2016 Report
Issue 1 *2016 Farm Progress Reports*

Number RFR-A16101

2017

Impact of Drainage Water Management on Crop Yield, Drainage Volume, and Nitrate Loss

Matt Helmers
Iowa State University, mhelmers@iastate.edu

Carl Pederson
Iowa State University, carl@iastate.edu

Kristina Craft
Iowa State University, kcraft@iastate.edu

Linda Schott
Iowa State University

Impact of Drainage Water Management on Crop Yield, Drainage Volume, and Nitrate Loss

RFR-A16101

Matt Helmers, professor
Carl Pederson, ag specialist
Kristina Craft, graduate student
Linda Schott, former graduate student
Greg Brenneman, ag engineering specialist
Myron Rees, farm superintendent
Department of Agricultural and Biosystems Engineering

Introduction

Subsurface drainage systems are an important component of agricultural production systems in many areas of Iowa. However, these drainage systems have been shown to deliver nitrate-N to downstream waterbodies. So, although subsurface drainage is important for crop production, we also need to consider the design of these systems to minimize nitrate-N loss. Use of drainage water management in the design and operation of subsurface drainage systems is one potential method to reduce nitrate-N loss. Drainage water management may consist of drains installed at shallower depths (i.e. shallow drainage) than conventional designs, or installing water control structures at the outlet (i.e. controlled drainage). Since 2007, a study has been conducted at the Southeast Research and Demonstration Farm, Crawfordsville, Iowa, to determine the impact of shallow, controlled, conventional, and no drainage on crop yields, subsurface drainage volumes, and nitrate loss through subsurface drainage. This research investigates whether drainage water management reduces nitrate loadings to downstream surface waters, as well as the yield benefits of these drainage systems.

Materials and Methods

Research was conducted at the Southeast Research Farm from 2007–2015. There are eight research plots with two replications for each drainage treatment. Each plot had corn and soybean present each year.

Conventional plot tile lines are installed at a depth of 4 ft and a spacing of 60 ft. Shallow and controlled drainage plots represent drainage water management. Controlled tile lines are the same design as the conventional. Shallow plot tile lines are installed at a depth of 2.5 ft with a spacing of 40 ft. All plots are designed to have a maximum drainage coefficient of 0.75 in./day.

The controlled drainage boards are typically removed in mid-April prior to planting to allow free flow to reduce the height of the water table for improved trafficability. The boards are replaced after planting.

Results and Discussion

Over the nine-year study period, the conventional plots drained more water than the controlled and shallow plots (Figure 1). The controlled and shallow drainage plots reduced drainage by 48 and 50 percent, respectively. Because the drainage water management treatments had little impact on nitrate-N concentration, the overall loss of nitrate-N was reduced by 51 percent and 40 percent by controlled and shallow drainage, respectively (Figure 2).

In general, no significant differences were observed in corn grain yields between drainage treatments, but there was overall yield benefits of the drainage treatments compared with the undrained treatments (Figure 3). Over the nine-year period, there was approximately a 13 bushel/acre increase in corn yield between the undrained treatment and the conventional drainage treatment. Consistent with corn yield increases with drainage, we observed an increase in soybean yields (~6 bushel/acre increase with conventional drainage compared with undrained) (Figure 4). However, crop planting occurred on the same date for all treatments. The undrained plots were adjacent to drained plots so there is likely some drainage impact, which provided beneficial drainage to the undrained plots. Because of these reasons, the potential yield benefits of the drainage systems are likely conservative.

Conclusions

Subsurface drainage is important for crop production in Iowa, however there is a need for implementation of practices that can reduce the downstream delivery of nitrate-N. This nine-year study found shallow and controlled drainage practices have potential to reduce downstream nitrate-N loss. These drainage water management systems had minimal impact on crop yield. This study also showed that drainage—either conventional, shallow, or controlled—benefits crop yield compared with an undrained system.

Acknowledgements

This research has been part of two regional collaborative projects supported by the USDA-NIFA:
1) Award No. 2011-68002-30190–Cropping Systems Coordinated Agricultural Project: Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems
2) Award No. 2015-68007-23193–Managing Water for Increased Resiliency for Drained Agricultural Landscapes.

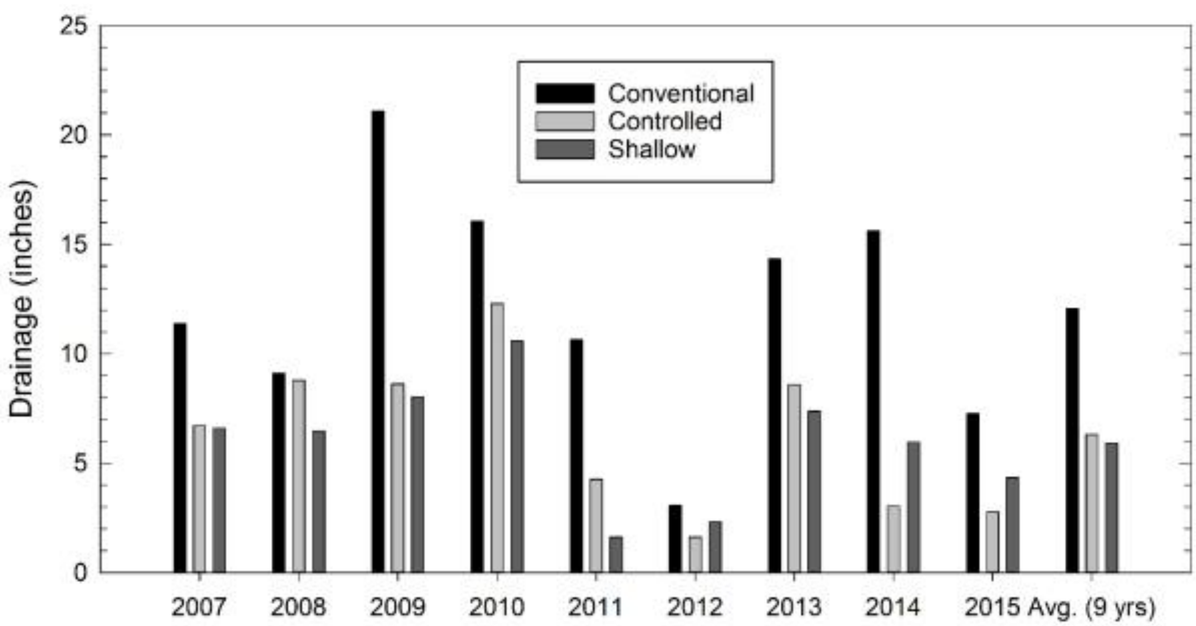

Figure 1. Annual drainage from 2007-2015 for drainage treatments.

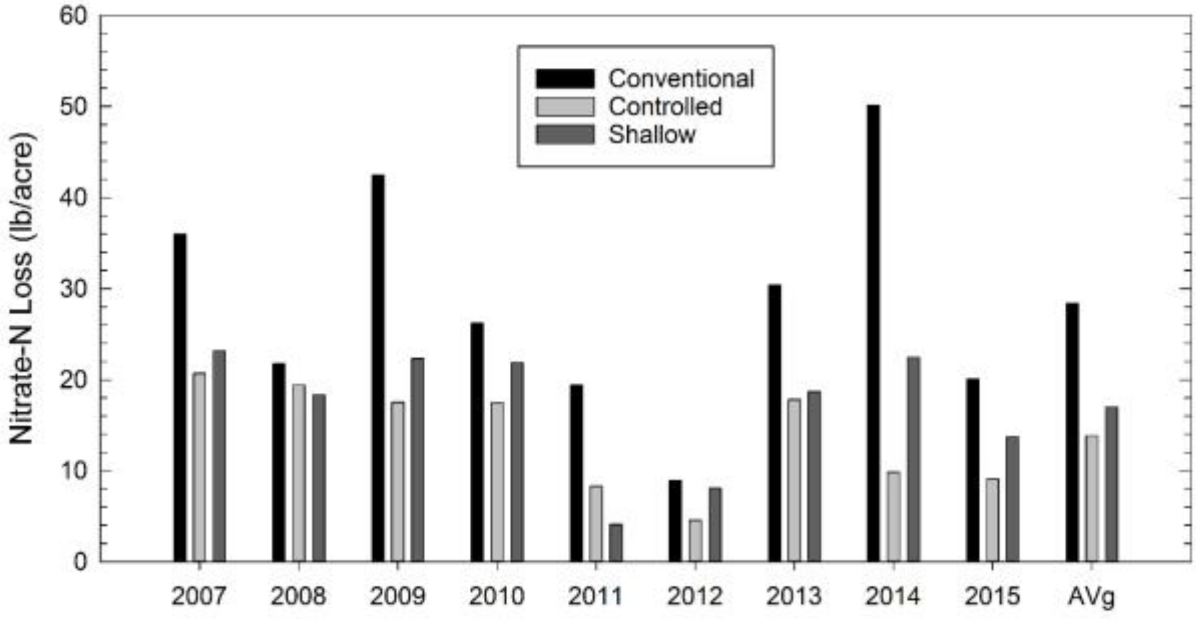

Figure 2. Annual nitrate-N loss from 2007-2015 for drainage treatments.

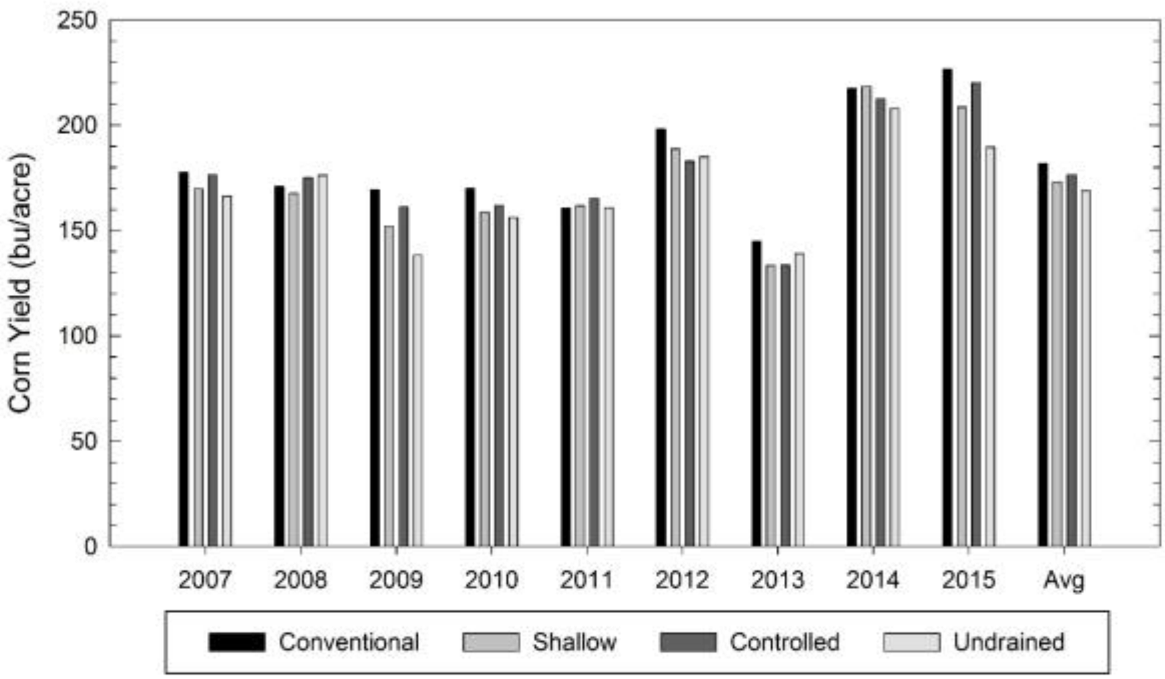

Figure 3. Corn yield from 2007-2015 for drainage treatments.

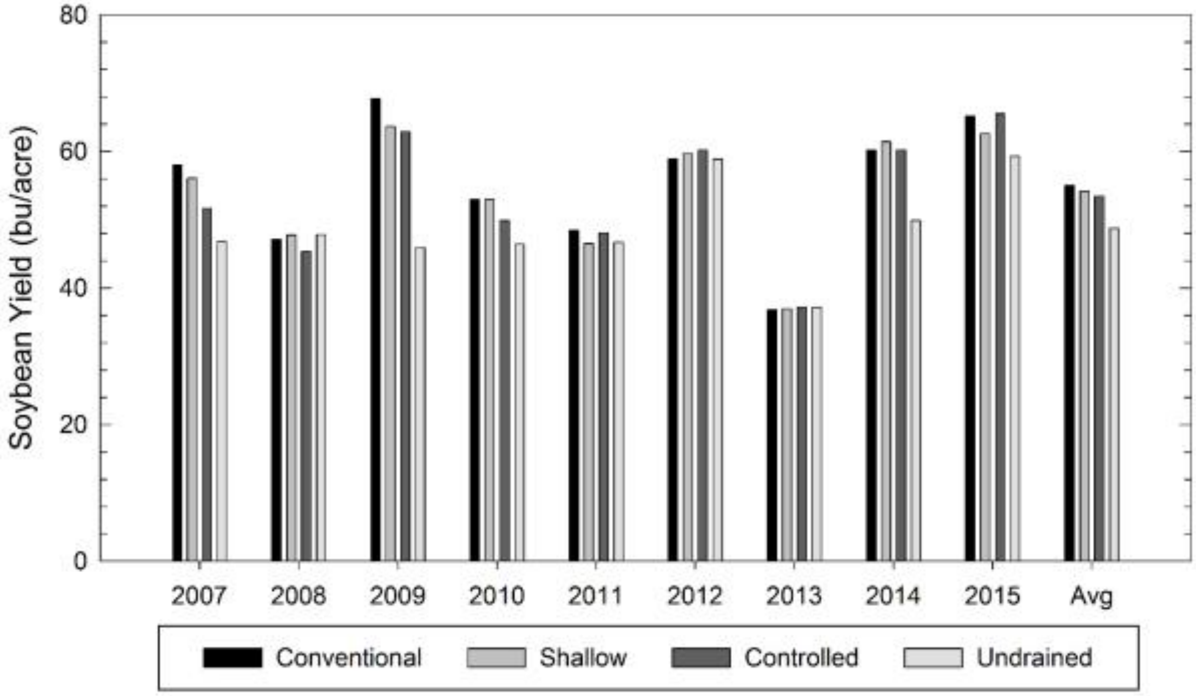

Figure 4. Soybean yield from 2007-2015 for drainage treatments.