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

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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. While subsurface drainage is important for crop production, the design of these systems to minimize nitrate-N loss also needs to be considered. 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 Iowa Research and Demonstration Farm near 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, plus the yield benefits of these drainage systems.

Materials and Methods

Research was conducted at the ISU Southeast Research Farm from 2007-2017. 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 11-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 52 and 53 percent, respectively. Since the drainage water management treatments had little impact on nitrate-N concentration, the overall loss of nitrate-N was reduced by 53 percent and 41 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 11-year period, there was approximately a 10 bushel/acre increase in corn yield between the undrained treatment and the conventional drainage treatment.

Consistent with corn yield increases with drainage, an increase in soybean yields was observed (~4 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 on the undrained plots. Because of these reasons, the potential yield benefits of the drainage systems likely are 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.

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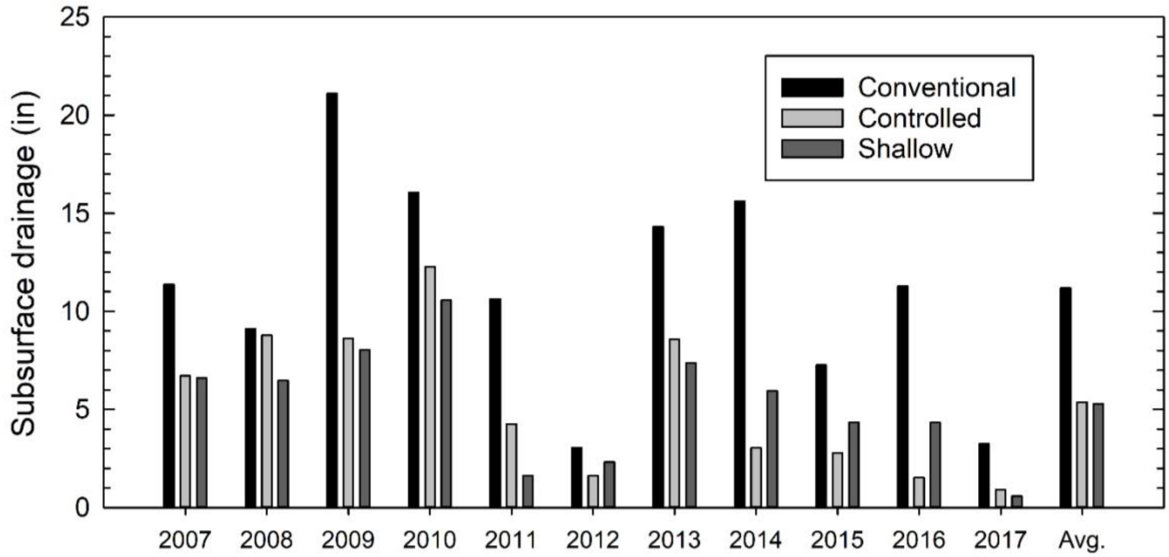

Figure 1. Annual drainage from 2007-2017 for drainage treatments.

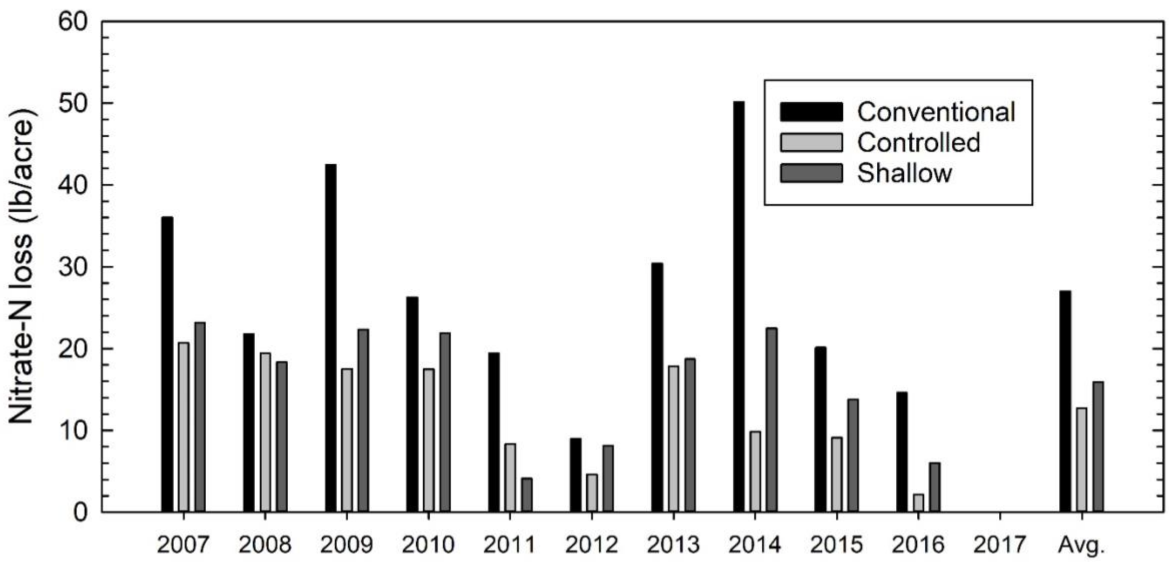

Figure 2. Annual nitrate-N loss from 2007-2016 for drainage treatments.

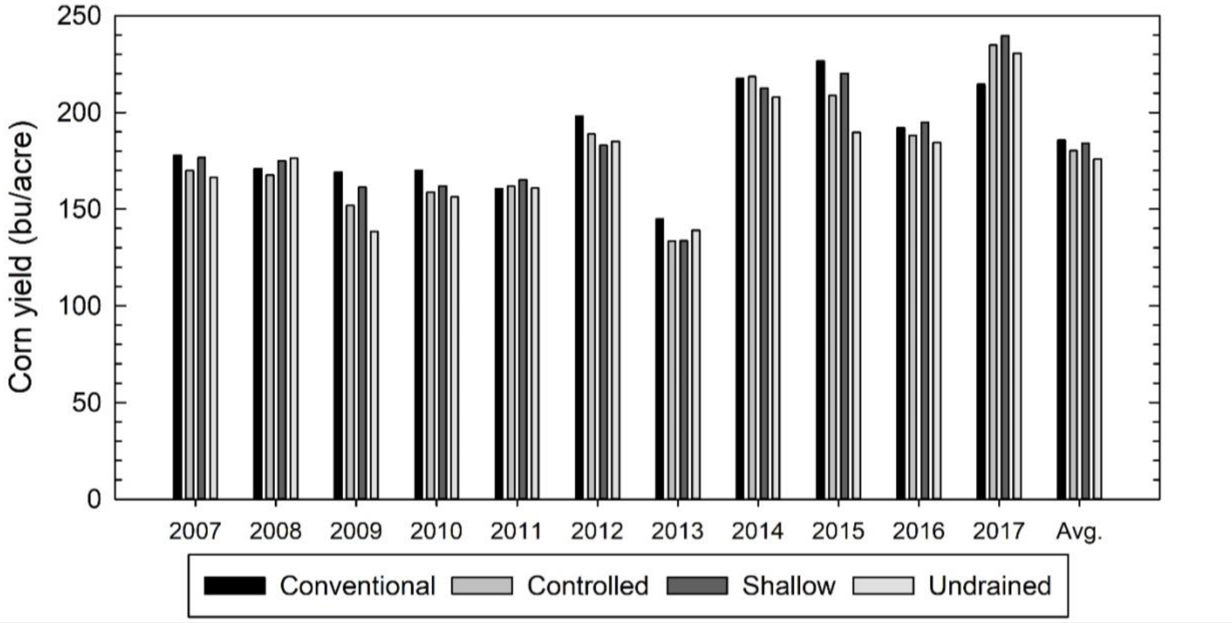

Figure 3. Corn yield from 2007-2017 for drainage treatments.

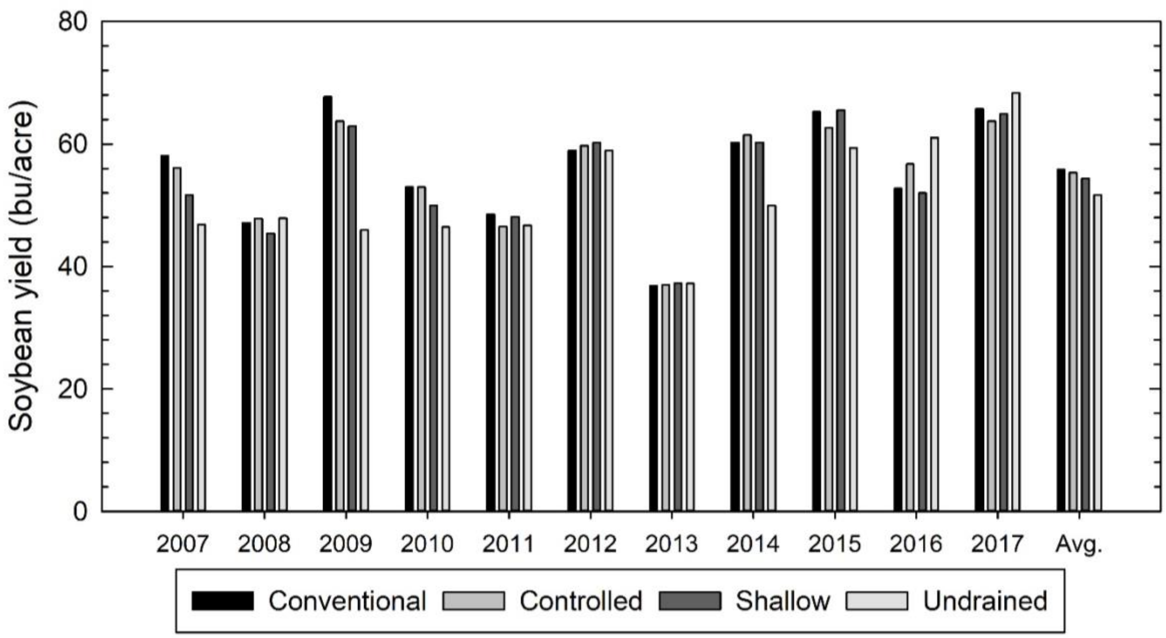

Figure 4. Soybean yield from 2007-2017 for drainage treatments.