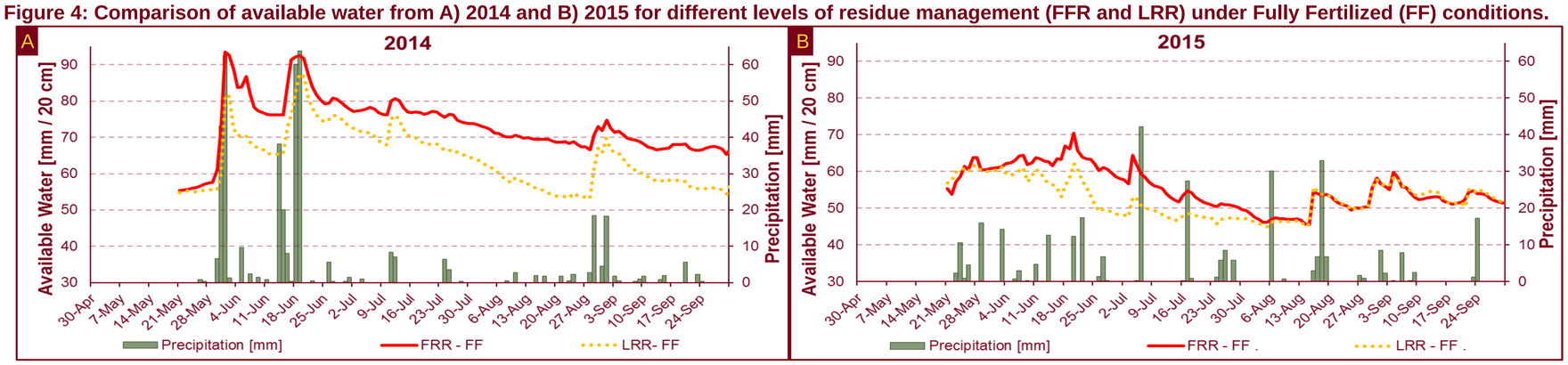
Full residue returned (FRR) **Low residue returned (LRR)**

Measurements

- Maize grain yield was obtained by harvesting two 9.1 m rows per plot corrected to 15.5% moisture content.
- Volumetric soil water content was continuously (15 min intervals, averaged daily) monitored in two replications with 5TM soil moisture and temperature sensors connected to EM50 data loggers (both Decagon Devices Inc., WA, USA) at depths of 0.1 m and 0.2 m.
- Weather data were obtained from a weather station (www.ncdc.noaa.gov) located near the experimental field.

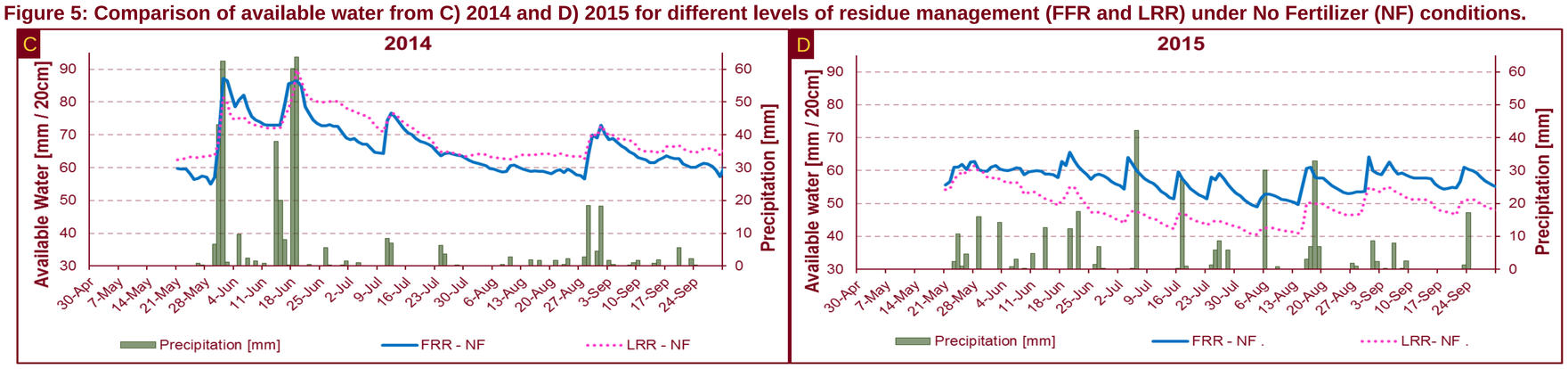
RESULTS

Figure 4: Comparison of available water from A) 2014 and B) 2015 for different levels of residue management (FFR and LRR) under Fully Fertilized (FF) conditions.



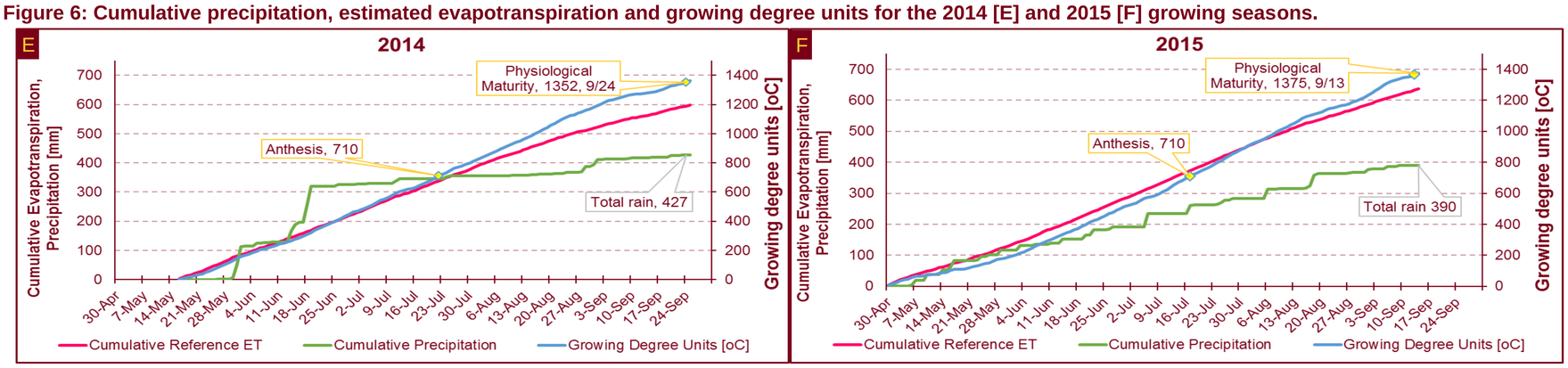
The FRR treatment showed higher available water content in the fully fertilized (FF) treatments in both years [Fig. 4A&B]. This trend continued into 2015, despite the evenly spaced rain events, until August [Fig. 4B].

Figure 5: Comparison of available water from C) 2014 and D) 2015 for different levels of residue management (FFR and LRR) under No Fertilizer (NF) conditions.



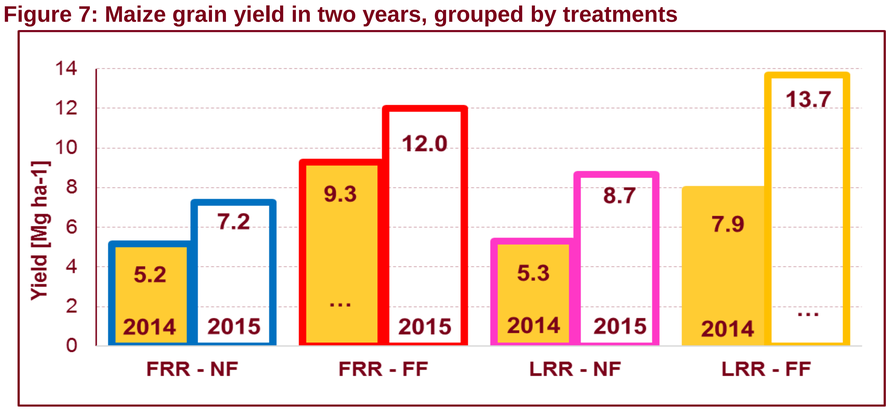
For 2014, the available water trend between residue treatments was not as obvious [Fig. 5C] as observed in the fully fertilized treatments [Fig. 4A&B]. In contrast during 2015, the FRR treatment showed higher available water content in the FRR treatment throughout the entire season [Fig. 5D].

Figure 6: Cumulative precipitation, estimated evapotranspiration and growing degree units for the 2014 [E] and 2015 [F] growing seasons.



The 2014 season was characterized by a colder spring, with two heavy rain events in the early season followed by a relatively dry summer [Fig. 6E]. The 2015 growing season [Fig. 6F] started with a fairly early planting, followed by evenly distributed, sufficient rain events providing very favorable growing conditions for the crop.

Figure 7: Maize grain yield in two years, grouped by treatments



- The FF treatments resulted in higher grain yield than the NF treatments in both years .
- The FRR treatment resulted in a yield advantage only in well fertilized conditions.
- The LRR treatments resulted in a yield advantage over the FRR treatments except for the FF treatment in 2014.

SUMMARY

- In general, where more residue was returned to the soil surface more water was available in to 0.2 m compared to where less residue was returned to the soil surface.
- The timing, frequency and amount of rainfall impacted available soil water content in the 0.2 m soil profile.
- Maize receiving adequate fertilizer resulted in superior yield compared to no fertilizer regardless of residue management.
- In general, maize grown under conditions with low amounts of residue resulted in superior yield compared to conditions with greater amounts of residue.

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