Crop Yield Effects of Controlled Drainage, Soil Drainage Class, and Elevation

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Introduction

Controlled drainage has the potential to increase crop yields by raising the outlet elevation during the growing season. However, published yield effects have been mixed.

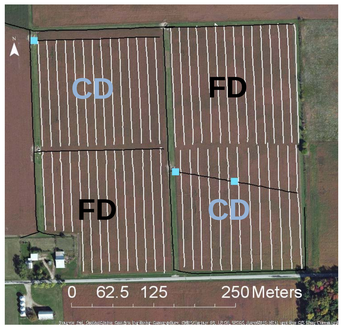
Location	Crop	Yield Impact	Reference
Iowa	corn & soybean	no effect Increase[2] Decrease(corn) [3]	Schott et al. 2017[1] Jaynes 2012[2] Helmers et al. 2012[3]
Illinois	corn & soybean	no effect	Cooke & Verma 2012
Ohio	corn & soybean	no effect[1] increase[2]	Fausey 2005[1] Ghane et al. 2012[2]
Canada	corn & soybean	no effect[1,2] Increase[3,4]	Drury et al. 2009[1] Tan et al. 1998[2] Sunohara et al. 2014[3] Crabbe et al. 2012[4]
North Carolina	corn & soybean	increase	Poole et al. 2013
Sweden	cereals	increase	Wesstrom and Messing 2007

The objective of this study is to evaluate how soil type or elevation may drive the impact of controlled drainage on crop yields over a multi-year period.

Site Description and Data

The field was located at the Davis Purdue Agricultural Center in eastern Indiana.

NW, 3.5 ha NE, 3.6 ha



SW, 3.5 ha SE, 3.7 ha

The field had two controlled (NW,SE) and two free (SW,NE) draining quadrants.

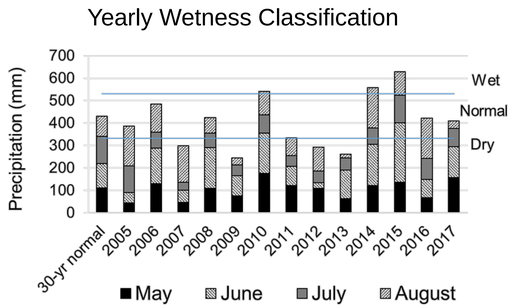
Water control structure

Corn was grown in 2005-2010 and then a corn and soybean rotation 2011-2017.

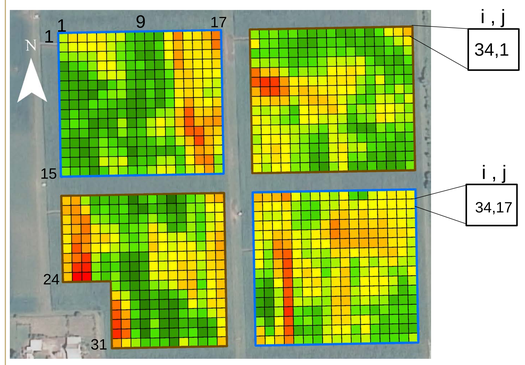
Methods

Defining Wet, Normal, Dry Years

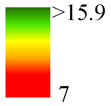
Monthly precipitation data for May-August from the on-site weather station was compared to the 30-year average(1981-2010) for the on-farm NOAA weather station to determine a wet, dry, or normal year by ±100 millimeters.



Yield Data



2010 Yield (MT ha^{-1})



Controlled

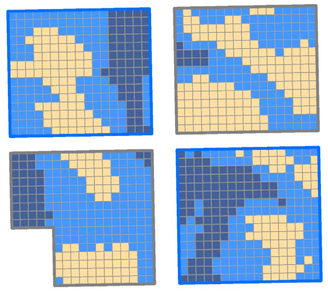
Free

- Yield data were cleaned in SMS Advanced Software and were clipped to the four quadrants, removing end rows.
- A grid of 10 by 10 meter cells was created for the field.
- The grid allowed for a numbering system of columns (i) and rows (j) for each cell.
- For each year the average of all the yield points within each cell was calculated.

Yield Analysis by Elevation

- LiDAR-based elevation from IndianaMap Framework data was used to calculate the average elevation for each cell (The southeast quadrant was divided to accommodate for the two water control structures).

Yield Analysis by Soil Type



Majority soil type for each cell

Blount (somewhat poorly drained)

Condit (poorly drained)

Pewamo (very poorly drained)

- Soil type was analyzed by using an order 1 soil map of the field.
- The majority soil type in each of the yield cells was assigned to the entire cell for analysis.

Results

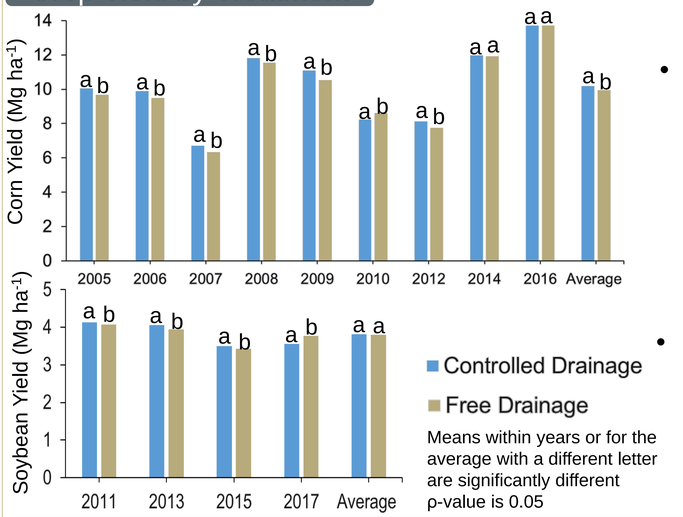
Statistical Analysis

- The yield response equation to be estimated was

$$yield_{ijt} = \beta_0 + X_{ijt}\beta + r_{ij} + \varepsilon_{ijt}$$

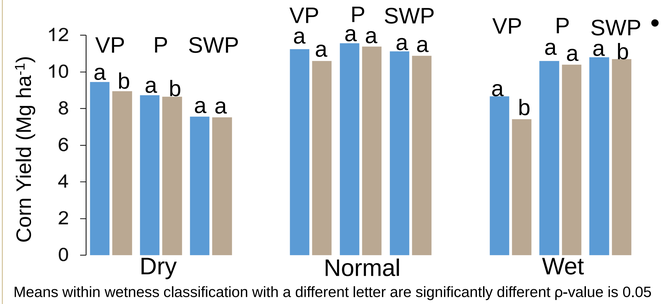
- r_{ij} account for temporal effect over the years, known as compound symmetry
- The spatial correlation was contained in ε_{ijt} by assuming the following spatial covariance structure $\sigma^2 \exp\{-d_{ij}/\theta\}$
- A t-test was used to analyze crop yield and treatment by year.

Crop Yield by Treatment



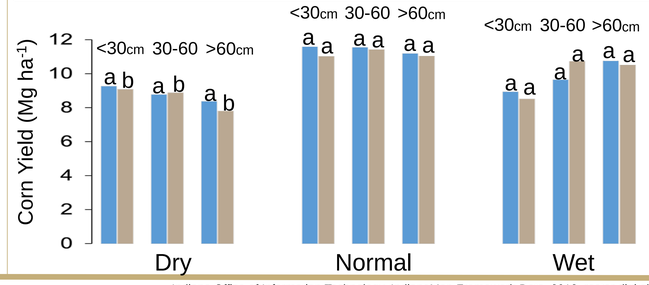
- Controlled drainage significantly increased corn yield in 7 out of 9 years.
- Controlled drainage significantly increased soybean yield in 3 out of 4 years.

Corn Yield by Soil Drainage Class & Wetness Classification



- Controlled drainage significantly increased corn yield in the very poorly and poorly drained soils during dry years, and the somewhat poorly and very poorly drained soils during wet years.

Corn Yield by Elevation & Wetness Classification



- Controlled drainage significantly increased corn yield in the <30 cm and >60 cm elevation ranges during dry years.

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