# Relationships Among Crop Yield, Protein, Soil Properties and Response to Nitrogen Fertilizer Application in an Undulating Landscape in South Central Saskatchewan

Soils and Crops

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# Context

## RELATIONSHIP OF NITRATE ACCUMULATION TO YIELD RESPONSE OF WHEAT IN SOME SASKATCHEWAN SOILS[1]

F. D. Cook, F. G. Warder and J. L. Doughty

*Canada Department of Agriculture, Swift Current, Saskatchewan*

[Received for publication October 6, 1956]

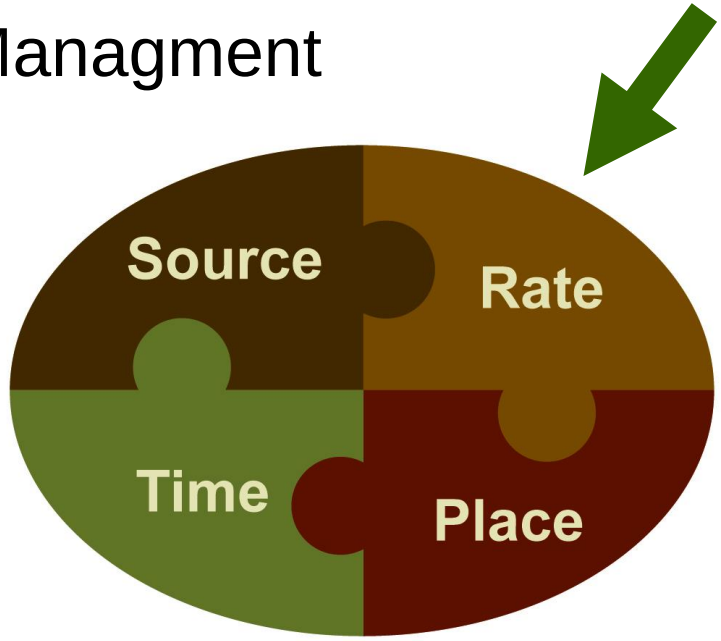
### ABSTRACT

The capacity of Saskatchewan soils to accumulate nitrate, as determined by a laboratory procedure, was investigated as a method for evaluating the response of wheat to nitrogenous fertilizers. The correlation coefficient between the field yield ratios (which are a measure of the response to nitrogen) and nitrate accumulation for 31 stubble fields was 0.846** and for 30 fallow soils was 0.830**. Greenhouse experiments with soil samples from 31 stubble fields showed a high correlation (0.874**) between nitrate accumulation and nitrogen uptake by wheat plants during a 30-day growth period.

It is considered that a significant increase from the application of nitrogenous fertilizers can be expected when the nitrate accumulation value is below 50 p.p.m. N in soil from stubble fields or 40 p.p.m. N in fallowed soils.

# Context

- Precision Agriculture
  - Variable Rate (VR) N Fertilizer Application
    - Does it work?
  - 4 R's N Managment



# Context

- **In practice:**
  - Most farmers apply the same fertilizer rate across a whole field regardless of variability in yield potential
- **Why?**
  - Efficient means are needed to create a variable application map
  - Cost to ID, sample and predict crop response in separate zones
  - Uncertainty surrounding benefits to be achieved
- **Challenge:**
  - ID efficient reliable mechanisms to make VR map

# Research Question

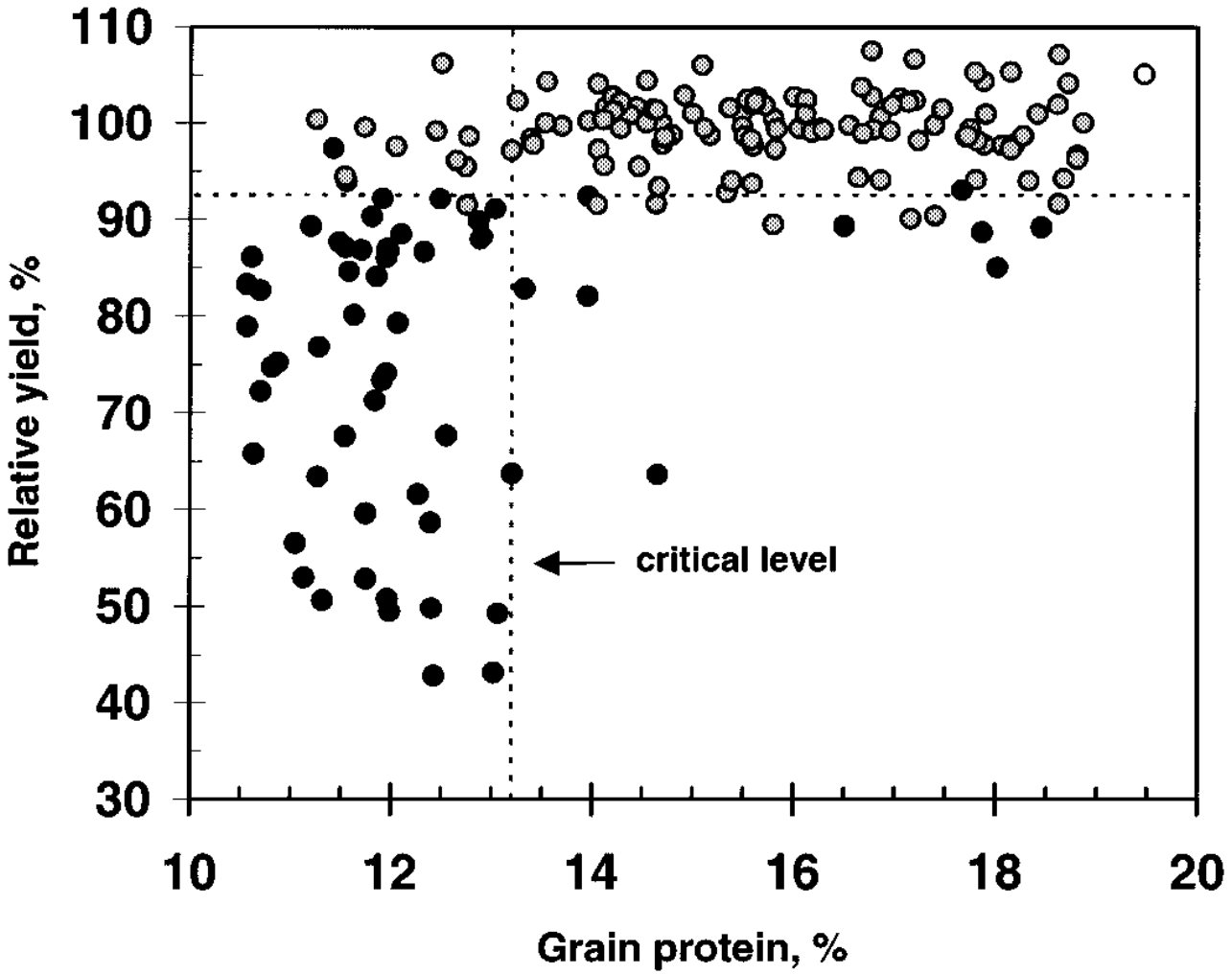
- Will protein concentration of crops help delineate fertilizer management zones?

# Research Question

- Yield
  - Can establish how much N it takes to produce a target yield
- Protein
  - Reflects balance of N to other yield limitations

# Typical Yield vs Protein Curve

**Spring Wheat**



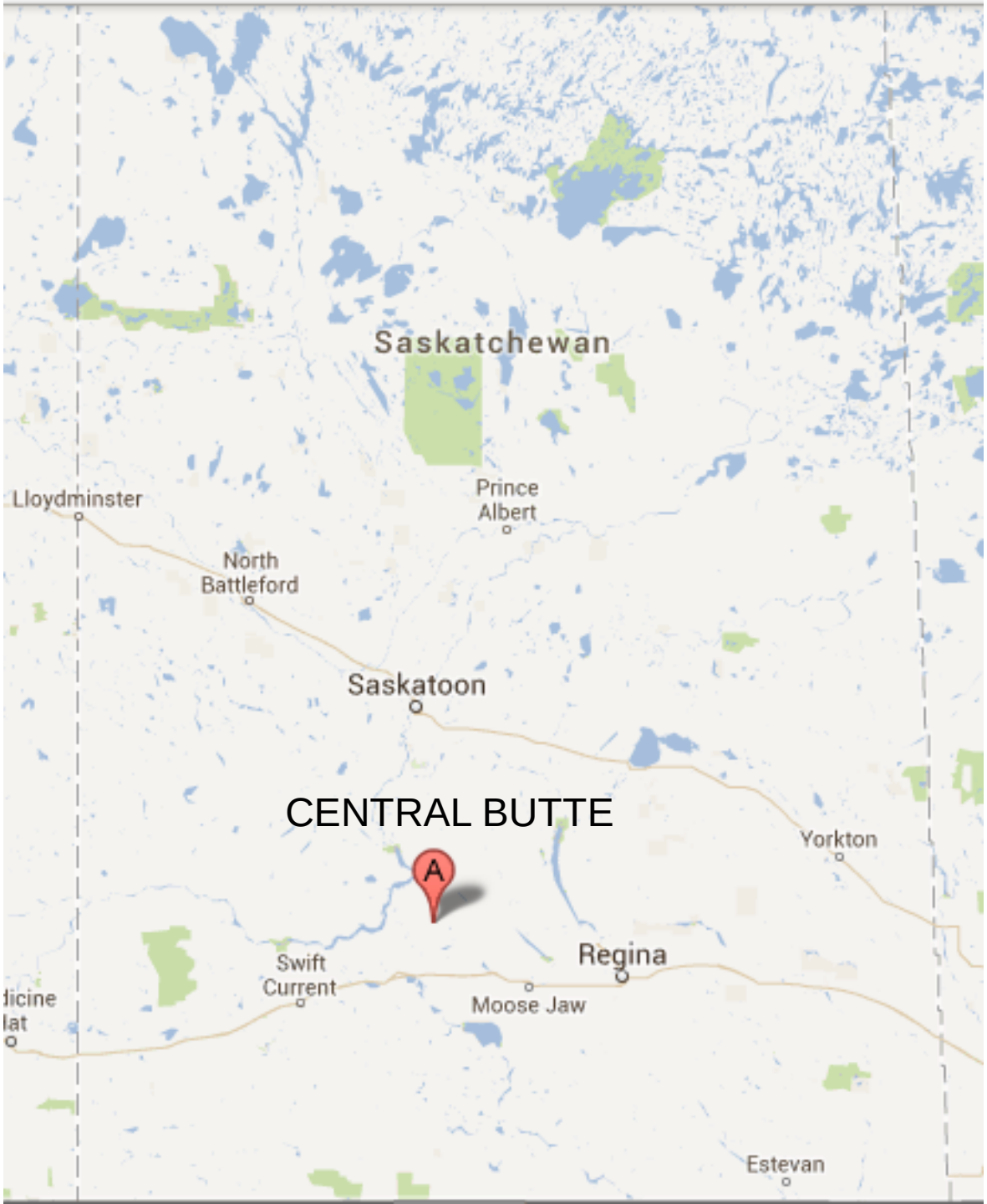

(Engel et al., 1999)

# Study Objectives

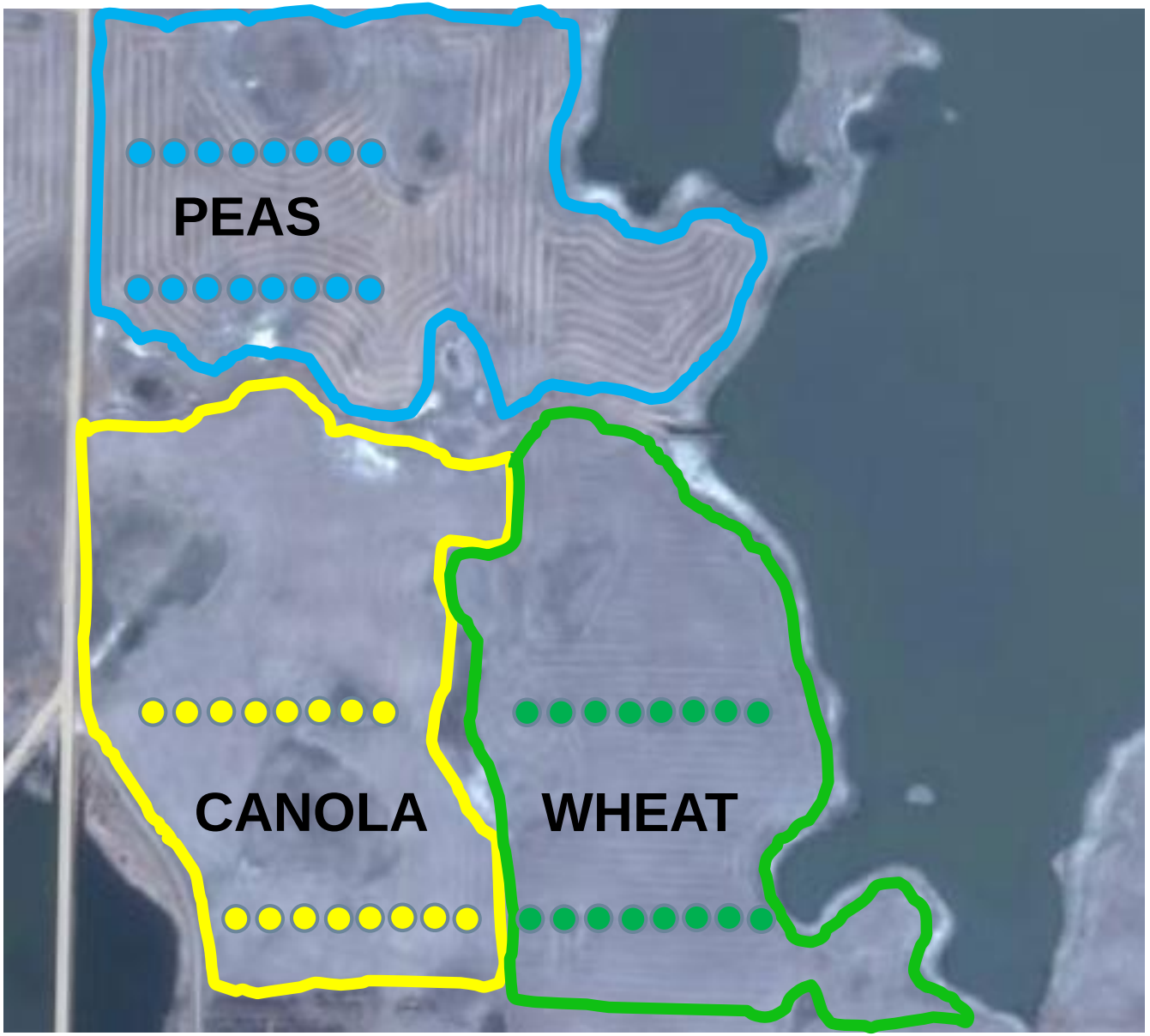
- Summer 2012
  - Typical southern Saskatchewan hummocky farm field
  - Determine relationships between:
    - Crop yield
    - Crop protein
    - Soil landscape properties
      - Salinity
      - Organic matter
      - pH
      - Soil nutrients

# Study Objectives

- Summer 2013
- Use these relationships to:
  - 1) develop variable nitrogen rate prescription
  - 2) compare performance to constant rate
    - Side by side comparison


Saskatchewan
Lloydminster
Prince Albert
North Battleford
Saskatoon
CENTRAL BUTTE
A
Yorkton
Regina
Swift Current
Moose Jaw
Estevan

# SW 31-20-03 W3 (2012)



# Relationships with Wheat

| | Yield | | Protein |
|---|---|---|---|
| | (kg/ha) | (bu/ac) | (%) |
| Mean | **1851** | **28** | **13.2** |
| Min | 882 | 13 | 10.5 |
| Max | 2554 | 39 | 14.4 |

| Soil Property | Yield | | Protein | |
|---|---|---|---|---|
| | $R^2$ | p-value | $R^2$ | p-value |
| OC 0-30cm (%) | **0.74** | **0.001**** | | |
| OC 30-60cm (%) | | | **-0.53** | **0.04*** |
| pH 0-30cm | | | | |
| pH 30-60cm | | | **0.51** | **0.05*** |
| EC 0-30cm (µS $cm^{-1}$) | **-0.53** | **0.03*** | **-0.56** | **0.02*** |
| EC 30-60cm (µS $cm^{-1}$) | | | | |

# Relationships with Canola

| | Yield | | Protein |
|---|---|---|---|
| | (kg/ha) | (bu/ac) | (%) |
| Mean | **1847** | **37** | **16.8** |
| Min | 1143 | 23 | 14.2 |
| Max | 2342 | 47 | 20.6 |

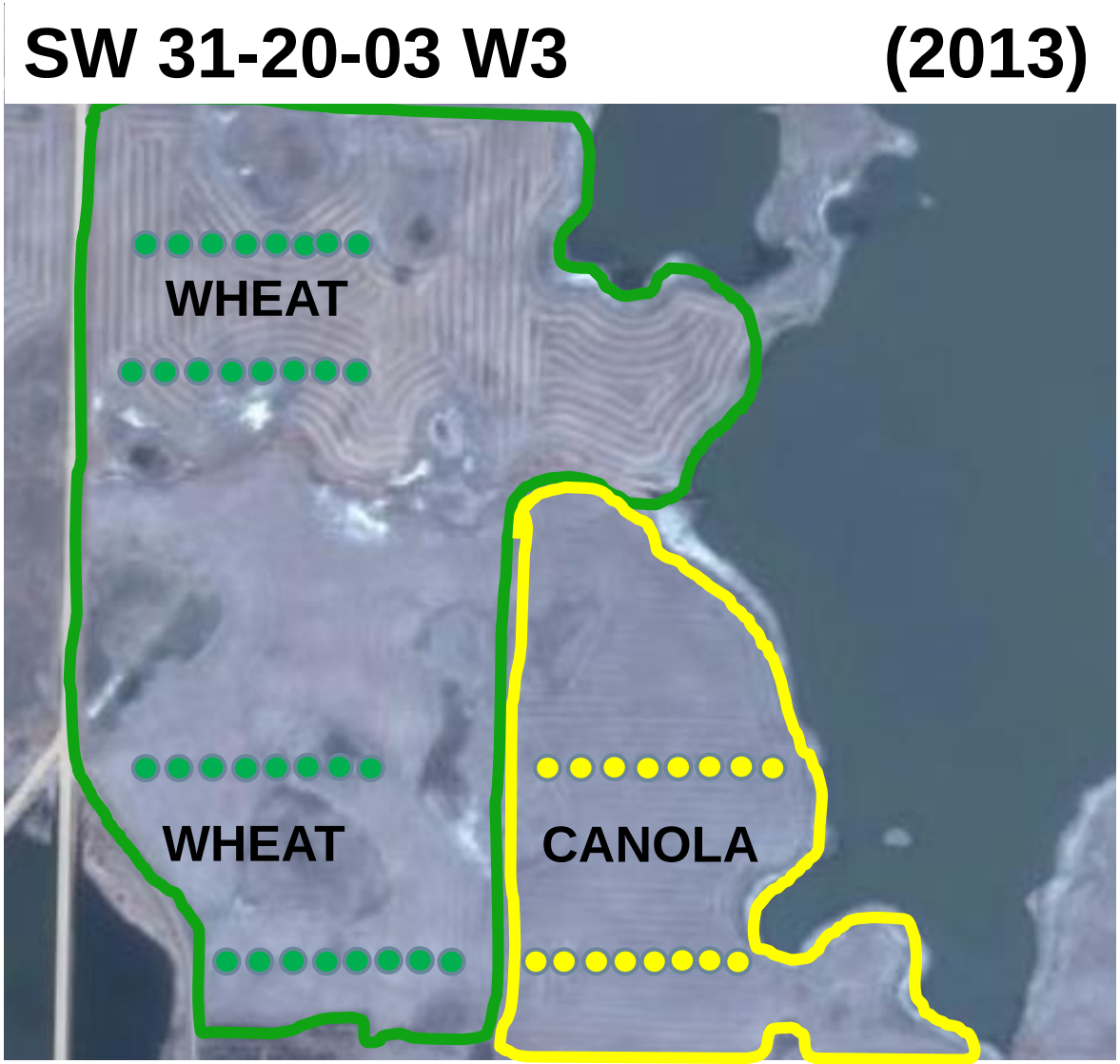
| Soil Property | Yield | | Protein | |
|---|---|---|---|---|
| | $R^2$ | p-value | $R^2$ | p-value |
| OC 0-30cm (%) | | | 0.65 | 0.007** |
| OC 30-60cm (%) | | | | |
| pH 0-30cm | | | | |
| pH 30-60cm | | | | |
| EC 0-30cm ($\mu S\ cm^{-1}$) | | | | |
| EC 30-60cm ($\mu S\ cm^{-1}$) | | | | |

# Relationships with Peas

| | **Yield** | | **Protein** |
|---|---|---|---|
| | (kg/ha) | (bu/ac) | (%) |
| Mean | **2198** | **33** | **16.5** |
| Min | 839 | 23 | 14.5 |
| Max | 3122 | 47 | 17.7 |

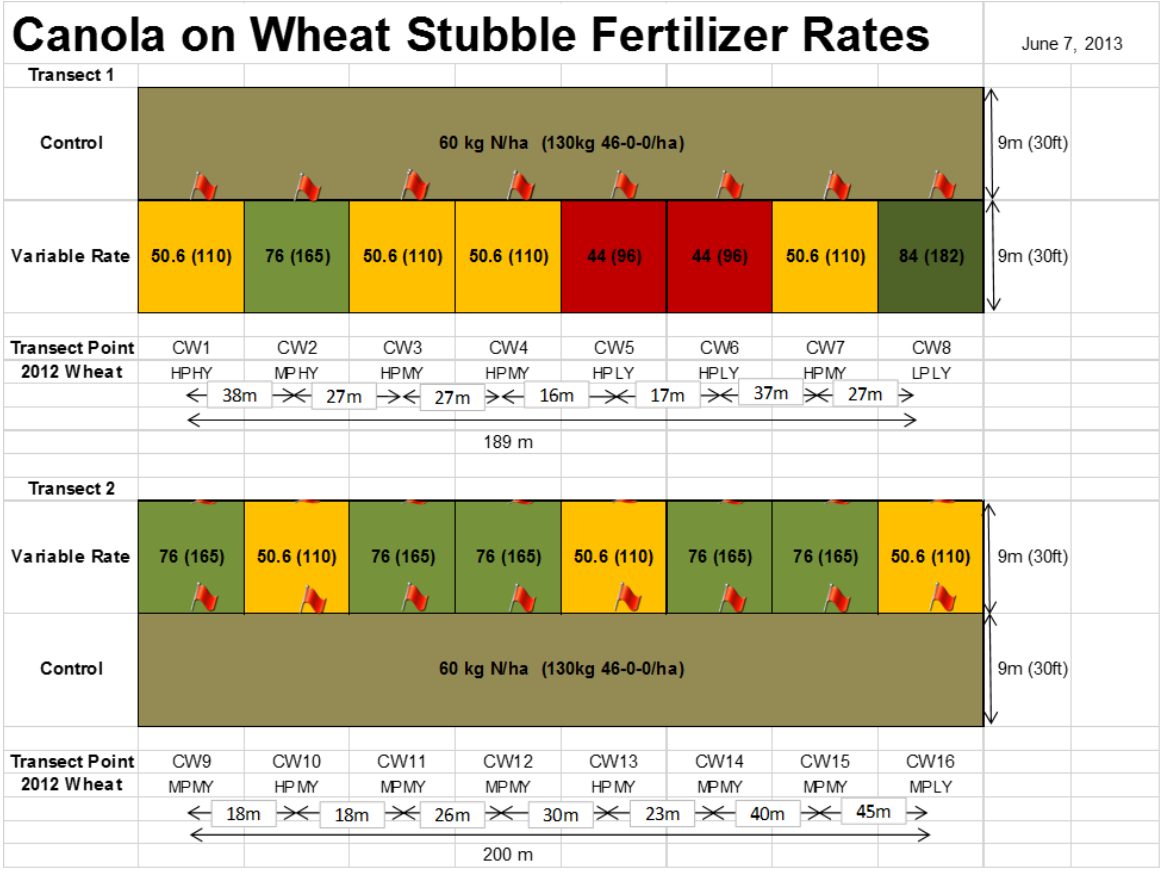
| Soil Property | Yield | | Protein | |
|---|---|---|---|---|
| | $R^2$ | p-value | $R^2$ | p-value |
| OC 0-30cm (%) | | | | |
| OC 30-60cm (%) | | | | |
| pH 0-30cm | | | | |
| pH 30-60cm | | | | |
| EC 0-30cm (µS $cm^{-1}$) | **-0.68** | **0.004**** | | |
| EC 30-60cm (µS $cm^{-1}$) | **-0.51** | **0.04*** | | |

# Field Season Two



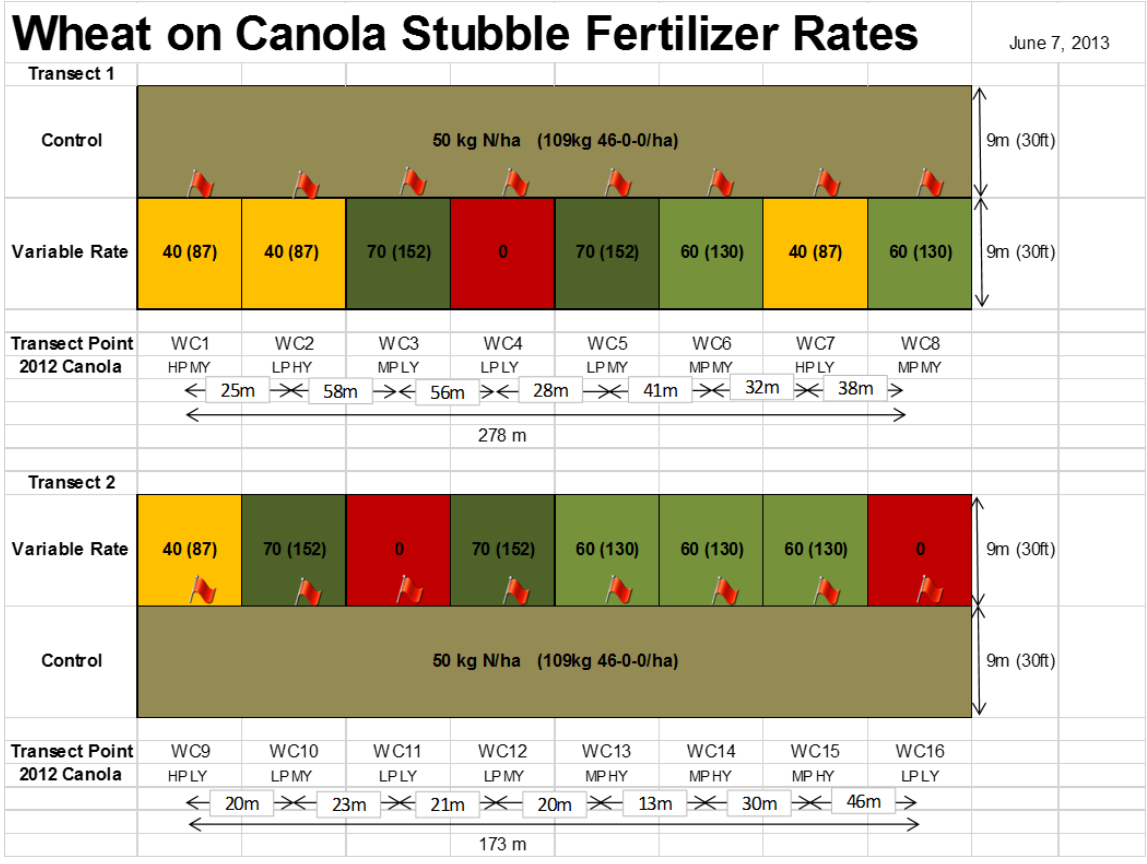
# Canola on Wheat N Rates

- 4 Varied N Rates (kg/ha actual)
  - 44 (2)
  - 51 (7)
  - 76 (6)
  - 84 (1)
- Control
  - 60



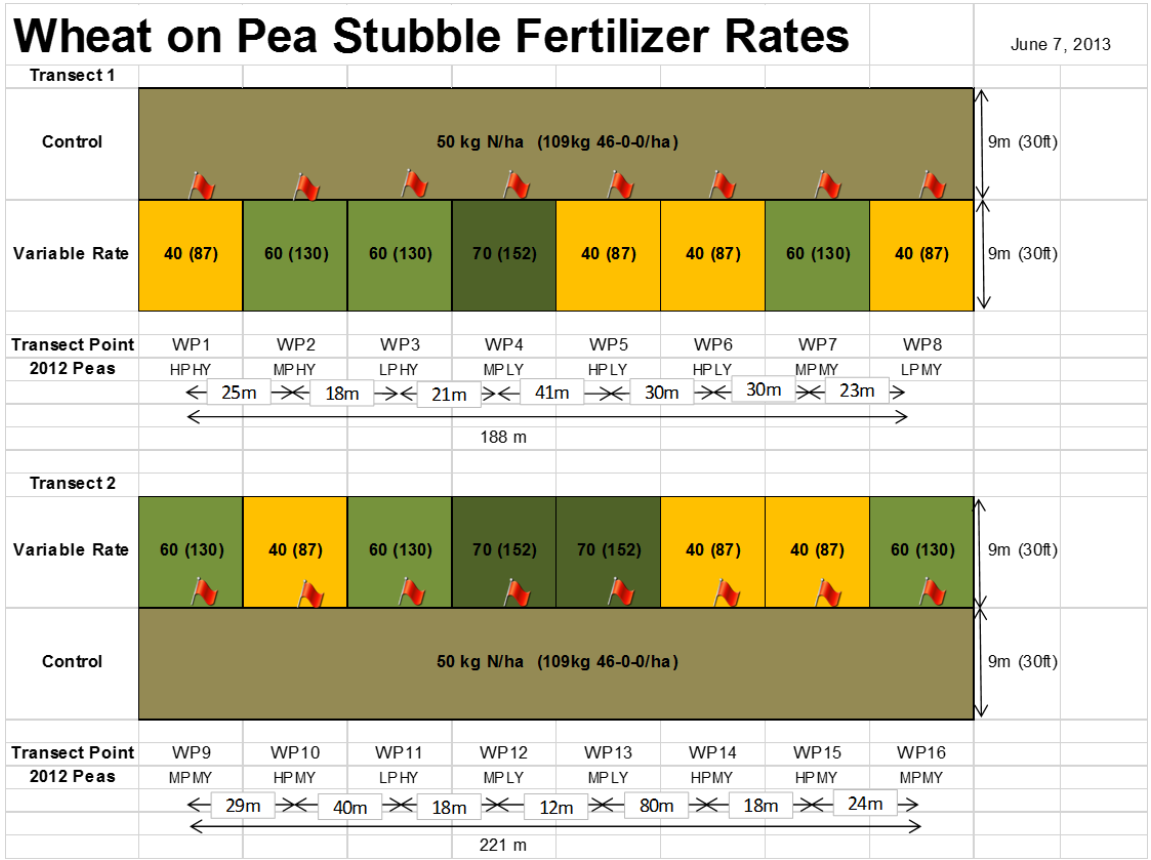
# Wheat on Canola N Rates

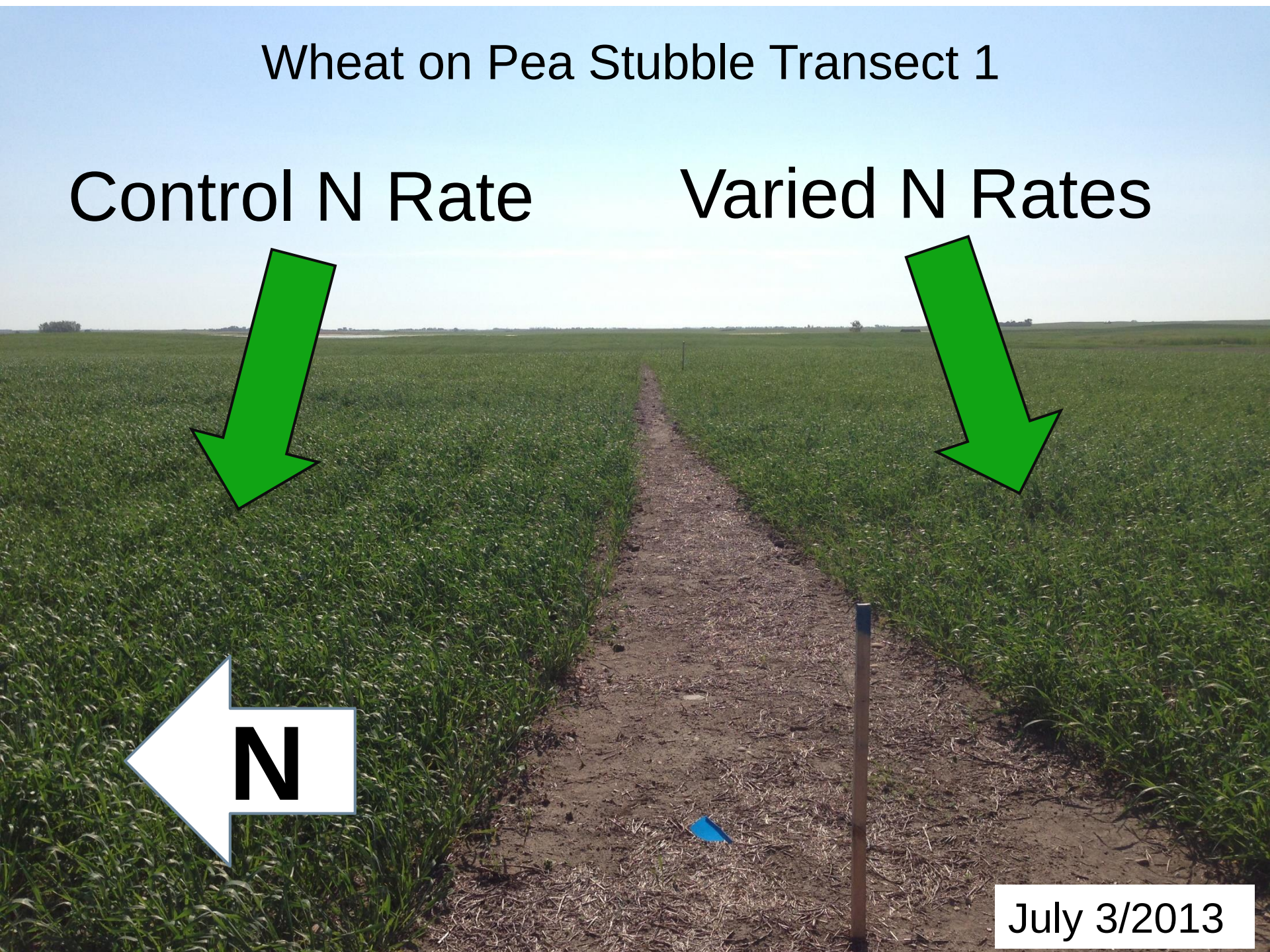
- 4 Varied N Rates (kg/ha actual)
  - 0 (3)
  - 40 (4)
  - 60 (5)
  - 70 (4)
- Control
  - 50



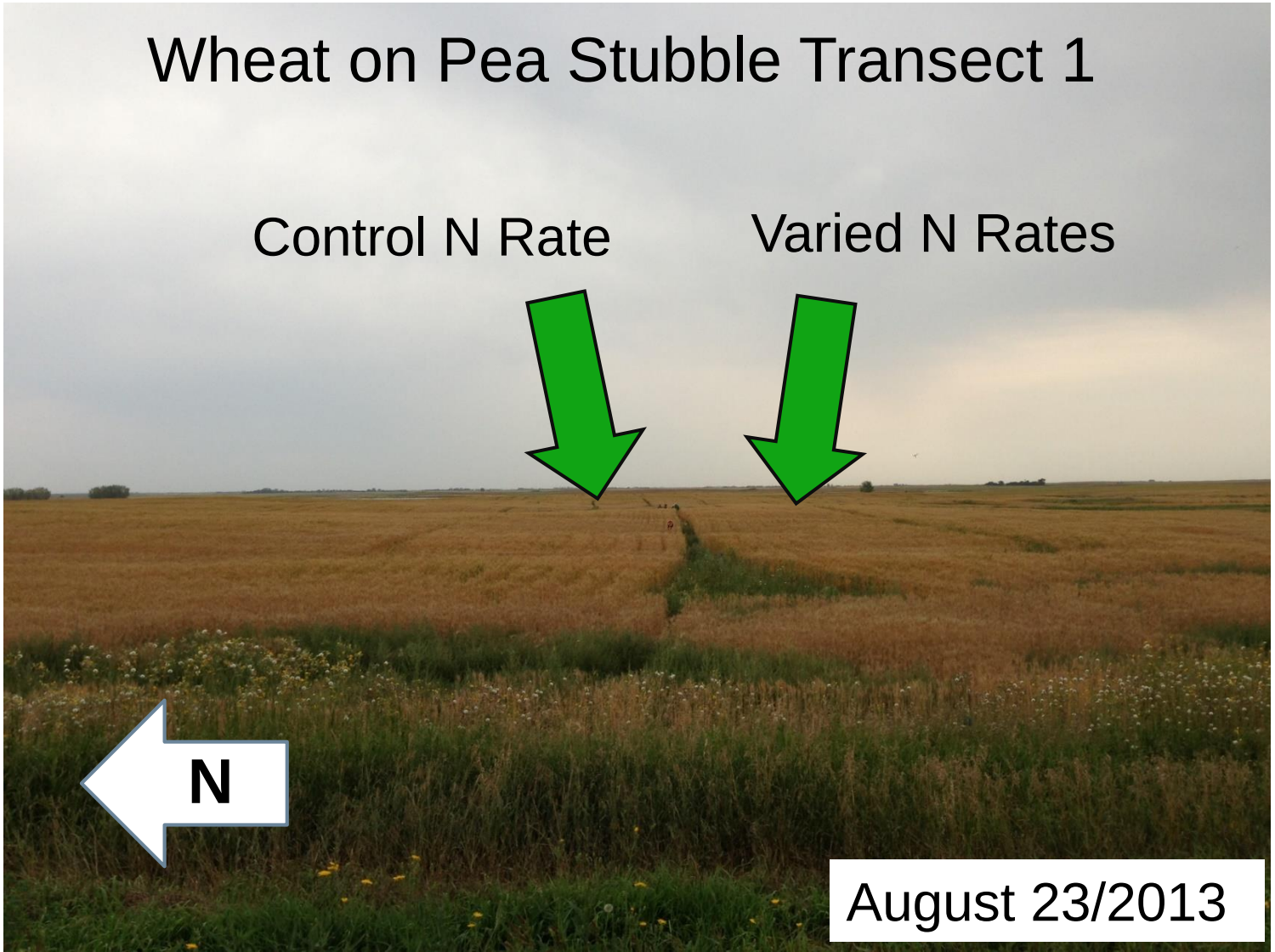
# Wheat on Pea N Rates

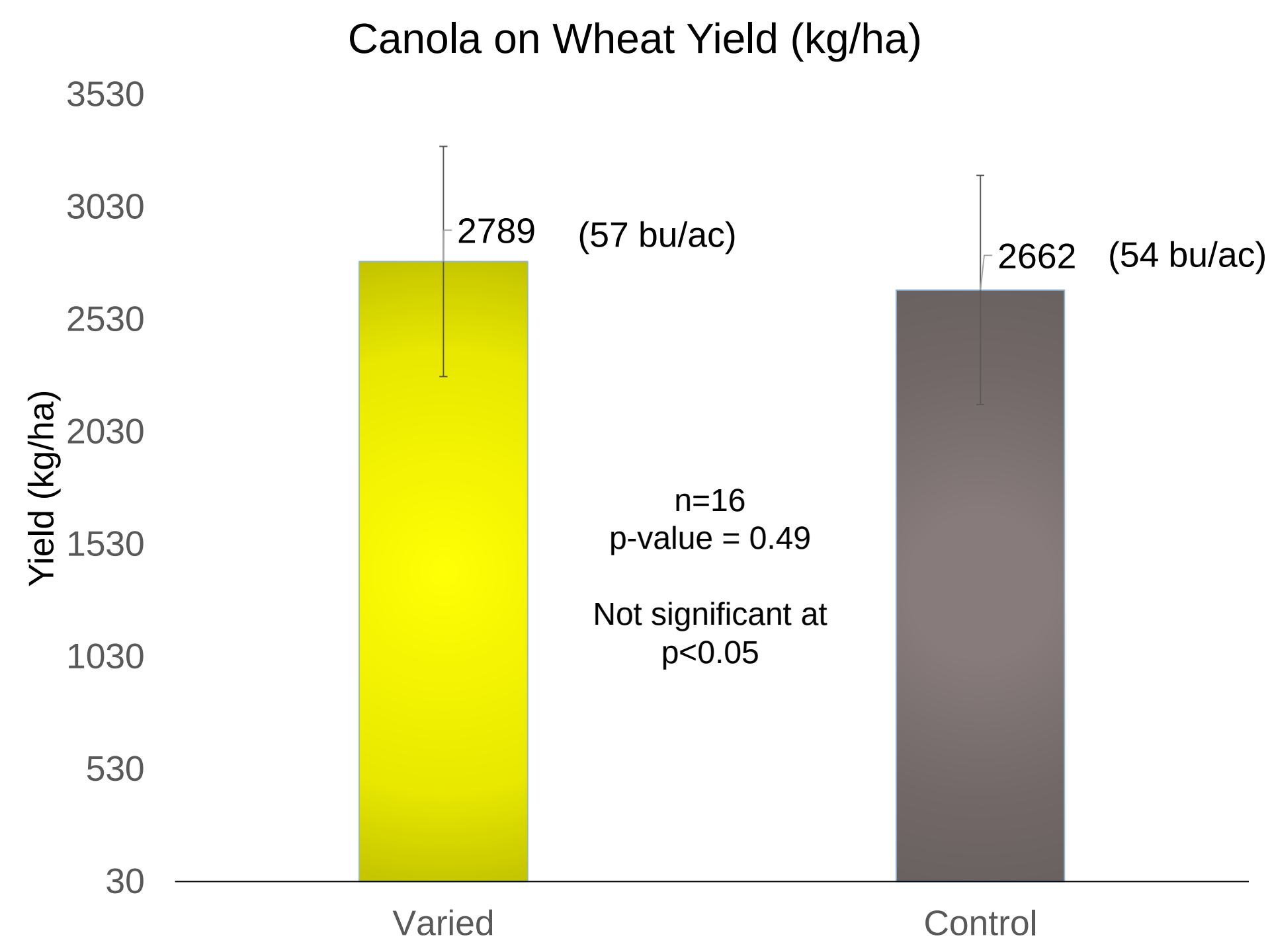
- 3 Varied N Rates (kg/ha actual)
  - 40 (7)
  - 60 (6)
  - 70 (3)
- Control
  - 50

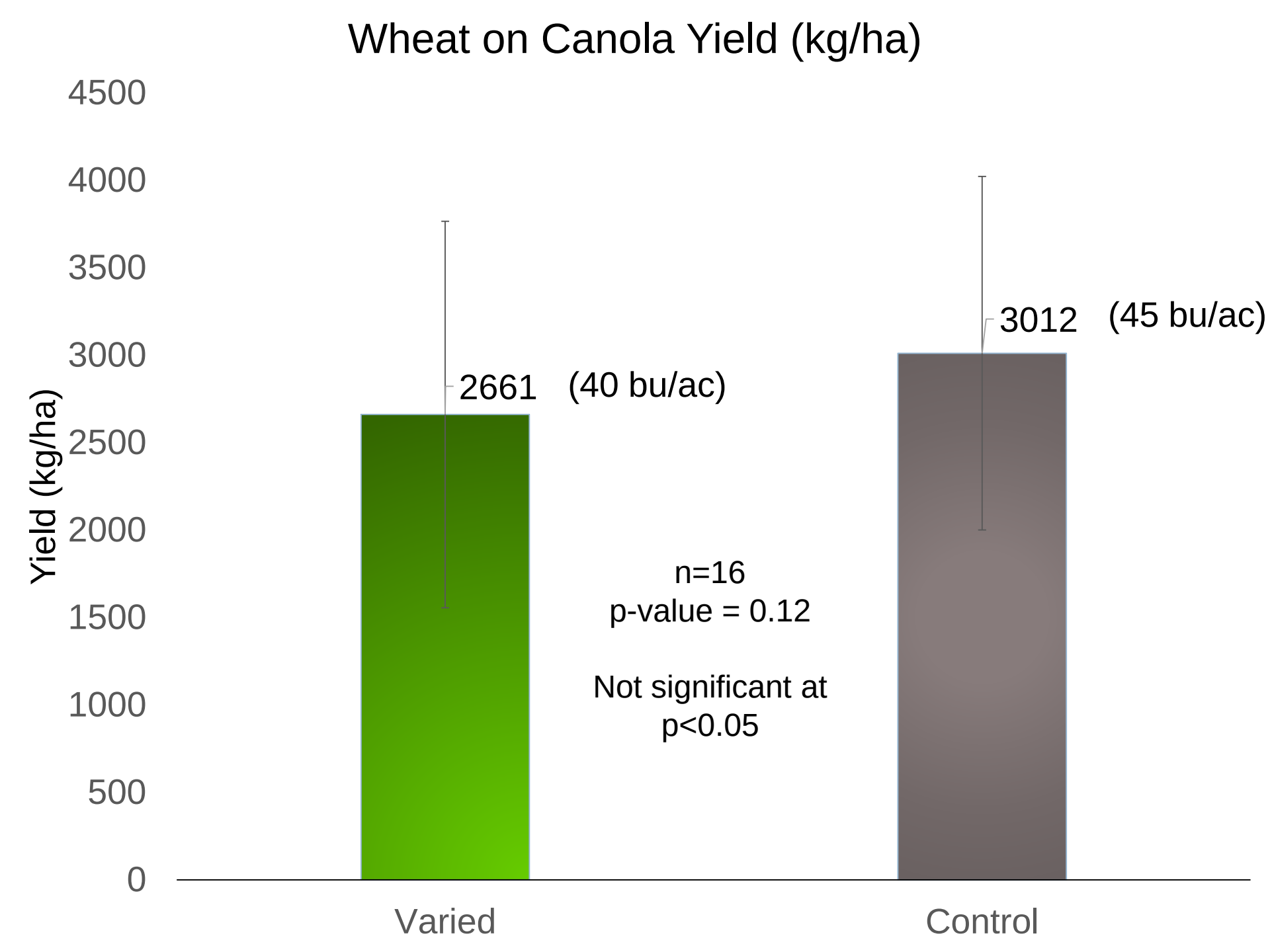


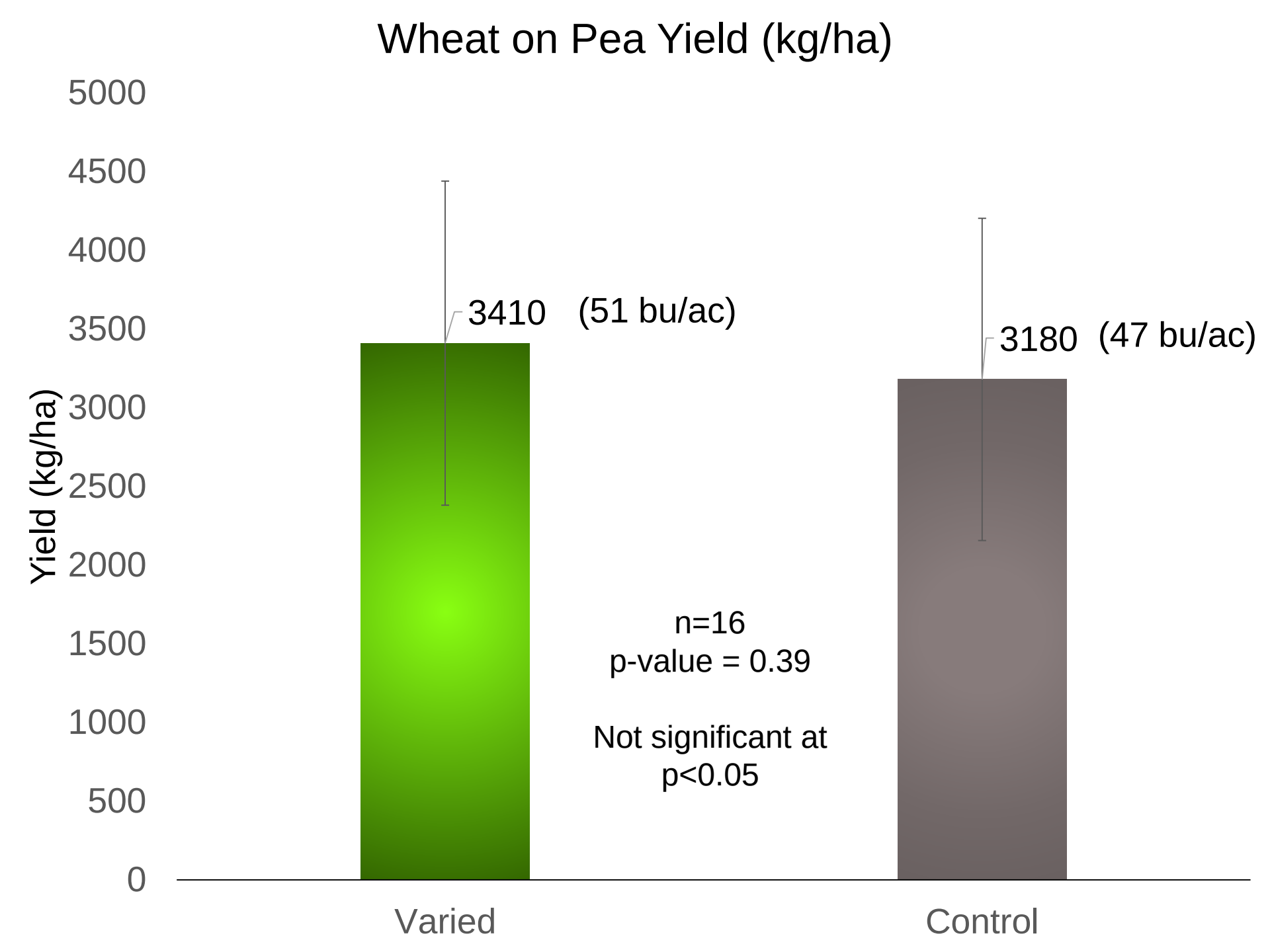

Wheat on Pea Stubble Transect 1
Control N Rate
Varied N Rates
N
July 3/2013

# Harvest 2013 Results




Canola on Wheat Yield (kg/ha)
3530
3030
2530
2030
1530
1030
530
30
Yield (kg/ha)
2789
(57 bu/ac)
2662
(54 bu/ac)
n=16
p-value = 0.49
Not significant at
p<0.05
Varied
Control


Wheat on Canola Yield (kg/ha)
Yield (kg/ha)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2661
(40 bu/ac)
3012
(45 bu/ac)
n=16
p-value = 0.12
Not significant at
p<0.05
Varied
Control


Wheat on Pea Yield (kg/ha)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Yield (kg/ha)
3410
(51 bu/ac)
3180
(47 bu/ac)
n=16
p-value = 0.39
Not significant at
p<0.05
Varied
Control

# Season 2 Conclusions to Date

- Average yield in varied N rate and constant N rate were similar.
- Since similar total amounts of N fertilizer were used in each, no difference in economic return.
  - Same results for each crop
- Prescription approach needs refining?
  - What can be improved?
- Does VR N Application work?
  - Not quite yet!

# Acknowledgements


- Supervisor: Dr Jeff Schoenau
- Committee members
- Ross Welford- Ag Engineering- U of S
  - Software
- 5C21 Lab Group

Thank You!

Questions?

# References


- Engel, R., Long, D., Carlson, G., and Meier, C. 1999. Method for precision nitrogen management in spring wheat: I. Fundamental relationships. Precision Agriculture. 1. 327-338.
- Ayres, K.W., D.F. Acton, J.G. Ellis. The soils of the Swift Current Map Area 72J. Saskatchewan Institute of Pedology. 1985. Extension Division, University of Saskatchewan. Extension Publication 481.