IN-SITU NITROGEN MINERALIZATION FOR CORN AND SOYBEAN IN POORLY DRAINED SOILS WITH AND WITHOUT TILE-DRAINAGE

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Introduction

- Nitrogen (N) represents a major input cost for corn (*Zea mays* L.) growers in Minnesota.
- While large amounts of N are required to achieve high yields, unused N loss to the environment is also a concern.
- Mineralization can provides substantial amounts of N, but quantification of when and how much N is produced in agricultural fields is lacking.

Objectives

- Our objective was to determine how much ammonium, nitrate and total inorganic N (TIN) is produced during the growing season in corn and soybean (*Glycine max* L. Merr.) in a corn-soybean rotation under different N and soil drainage management.

Materials and Methods

- A multi-year study was initiated in the 2014 growing season near Wells, Minnesota.
- Controlled drainage structures installed in 2011 provided drained or undrained conditions in a RCBD with four replications. The top 15 cm of drained plots contained 1.4 g kg^{-1} total organic-N and 19.7 g kg^{-1} total organic-C. The undrained plots contained 1.6 g kg^{-1} total organic-N and 23.8 g kg^{-1} total organic-C.
- Corn received pre-plant 0 and 134 kg N ha^{-1} and soybean received 0 and 45 kg N ha^{-1} as urea-N (46-0-0) broadcast and incorporated by shallow (5 cm) tillage on May 23, 2014.
- *In situ* incubation started in June 5, 2014 by inserting PVC tubes (5 cm diameter, 15-cm deep) in the soil and capped. Mineralization and nitrification was measured by the difference in ammonium and nitrate concentrations at the start of the incubation (from samples collected near the incubation tube) and concentrations inside the tube after incubation. This process was repeated approximately every 14 days until Aug 27, 2014. Soil moisture difference in the incubation tube vs. surrounding soil was <5%.
- Continuous volumetric water content (VWC) and temperature were measured from 0-5, 5-10, and 10-15 cm depths during the season.
- Corn and soybean grain yield was measured at harvest.
- Statistical analysis was conducted using SAS assuming drainage systems and N rates as fixed effects and blocking as random effect using PROC GLIMMIX procedure.

Results and Discussion

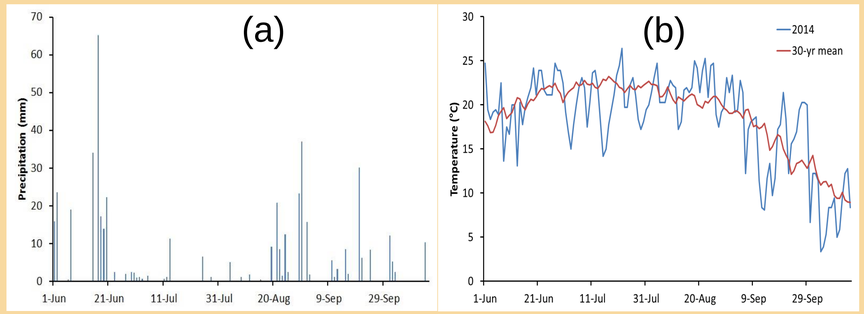


Figure 1. Total precipitation (a) and average air temperature (b) at the study site during the 2014 growing season.

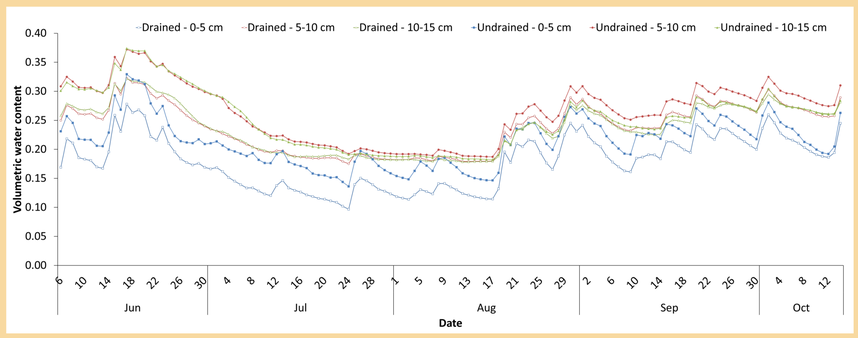


Figure 2. Volumetric soil water content averaged across N rates and crops.

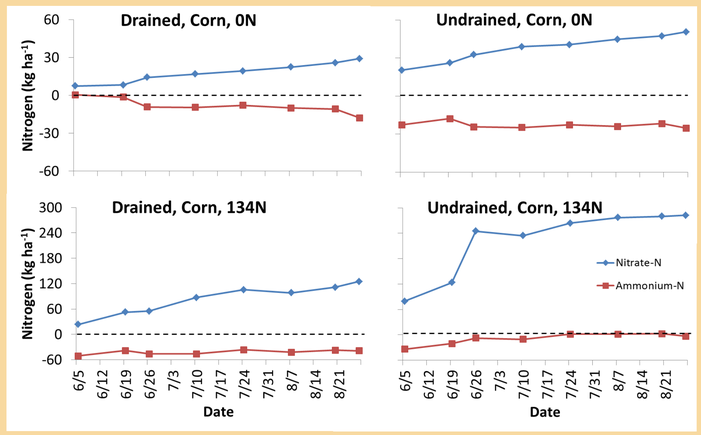


Figure 4. Season-long cumulative ammonium and nitrate amounts for drained and undrained conditions for N treatments (pre-plant 0 or 134 kg N ha^{-1}) applied to corn.

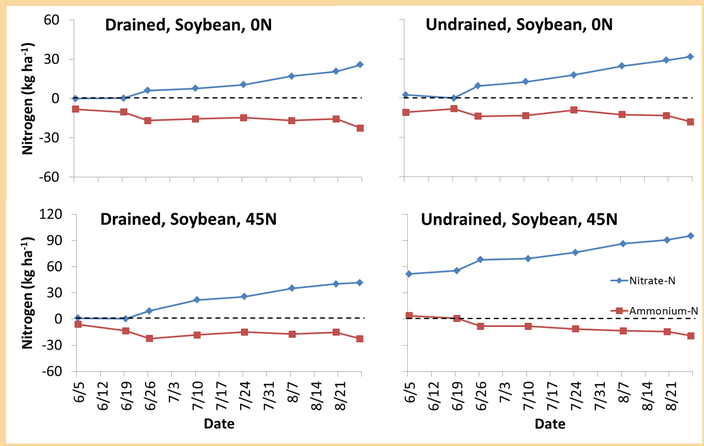


Figure 5. Season-long cumulative ammonium and nitrate amounts for drained and undrained conditions for N treatments (pre-plant 0 or 45 kg N ha^{-1}) applied to soybean.

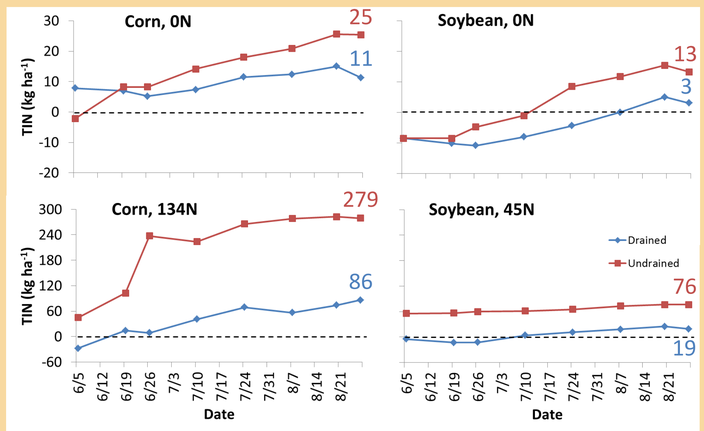
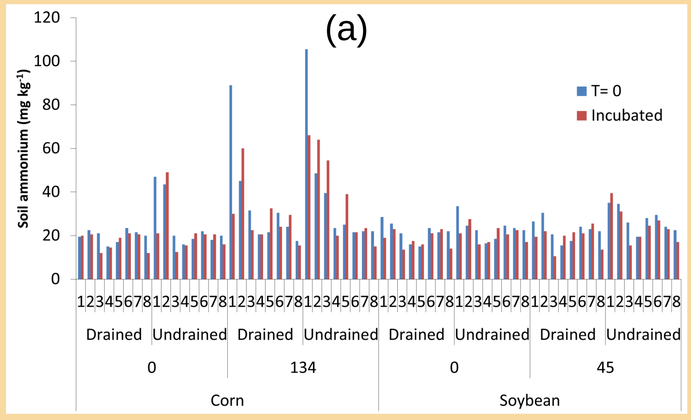


Figure 6. Season-long cumulative total inorganic N (TIN) amounts for drained and undrained conditions for N treatments (pre-plant 0, 45, and 134 kg N ha^{-1}) and crops.



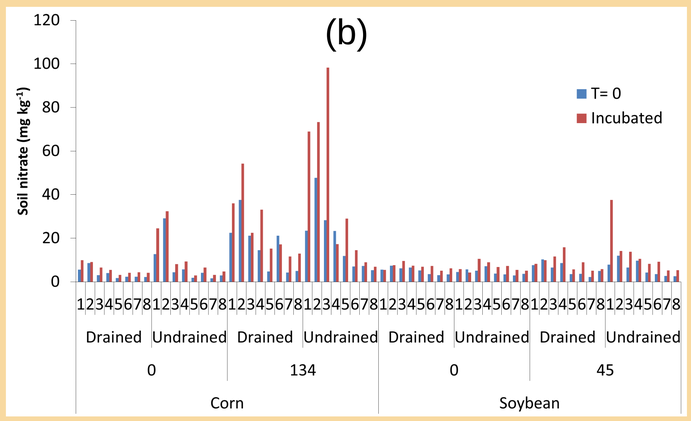


Figure 3. Ammonium (a) and nitrate (b) concentrations before and after incubation by sampling (1-8 in x axis) as influenced by drainage, N rate, and crop variables.

- Precipitation (Fig. 1a) largely influenced soil VWC (Fig. 2). Small precipitation events (late-Jun to mid-Aug) influenced 0-5 cm depth VWC more than the other depths.
- Air temperature was close to the 30-yr mean except in July where it was 2.1°C cooler (Fig. 1b).
- VWC at 0-5 cm was lower than other depths and consistently greater for undrained than drained conditions (Fig. 2). The VWC at 5-10 and 10-15 cm was also greater for undrained than drained conditions but for the 10-15 cm depth only through July.
- Ammonium concentrations overall declined during incubation (Fig. 3a) and nitrate increased, especially in undrained conditions with N applications (Fig. 3b).
- The amount of ammonium present remained nearly constant or declined as cumulative nitrate amounts increased except for the undrained conditions with N fertilization in corn (Fig. 4 and 5).
- The season-long cumulative TIN (ammonium plus nitrate) was greater for undrained than drained conditions regardless of crop or N rate (Fig 6).
- In corn (after soybean) there was net positive mineralization starting in June even when no N was applied; whereas in soybean (after corn) there was net negative mineralization until later in the season (especially in drained conditions) but N fertilization helped reduce this effect (Fig. 6).
- Overall there was a 3.3 fold increase in TIN produced in undrained relative to drained conditions and N fertilization produced a 10.0 and a 5.9 fold increase in TIN production in corn and soybean, respectively relative to the unfertilized check, indicating that N fertilization enhances mineralization.

Acknowledgements

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