Use of Nitrogen Fertilizer Sources to Enhance Tolerance and Recovery of New Corn Hybrids from Early Season Soil Waterlogging

Gurpreet Kaur[1], Peter P. Motavalli[1], Kelly A. Nelson[2] and Felix B. Fritschi[2]

[1]Department of Soil, Environmental and Atmospheric Sciences, University of Missouri, Columbia, MO 65211

[2]Division of Plant Science, University of Missouri, Columbia, MO 65211

Greenley Research Center
University of Missouri

INTRODUCTION

- Excessive soil moisture affects corn (*Zea mays* L.) growth due to anoxic soil conditions and may promote environmental N losses through denitrification or leaching.
- The early (V2-V3) crop stage of corn has a higher probability and vulnerability for soil waterlogging compared to later stages.
- Application of N fertilizer may increase tolerance to excessive soil moisture and reduce yield losses (Ritter and Beer, 1969).
- Use of enhanced efficiency N fertilizers, such as polymer-coated urea (PCU), has been shown to improve corn yields and N use efficiency (NUE) under wet soil conditions due to lower environmental N losses (Nelson et al., 2010).

OBJECTIVES

- To assess the effects of different N fertilizer sources on soil NH_4^+ and NO_3^- content before and after a 7-day waterlogging event.
- To assess the interactive effects of corn hybrids and pre- and post-waterlogging applications of different N fertilizer sources on corn grain yields.
- To evaluate effect of waterlogging with time on urea release from PCU.

MATERIALS & METHODS

- The experiment was conducted at the Greenley Memorial Research Center in Northeast Missouri in 2013 and 2014 and was arranged in a randomized split- split-split block design with three replications.
- The soil was classified as a Putnam silt loam (fine, smectitic, mesic, Vertic Albaqualfs).
- Pre-plant fertilizer treatments were non-fertilized control (CO), non-coated urea (NCU), non-coated urea plus Instinct (NCU+NI), and polymer-coated urea (PCU) applied at 168 kg N ha^{-1}.
- The waterlogging was started at the V3 growth stage and imposed for seven days.
- Two hybrids were used in this study.
- A post-flood rescue N application of 84 kg N ha^{-1} of urea was surfaced-applied with Agrotain urease inhibitor (NCU+UI) at the V7 growth stage.
- Soil samples were collected before and after the 7-day flooding event at depths of 0-10, 10-20 and 20-30 cm and analyzed for NH_4^+-N and NO_3-N using a 2M KCl extracting solution and a Lachat Quikchem ion analyzer.
- PCU packets weighing 10 g each were placed on the soil surface after fertilizer applications.
- The PROC MIXED procedure of the SAS statistical software was used for data analysis.

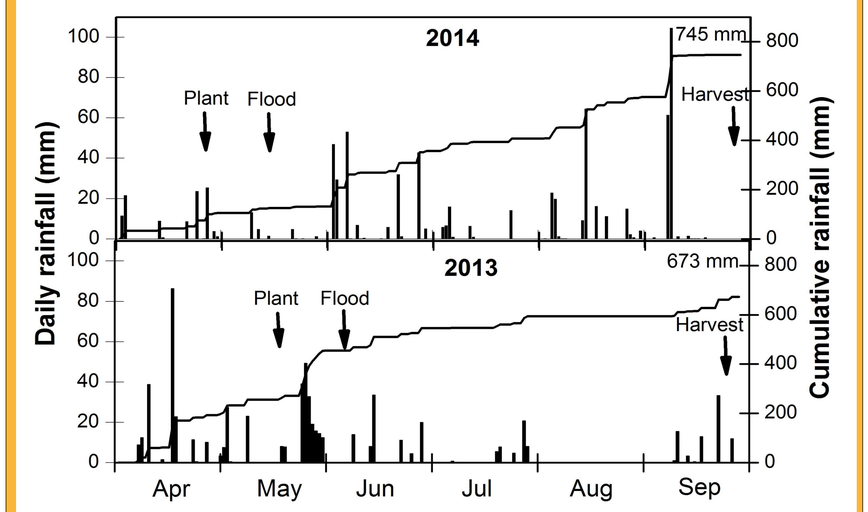

Figure 1. Daily and cumulative precipitation values from April 1st to September 30th for 2013 and 2014 at the Greenley Research Station.

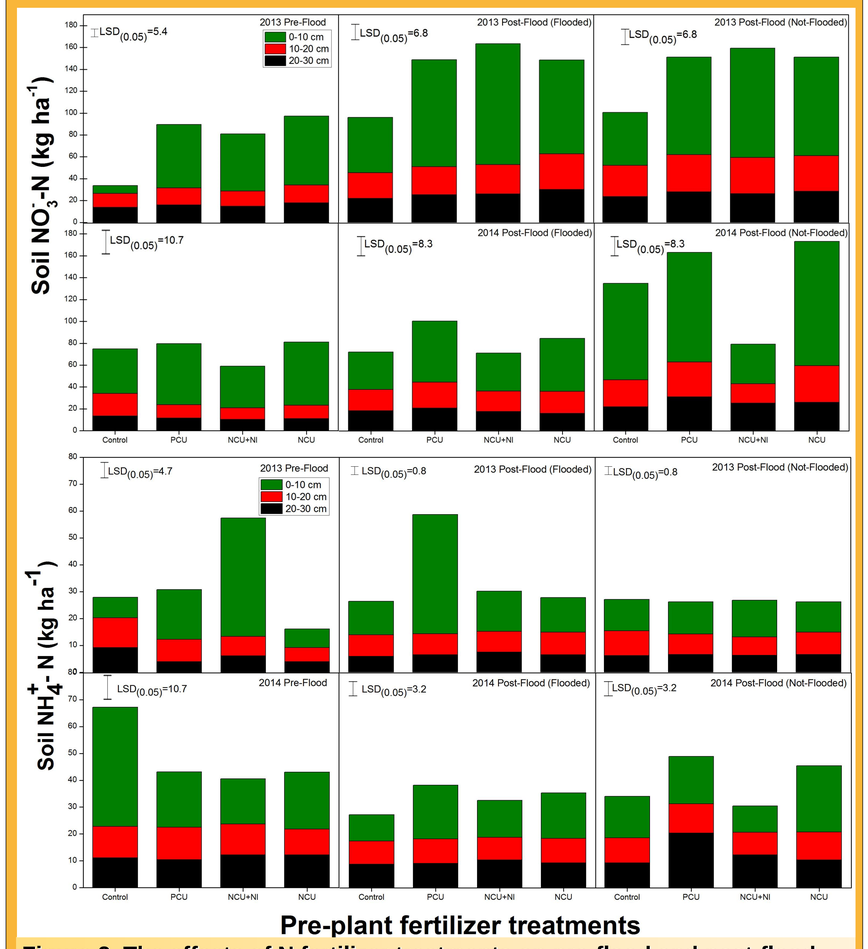

Figure 2. The effects of N fertilizer treatments on pre-flood and post-flood soil NH_4^+-N and NO_3^--N concentrations by depth in 2013 and 2014.

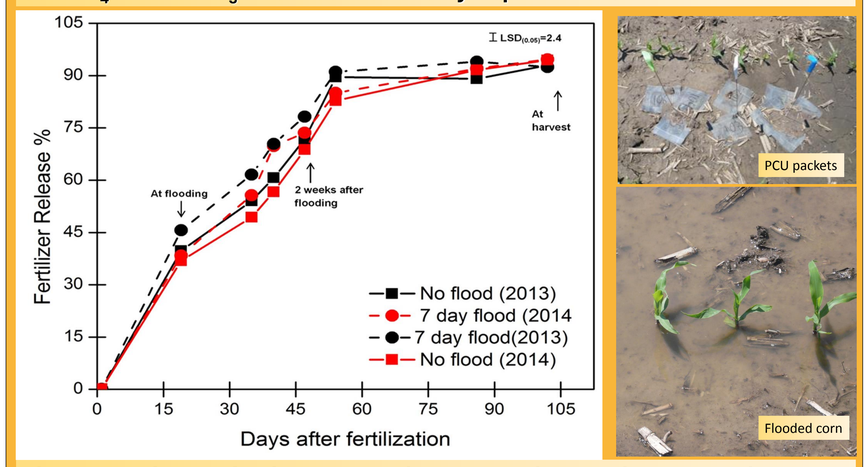

Figure 3. Release of polymer coated urea over the growing season in 2013 and 2014.

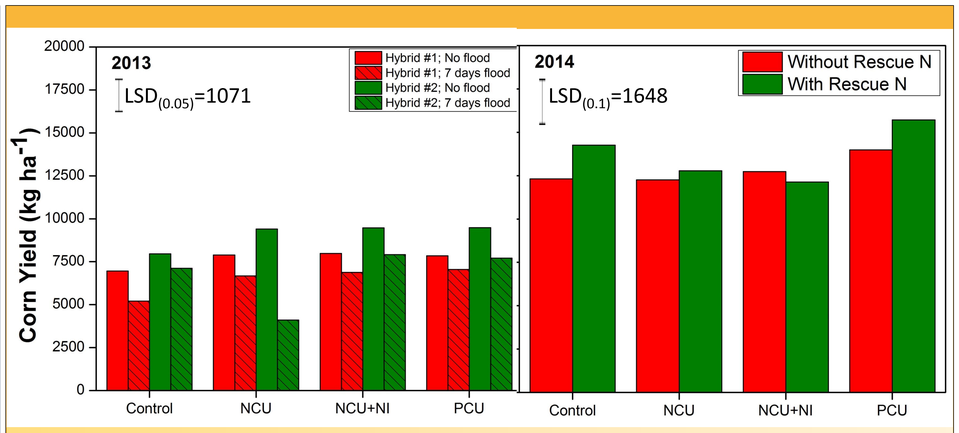

Figure 4. Average corn grain yield among different pre-plant fertilizer treatments during 2013 and 2014 showing effects of corn hybrid, flooding and rescue N.

RESULTS & DISCUSSION

- Cumulative rainfall for the 2014 season was 72 mm higher compared to that of 2013 (Fig. 1).
- Both pre-flood and post flood NO_3^--N and NH_4^+-N were significantly higher at the 0-10 cm depth compared to the other two depths (Fig. 2).
- All pre-plant fertilizer treatments had higher pre-flood and post-flood soil NO_3^--N compared to the control during 2013, but pre-flood soil NH_4^+-N was higher in the NCU+NI treatment compared to other fertilizer treatments (Fig. 2).
- The post flood NO_3^--N was significantly different between PCU and NCU+NI in 2014.
- The urea release from PCU was greater in flooded plots compared to non-flooded treatments, with >60% release two weeks after flooding (Fig. 3).
- Corn grain yields of both hybrids were affected by waterlogging duration and pre-plant fertilizer treatments during 2013 (Fig. 4).
- The PCU had 14% greater yields compared to the control and NCU with no rescue N applications during 2014.
- Post-flood rescue N applications of NCU+UI in 2014 resulted in 901 kg ha^{-1} higher grain yield compared to treatments not having the rescue N application.

CONCLUSIONS

- The two corn hybrids in this study differed in their growth response to waterlogged conditions at early growth stages.
- No consistent yield responses to rescue N fertilizer applications were observed in this study possibly due to dry conditions experienced after rescue N application in 2013 and to residual N in the soil from the previous year.
- Significant soil NO_3^--N loss was experienced due to flooding in 2014, which was a comparatively wet year compared to 2013.
- These results suggest that changes in climatic conditions will have effect on corn response to both pre-plant and rescue N applications prior to and after flooding.

REFERENCES

Nelson, K.A., P.C. Scharf, W.E. Stevens, B.A. Burdick. 2010. Rescue applications for corn. Soil Sci. Soc. Am. J. 75: 143-151.

Ritter, W.F., and C.E. Beer. 1969. Yield reduction by controlled flooding of corn. Trans. Am. Soc. Agric. Engineers 12:46-50.