Drainage design for improved profits and water quality

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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. So, while 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 a 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, IA 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 Iowa State University Southeast Research Farm located near Crawfordsville, Iowa from 2007-2015. There are eight research plots with two replications for each drainage treatment (Figure 1). Each plot had corn and soybean present in 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 2). The controlled and shallow drainage plots reduced drainage by 48 and 50%, respectively. Since the drainage water management treatments had little impact on nitrate-N concentration, the overall loss of nitrate-N was reduced by 51% and 40% by controlled and shallow drainage, respectively.

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 to the undrained treatments (Figure 4). 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 soybeans yields (~6 bushel/acre increase with conventional drainage compared to undrained) (Figure 5). Of note in reviewing crop yield is crop planting occurred on the same date for all treatments and that the undrained plots were adjacent to drainage plots such there is likely some drainage impact on the undrained plots. Because of these reasons the potential yield benefits of the drainage systems are likely conservative.

Conclusions

While subsurface drainage is important for crop production in Iowa there is a need for implementation of practices that can reduce the downstream delivery of nitrate-N. This nine-year study found that 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 drainage benefits crop yield compared to an undrained system.

Acknowledgements

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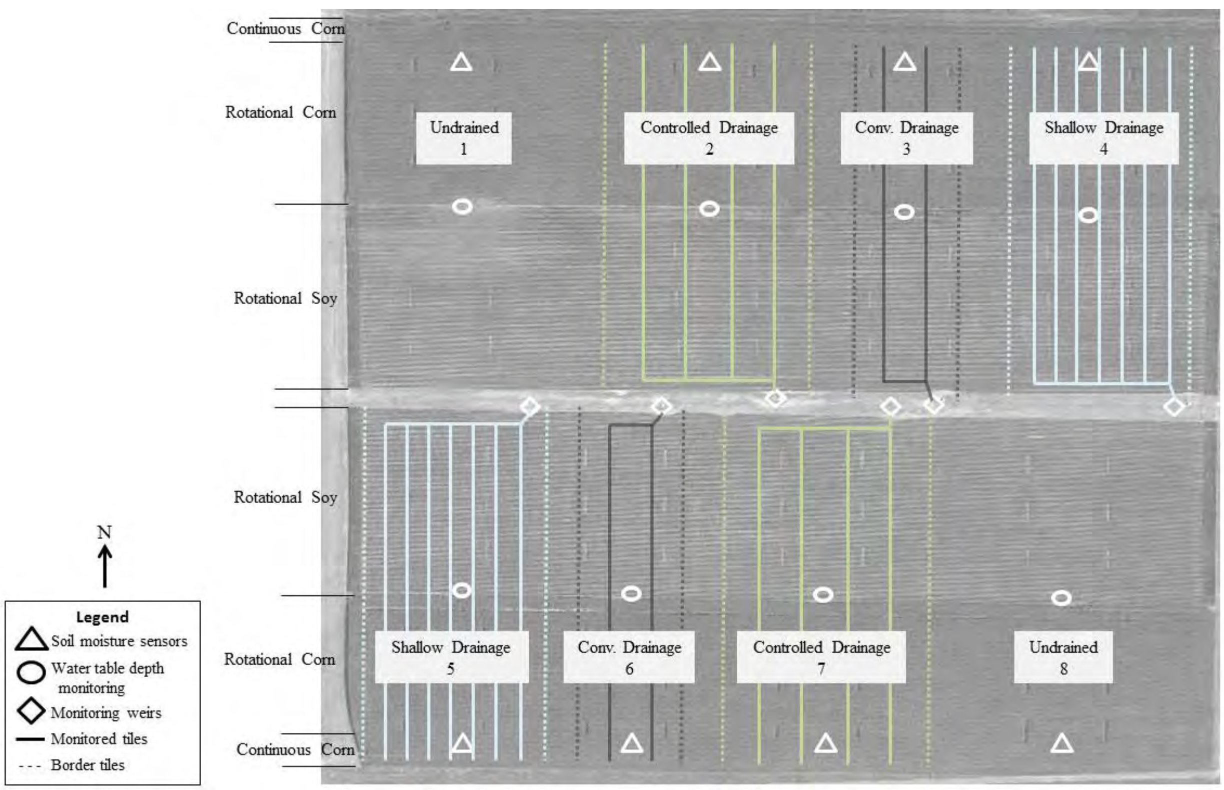

Figure 1. Overall map of the drainage research facility

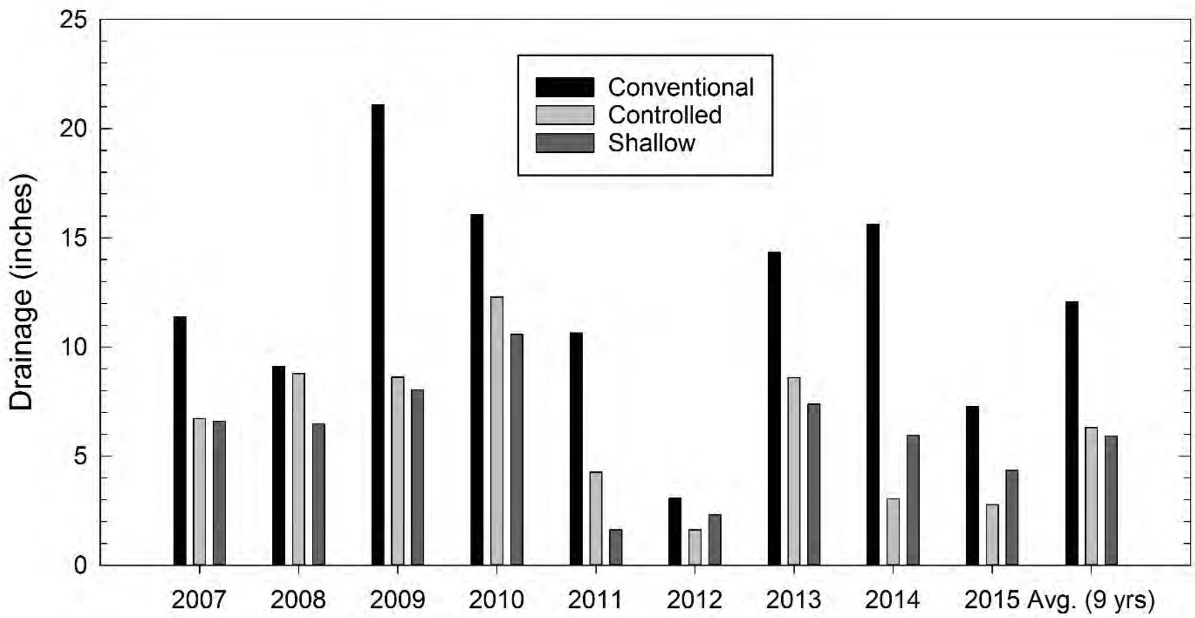

Figure 2. Annual drainage from 2007-2015 for drainage treatments

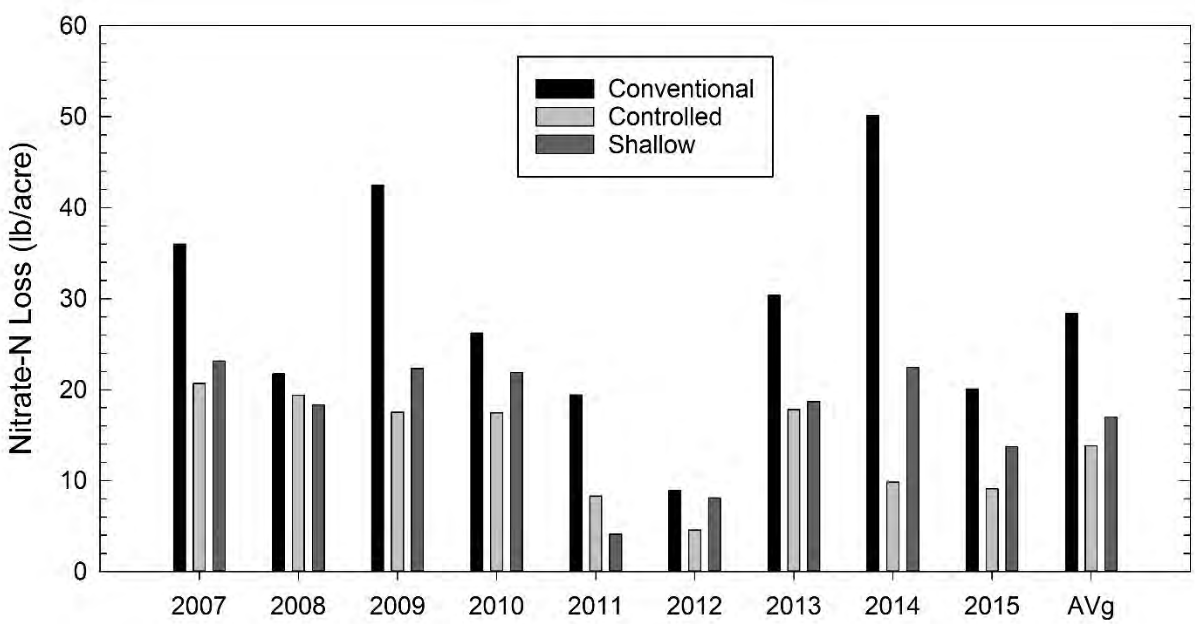

Figure 3. Annual nitrate-N loss from 2007-2015 for drainage treatments

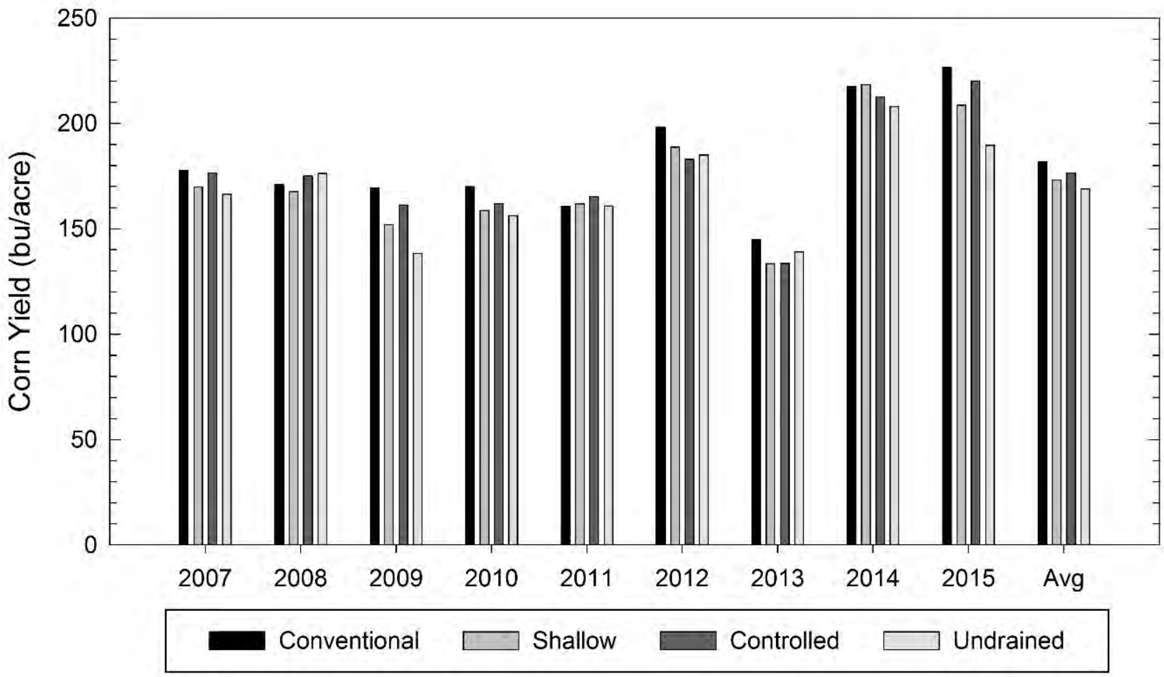

Figure 4. Corn yield from 2007-2015 for drainage treatments

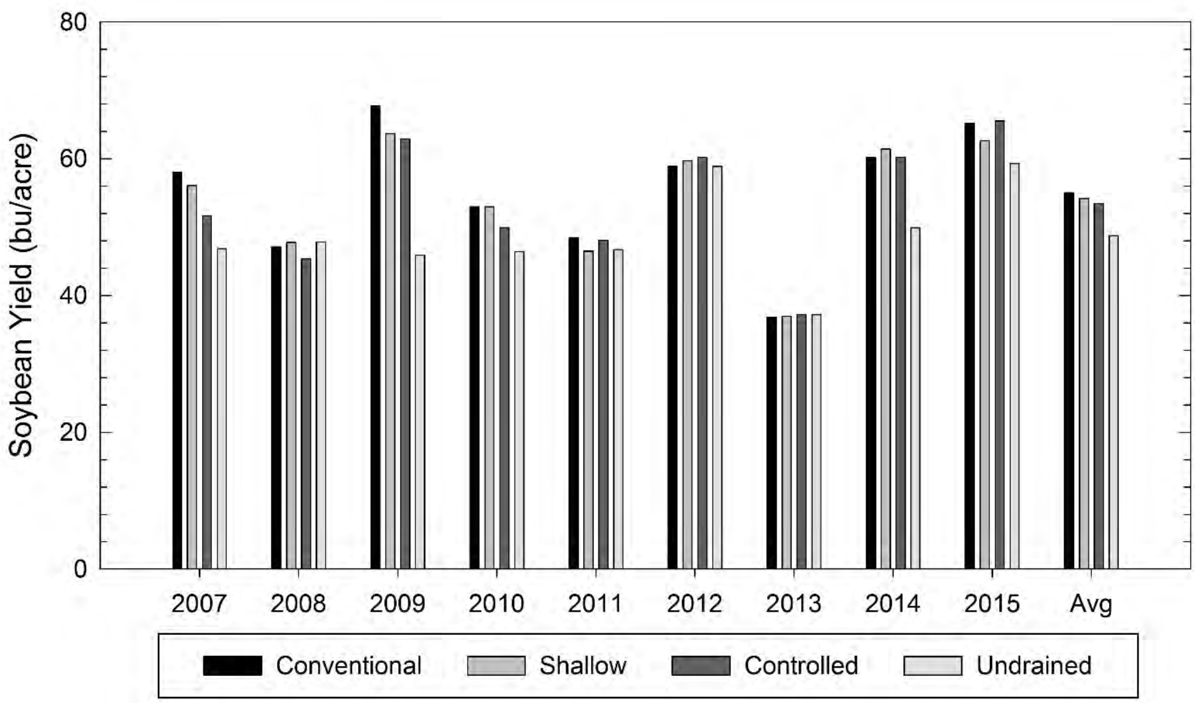

Figure 5. Soybean yield from 2007-2015 for drainage treatments