IDENTIFYING FACTORS CONTROLLING THE CONTINUOUS CORN YIELD PENALTY

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ABSTRACT

It is widely accepted that yields decline when corn (*Zea mays* L.) is grown continuously versus in rotation with soybean (*Glycine max* L.), although causes for the yield reduction are unclear. We conducted a study from to elucidate the source(s) of the continuous corn yield penalty (CCYP). The experiment was conducted from 2005-2010 in east-central Illinois beginning with 3rd year continuous corn (CC) or a soybean-corn (SC) rotation at six nitrogen (N) fertilizer rates. Averaged across all years, yield at the agronomic optimum N rate for CC was 167 bu a^{-1} and for CS was 192 bu a^{-1}, resulting in a CCYP of 25 bu a^{-1}; values ranged yearly from 9 to 42 bu a^{-1}. Three significant and independent predictors explained >99% of variability in the CCYP: Unfertilized CC yield (0NCCYD), years in CC (CCYRS), and the difference between CC and SC delta yields (DELTADIFF). The strongest predictor, 0NCCYD, reflects net soil N mineralization and demonstrates that it decreases in CC systems. CCYRS was strongly and positively correlated with CCYP, indicating that the CCYP increased over time through year 7. We believe that CCYRS is demonstrating effects of accumulated corn residue in CC systems. Finally, we consider DELTADIFF a measure of the interaction between yearly weather patterns and crop rotation which results in more negative yield responses for CC, compared to SC, under hot and/or dry conditions. This study concludes that the primary causative agents of the CCYP are nitrogen availability, corn residue accumulation, and weather.

THE CONTINUOUS CORN YIELD PENALTY:

UNDERSTANDING THE AGENTS & MECHANISMS

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Project Objectives

- Quantify CC yield penalty relative to S-C
- Track the yield penalty with time in C-C
- Identify contributing factors to the C-C yield penalty

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Methodology

- Study initiated in 2003
- Split-block, replicated 4X
  - Block trts = previous crop (corn or soybean)
  - Plot trts = N fertilizer application rate
- Two sites were established for this study, within 4.25 km
  - Study location was rotated every other year
  - 'Set-up' site was used to est. previous crop trts

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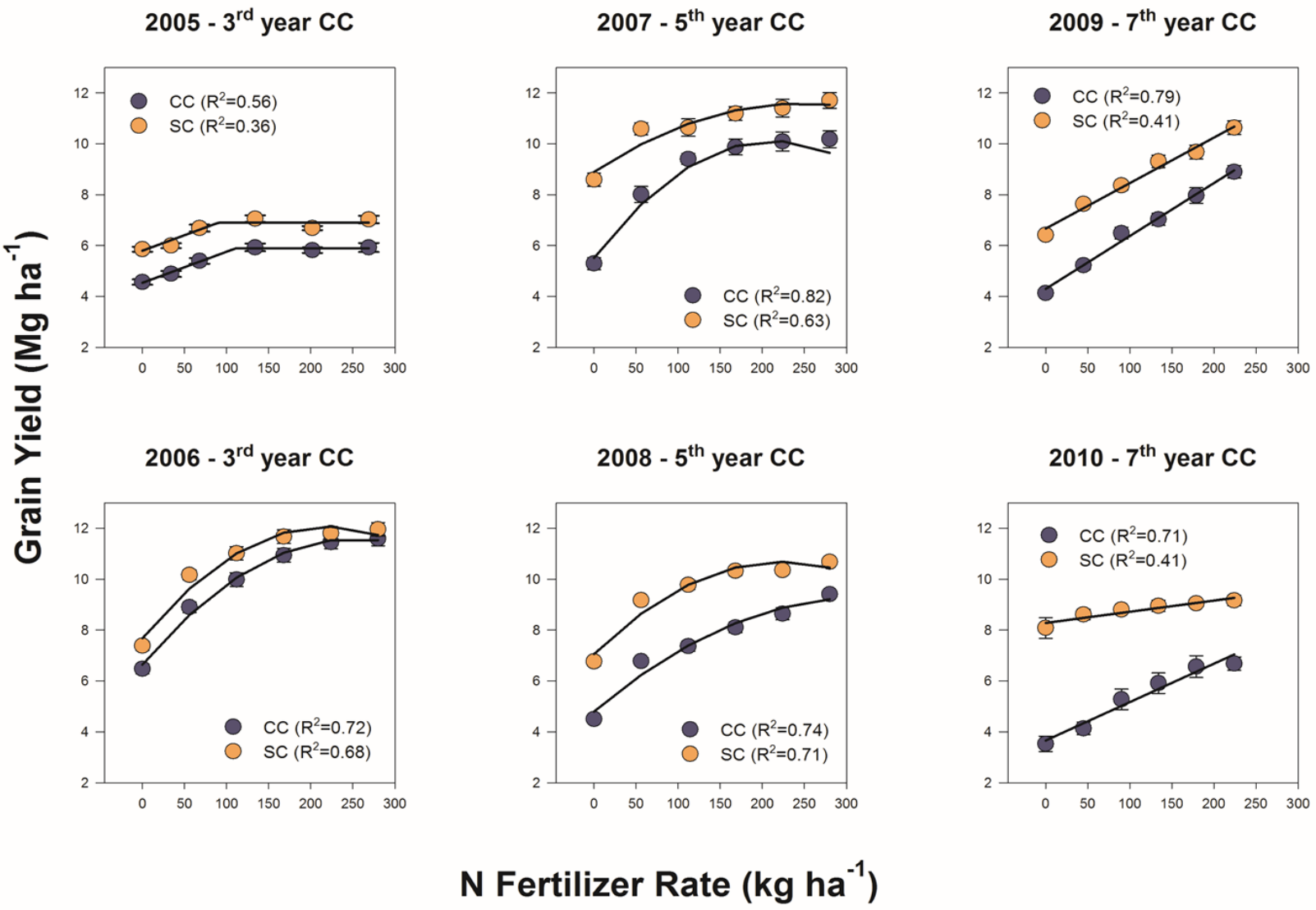
Results


2005 - 3rd year CC
CC (R2=0.56)
SC (R2=0.36)
2007 - 5th year CC
CC (R2=0.82)
SC (R2=0.63)
2009 - 7th year CC
CC (R2=0.79)
SC (R2=0.41)
2006 - 3rd year CC
CC (R2=0.72)
SC (R2=0.68)
2008 - 5th year CC
CC (R2=0.74)
SC (R2=0.71)
2010 - 7th year CC
CC (R2=0.71)
SC (R2=0.41)
Grain Yield (Mg ha-1)
N Fertilizer Rate (kg ha-1)

Potential Predictors of CCYP

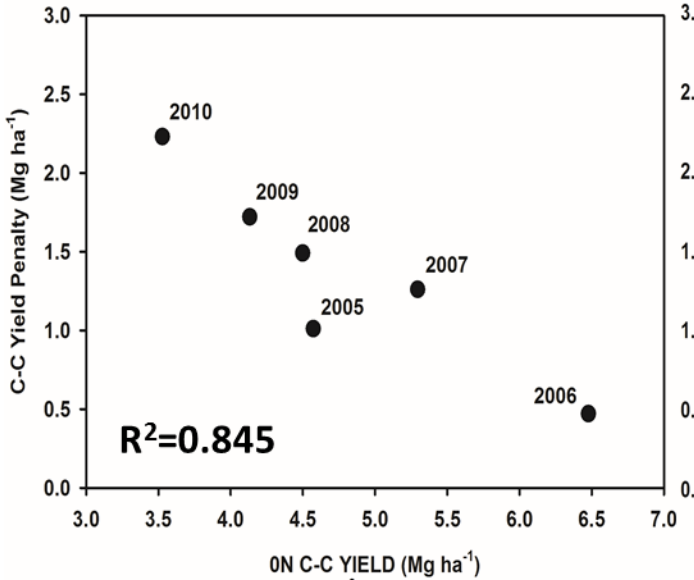
- Years in CC
- Growing Degree Days
- CC AONR
- CS AONR
- CC Yield at AONR
- CS Yield at AONR
- CC Max. Yield
- CS Max. Yield
- 0N CC Yield
- 0N CS Yield
- 0N Difference
- CC Delta Yield
- CS Delta Yield
- Delta Difference

Predictors of C-C Yield Penalty

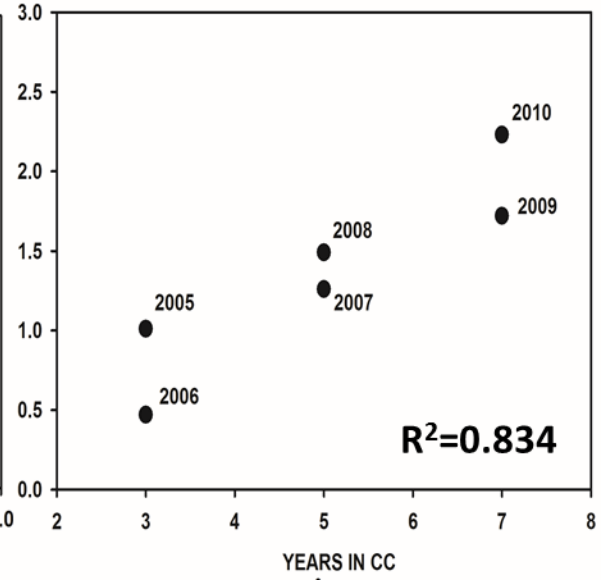
1. 0N C-C Yield
2. Years in C-C
3. Delta Difference (CC Delta Yd. – SC Delta Yd.), ΔDIFF

2005 – drought
2006 – dry except July
2007 – dry except June
2008 – wet May-July
2009 – wet
2010 – dry except June

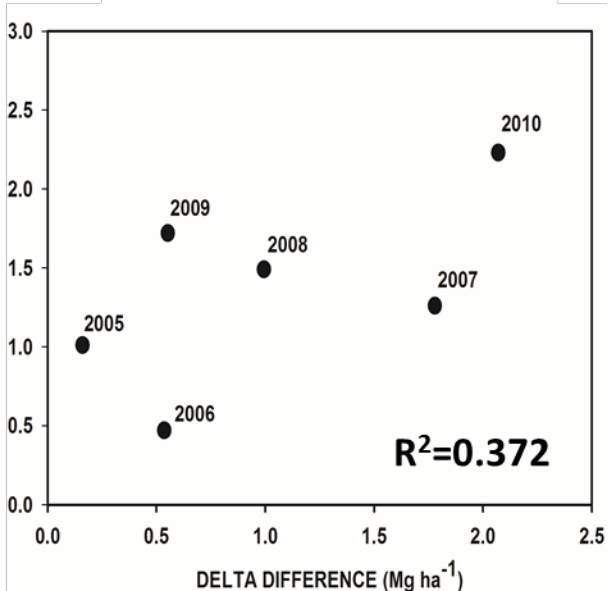
0N C-C YIELD



YEARS IN C-C



DELTA DIFFERENCE



CONCLUSIONS

- C-C produced 1.36 Mg ha^{-1} (26 bu a^{-1}) less grain than S-C and required additional N (up to 56 kg N a^{-1})
- The CCYP became worse with time
- The CCYP is a factor of N availability, residue accumulation, & weather

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