Soybean Response to Nitrogen Application Across the U.S.

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Introduction

- USA soybean production has increased by 60% from 1996 to 2016 due to a 30% increase in area planted to soybean, and to better genetics and improved crop management practices.

- While these historic seed yield increases have been substantial, USA soybean producers continually search for opportunities to optimize crop management and increase soybean seed yield, including applying fertilizer N to soybean.

- The N requirement of soybean is generally fulfilled by biological nitrogen fixation (BNF) plus N uptake from soil. However, BNF activity can be limited by a number of environmental conditions such as low soil moisture, extremes of soil pH and temperature, and soil compaction.

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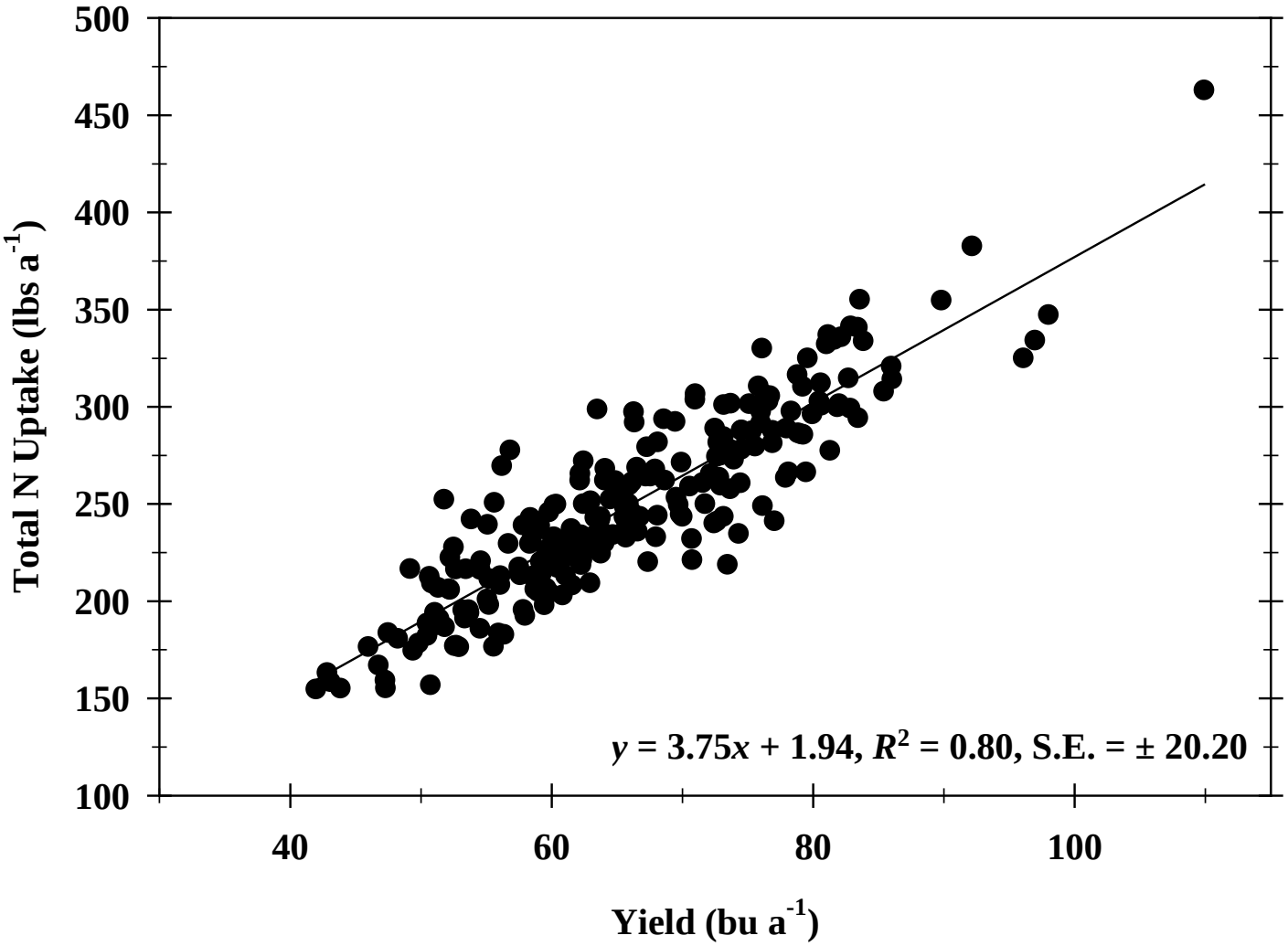
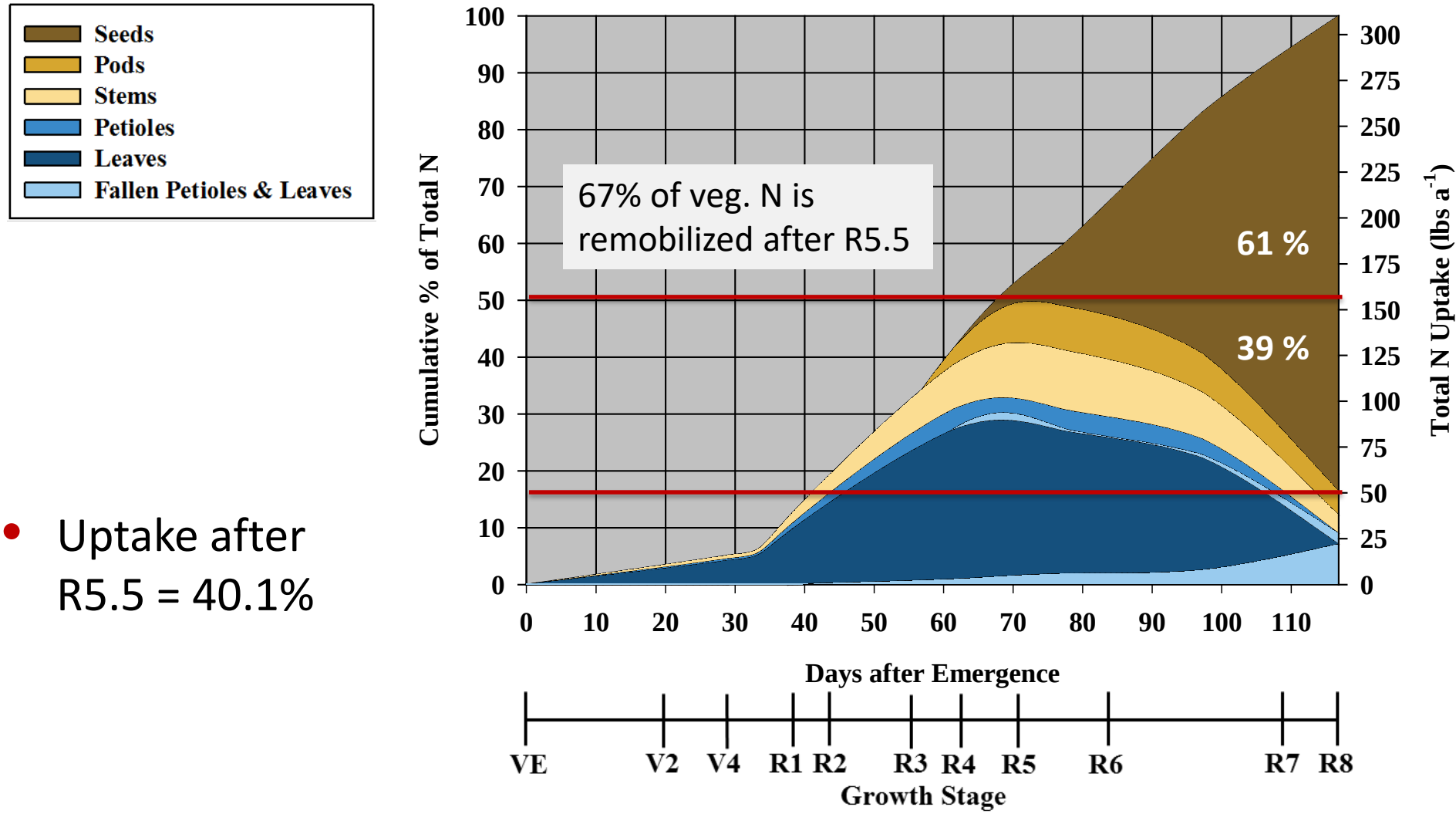
Todays Nitrogen Uptake..the Real Story!

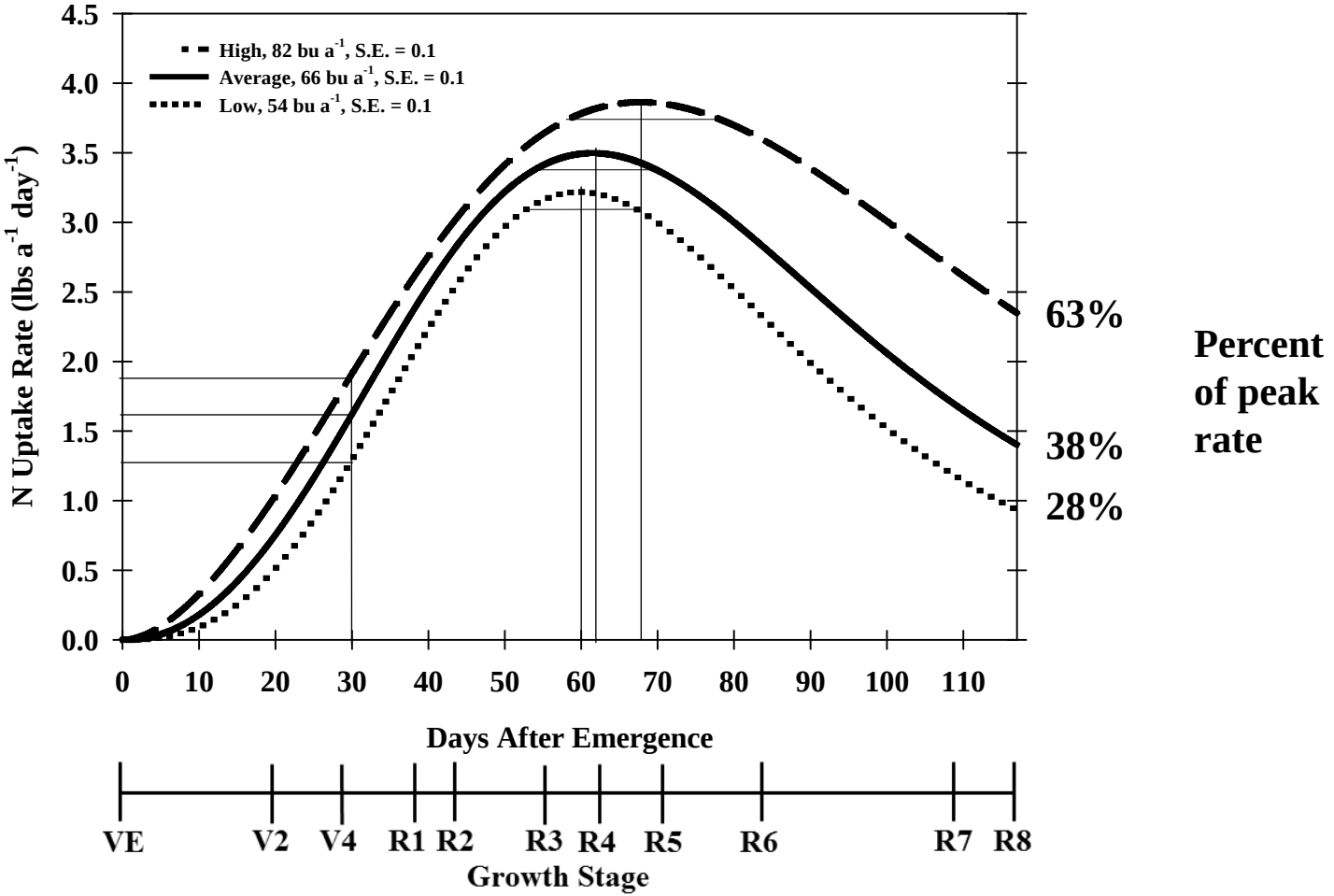


Nitrogen Partitioning: High



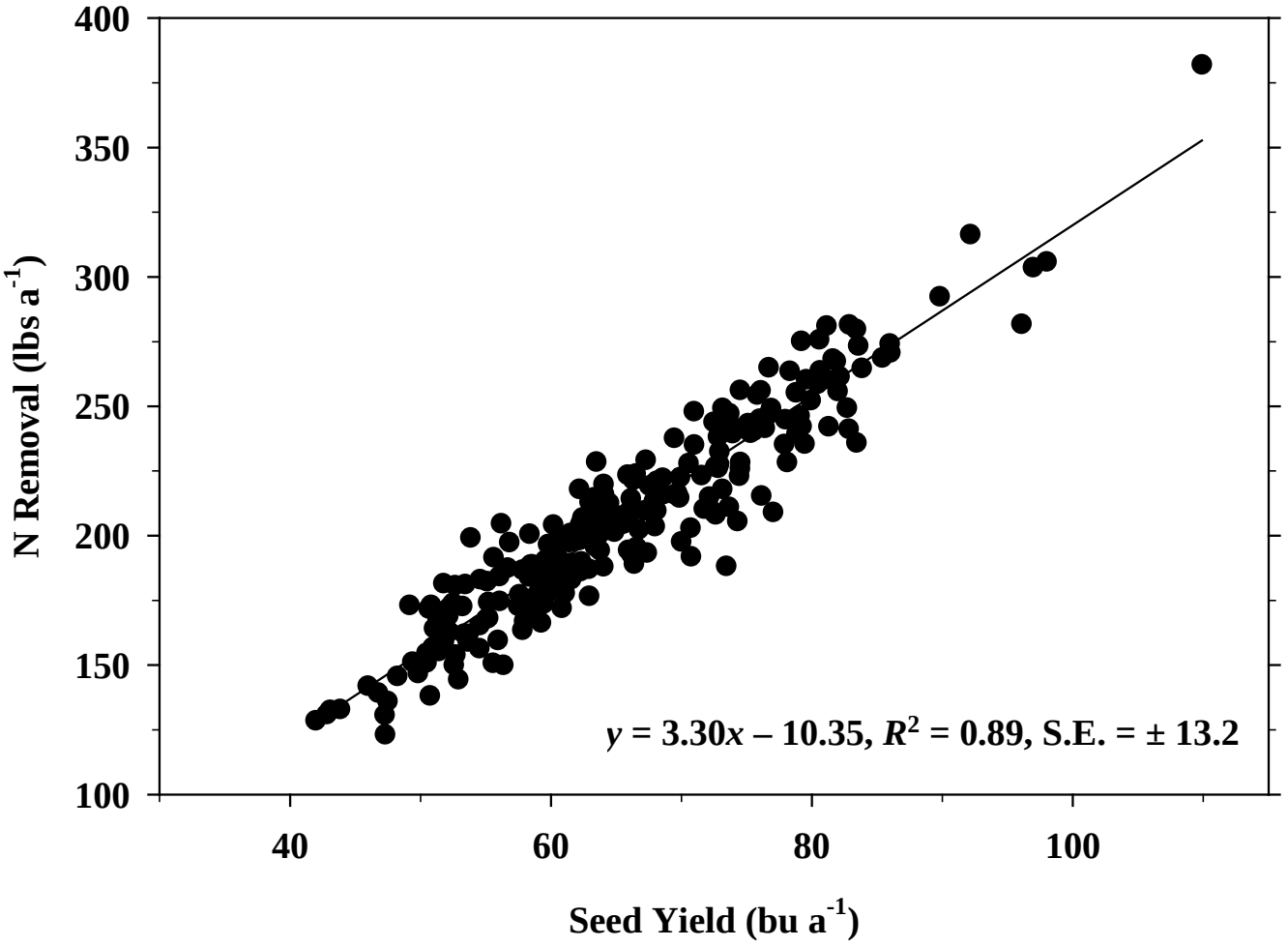
- Uptake after R5.5 = 40.1%

N Uptake Rate



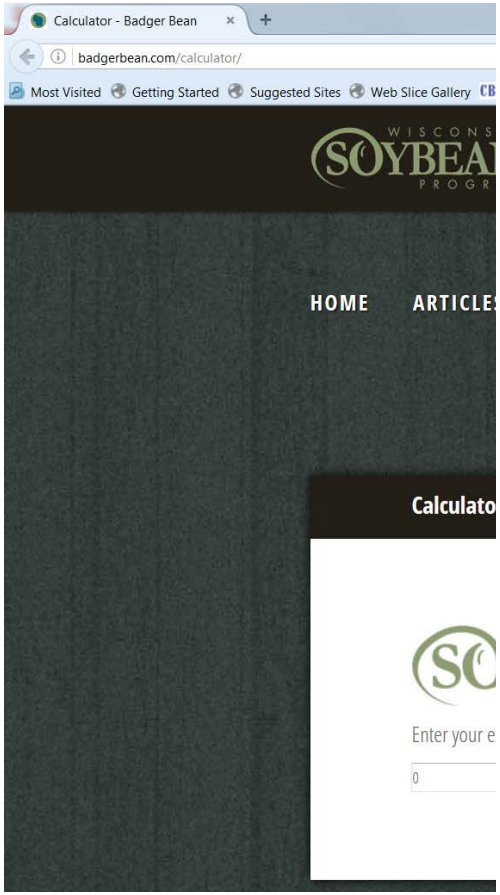
- Less time in lag phase for greater early season uptake, higher peak rate and longer duration and higher late season rates

Current Status: Nitrogen Removal



- Average seed N content of 6.02%, DM basis

Soybean crop uptake and removal rate calculator



Total Removal in the Grain in lbs/ac

Nutrient	Total Removal in Grain(lbs/ac)	SE (+/-)	R^2
N	274.35	13.0	0.89
P_2O_5	59.52	2.9	0.89
K_2O	97.8	3.9	0.92
S	13.21	1.0	0.76
Mg	13.01	0.7	0.88
Ca	10.58	1.0	0.67
Zn	0.169	0.02	0.59
Mn	0.169	0.02	0.51
Cu	0.097	0.01	0.66
Fe	0.17	0.04	0.34
B	0.086	0.03	0.22

Total Removal in the Stover in lbs/ton of DM

Nutrient	Total Removal in Stover(lbs/ton)	SE (+/-)
N	18.8	0.17
P_2O_5	5.1	0.10
K_2O	38.7	0.47

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Objective

- Because a single study was not conducted at multiple USA locations for several years, we combined data from multiple soybean N fertilization studies across multiple locations and years.

- The objectives of this study were to examine the effects of N fertilizer in terms of N-application number (single or split applied), N-method (soil surface, soil incorporated, foliar, or a combination of these), N-timing (pre-plant, at-planting, Vn or Rn growth stages, or combination of these), and N-rate on soybean seed yield across the USA.

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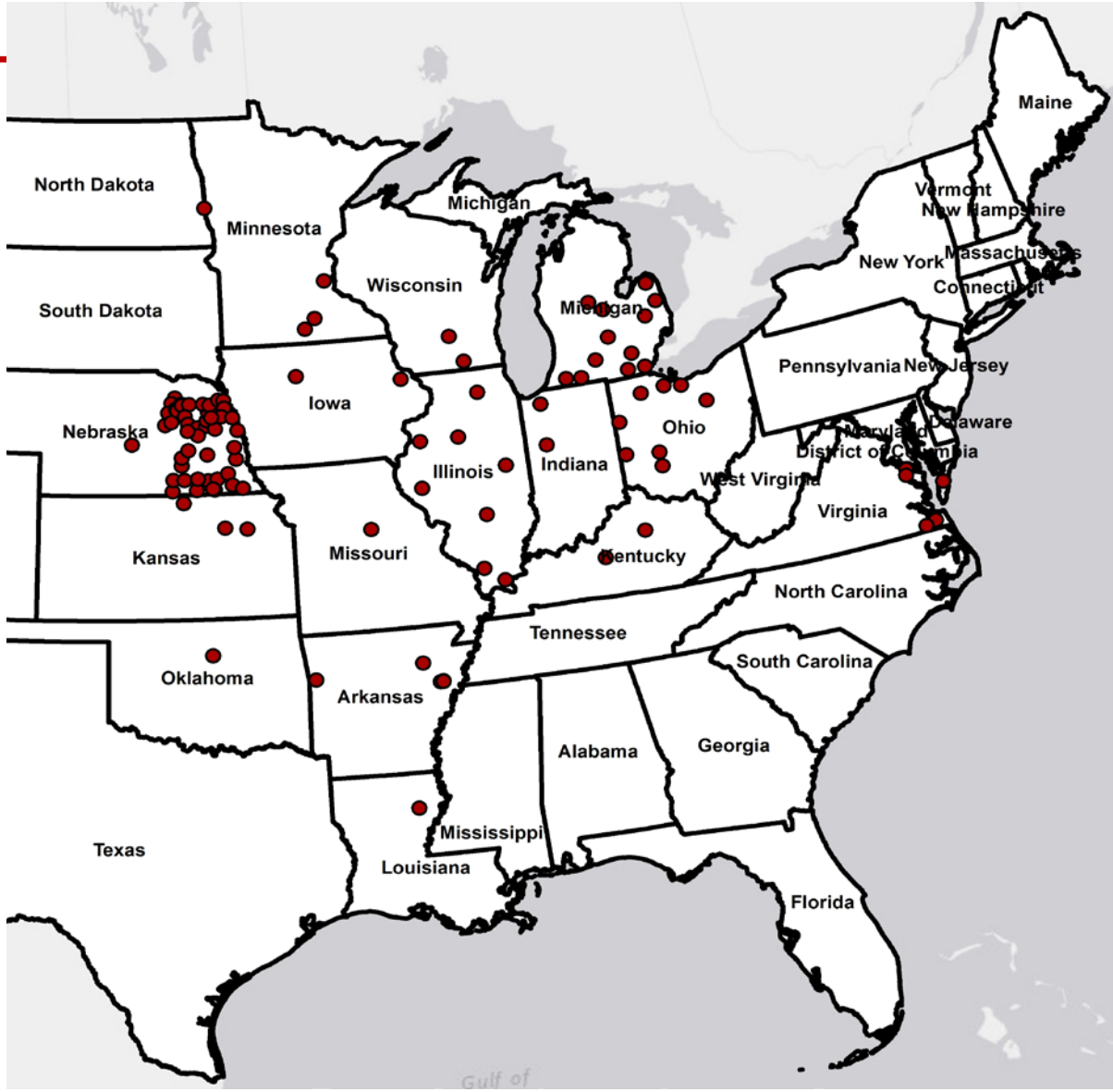
Materials and Methods

- Soybean yield data were aggregated from replicated field experiments established from 1996 to 2016, at 105 locations within 16 states.
- The database consisted of 5991 plot-specific yields for a total of 207 environments (experiment × year).



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Materials and Methods *cont.*

- Data were coded for the four N-related variables and for five major management variables (“MM”.) The N variables were:
  - (a) **N-applications** (i.e., zero N control, one, or two applications),
  - (b) **N-method** (i.e., zero N control, applied to the soil surface prior to emergence, soil-incorporated, foliar-applied, or a combination of these methods),
  - (c) **N-timing** [i.e., zero N control, pre-plant applied (pP), applied at planting (P), or at a vegetative stage (Vn), or at a reproductive stage (Rn), or split-applied at planting then at an Rn stage (PR), or split applied at two Rn stages (RR)], and
  - (d) **N-rate** (0-505 lb/ac).

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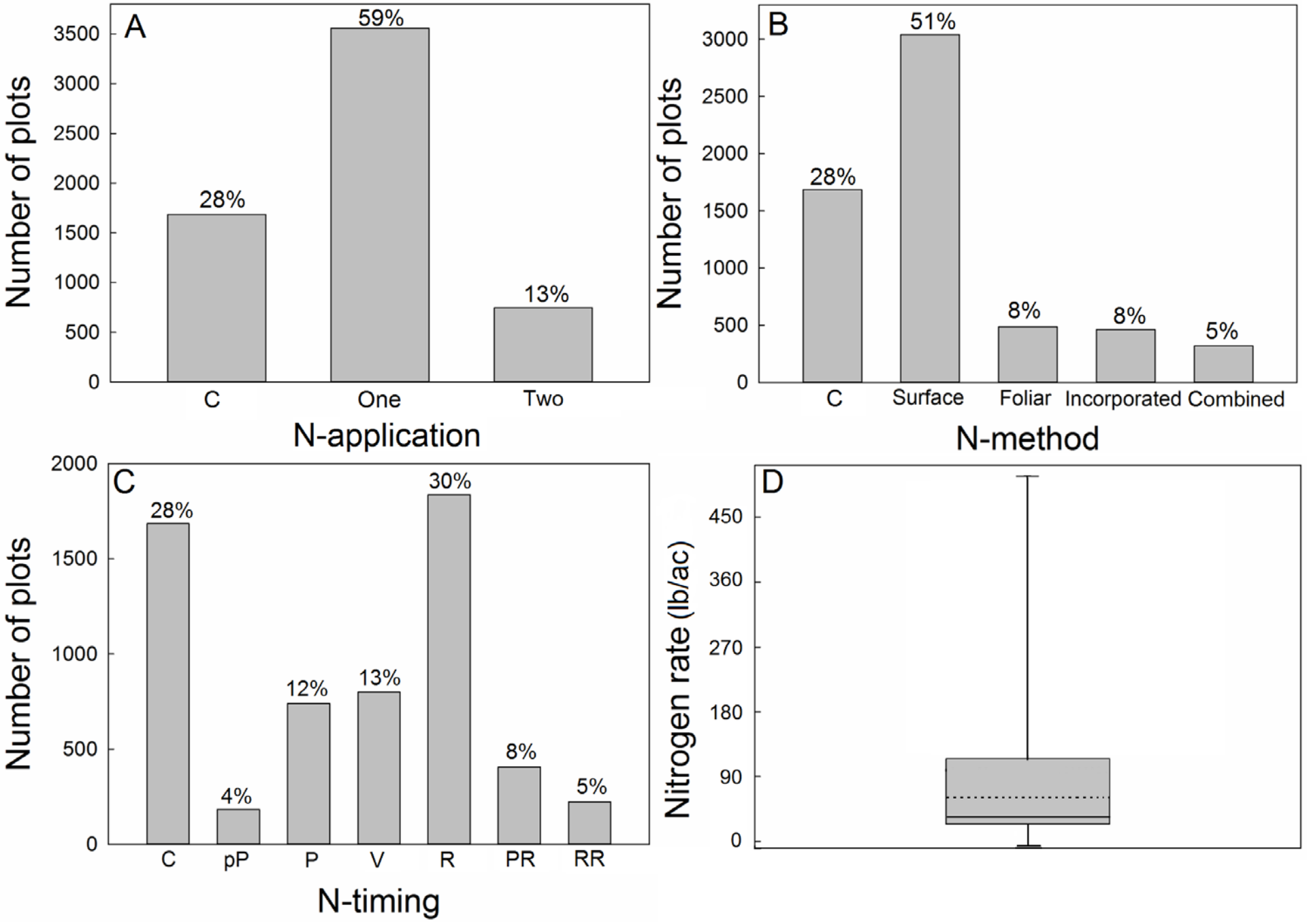
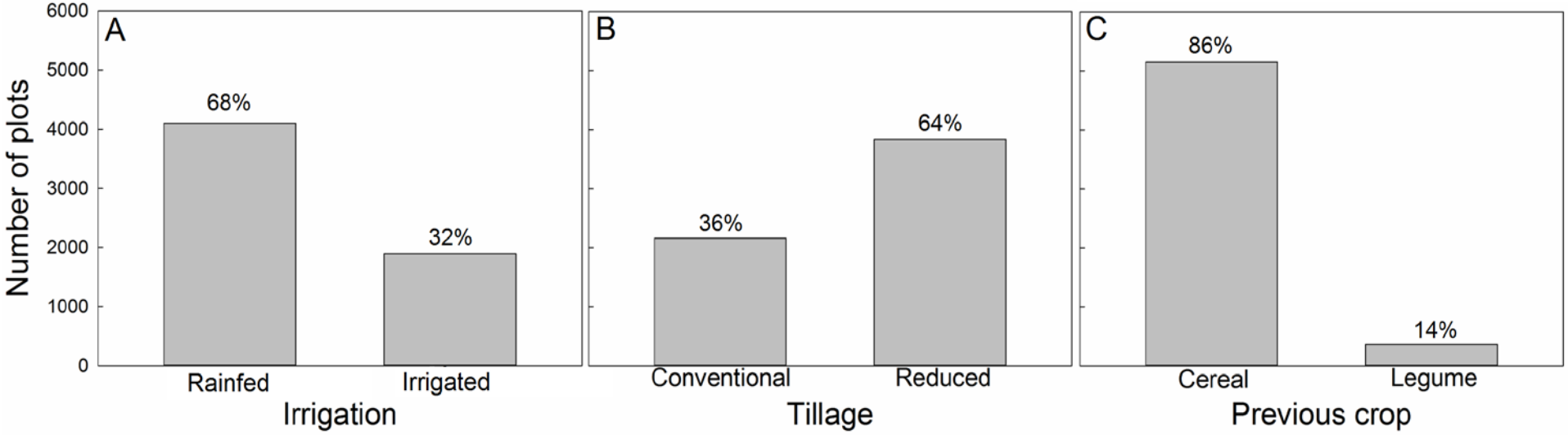
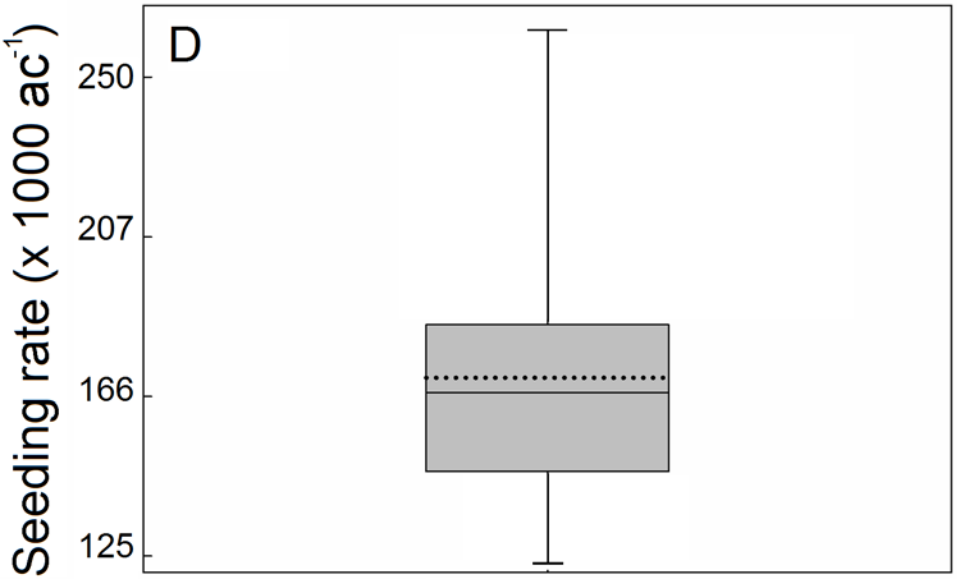
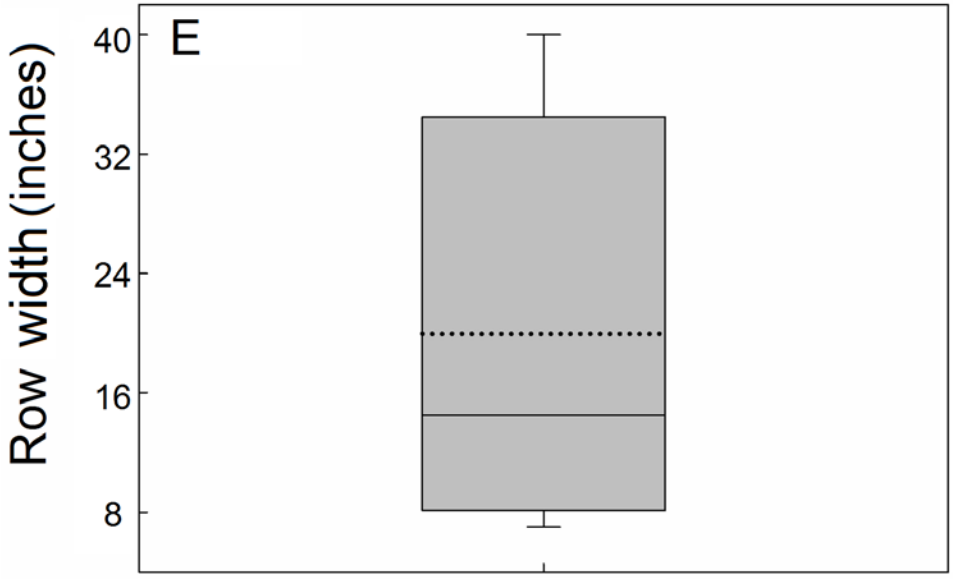

A
Number of plots
3500
3000
2500
2000
1500
1000
500
0
28%
59%
13%
C
One
Two
N-application
B
Number of plots
3000
2500
2000
1500
1000
500
0
28%
51%
8%
8%
5%
C
Surface
Foliar
Incorporated
Combined
N-method
C
Number of plots
2000
1500
1000
500
0
28%
4%
12%
13%
30%
8%
5%
C
pP
P
V
R
PR
RR
N-timing
D
Nitrogen rate (lb/ac)
450
360
270
180
90
0

Materials and Methods *cont.*







Results

- Among all experiments, only a small fraction (<1%) of total variability was attributed to each N variable within experiment × year.

- This result shows the small N-related effect on soybean yield relative to other sources of variability (e.g., weather, soil, and MM decisions).

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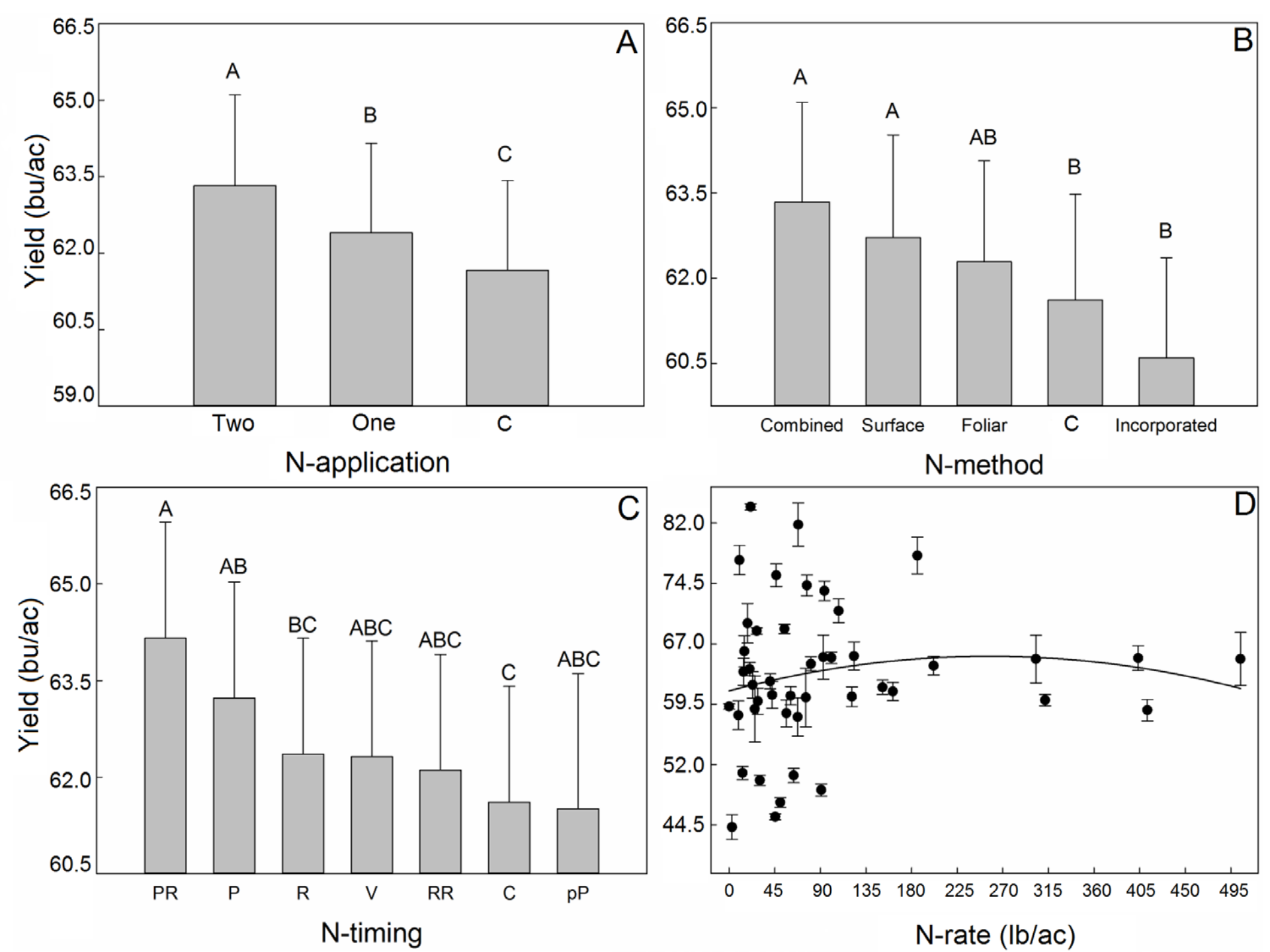
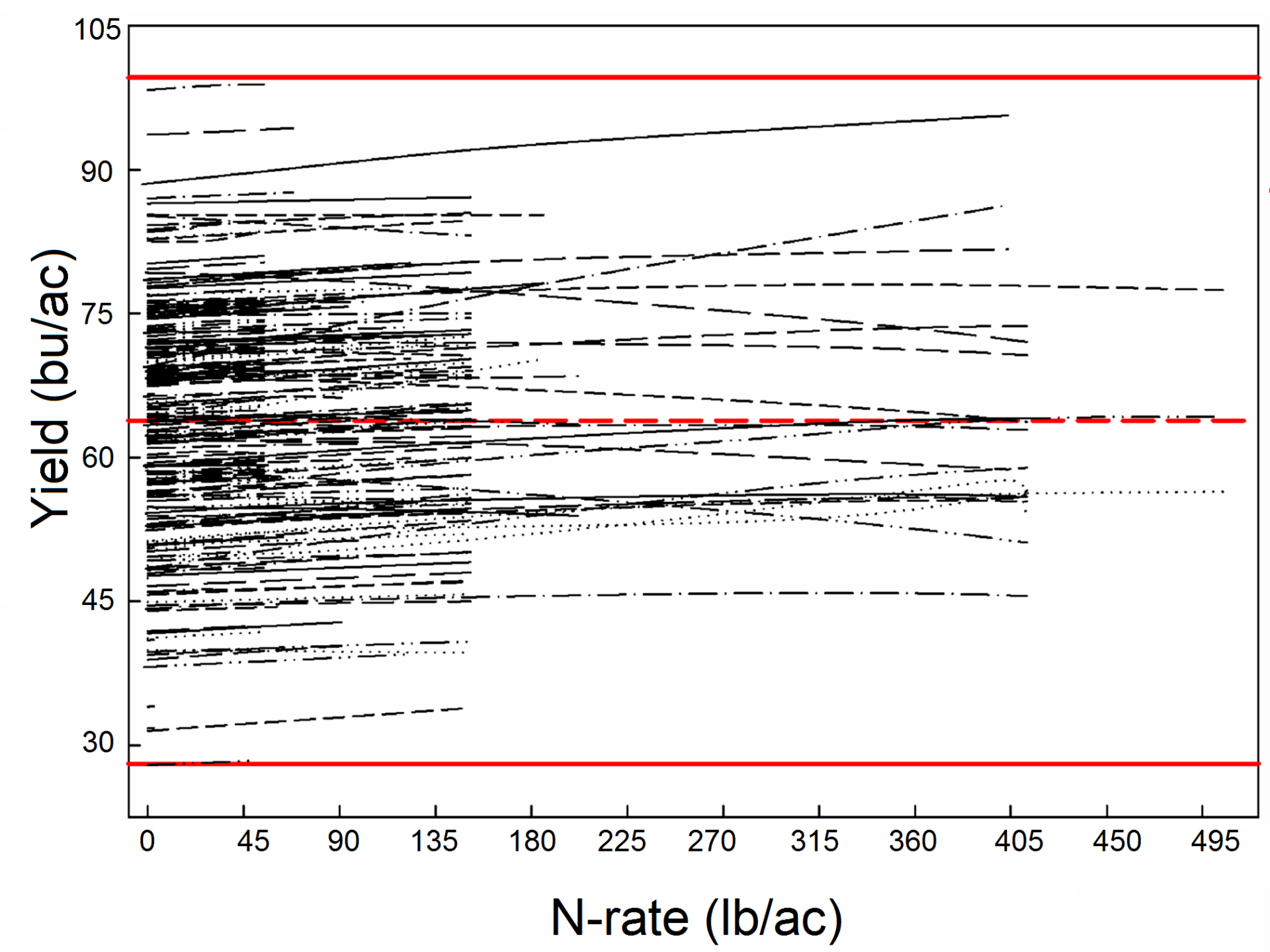
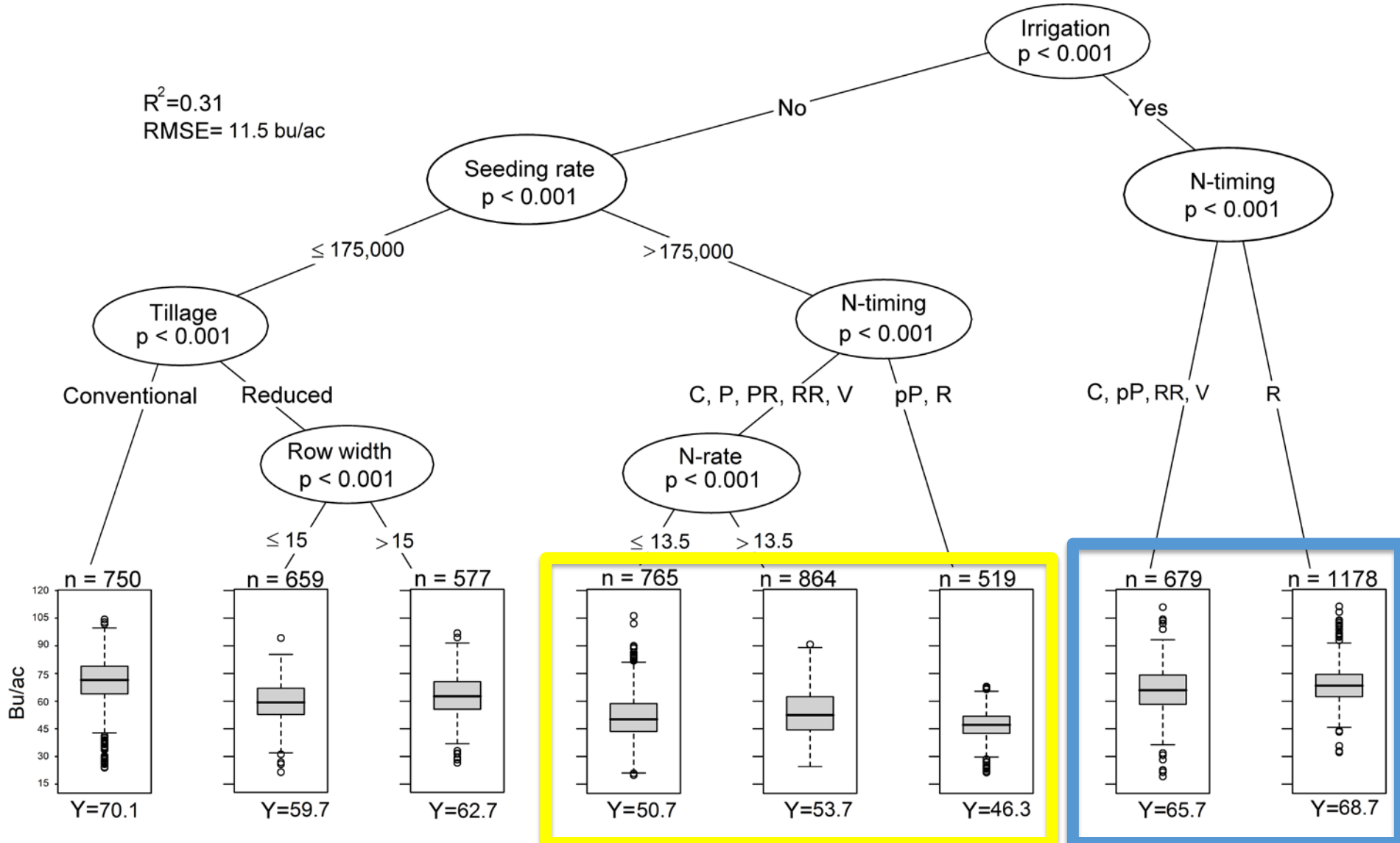
WTH!! Dowdy says it works so it must be real!!!!!
#FakeNEWS
#ExtensionIsIrrelevant
Disclaimer: Not an actual picture of my mother-in-law.


A
Yield (bu/ac)
66.5
65.0
63.5
62.0
60.5
59.0
A
B
C
Two
One
C
N-application
B
66.5
65.0
63.5
62.0
60.5
A
A
AB
B
B
Combined
Surface
Foliar
C
Incorporated
N-method
C
Yield (bu/ac)
66.5
65.0
63.5
62.0
60.5
A
AB
BC
ABC
ABC
C
ABC
PR
P
R
V
RR
C
pP
N-timing
D
82.0
74.5
67.0
59.5
52.0
44.5
0
45
90
135
180
225
270
315
360
405
450
495
N-rate (lb/ac)


105
90
75
60
45
30
Yield (bu/ac)
0
45
90
135
180
225
270
315
360
405
450
495
N-rate (lb/ac)

Results *cont.*



Conclusions

- The analysis revealed that N management decisions had a measurable, but small, effect on soybean yield.

- Overall, the limited responses to N effects in our study, as well as the costs associated with N application, indicate that these small positive effects would be unlikely to result in positive economic returns from N fertilization decisions.

- The research findings we present here suggest that N management can only be optimized when considering the cropping system because non-N management practices such as irrigation and seeding rates interacted with N-timing and N-rate.

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