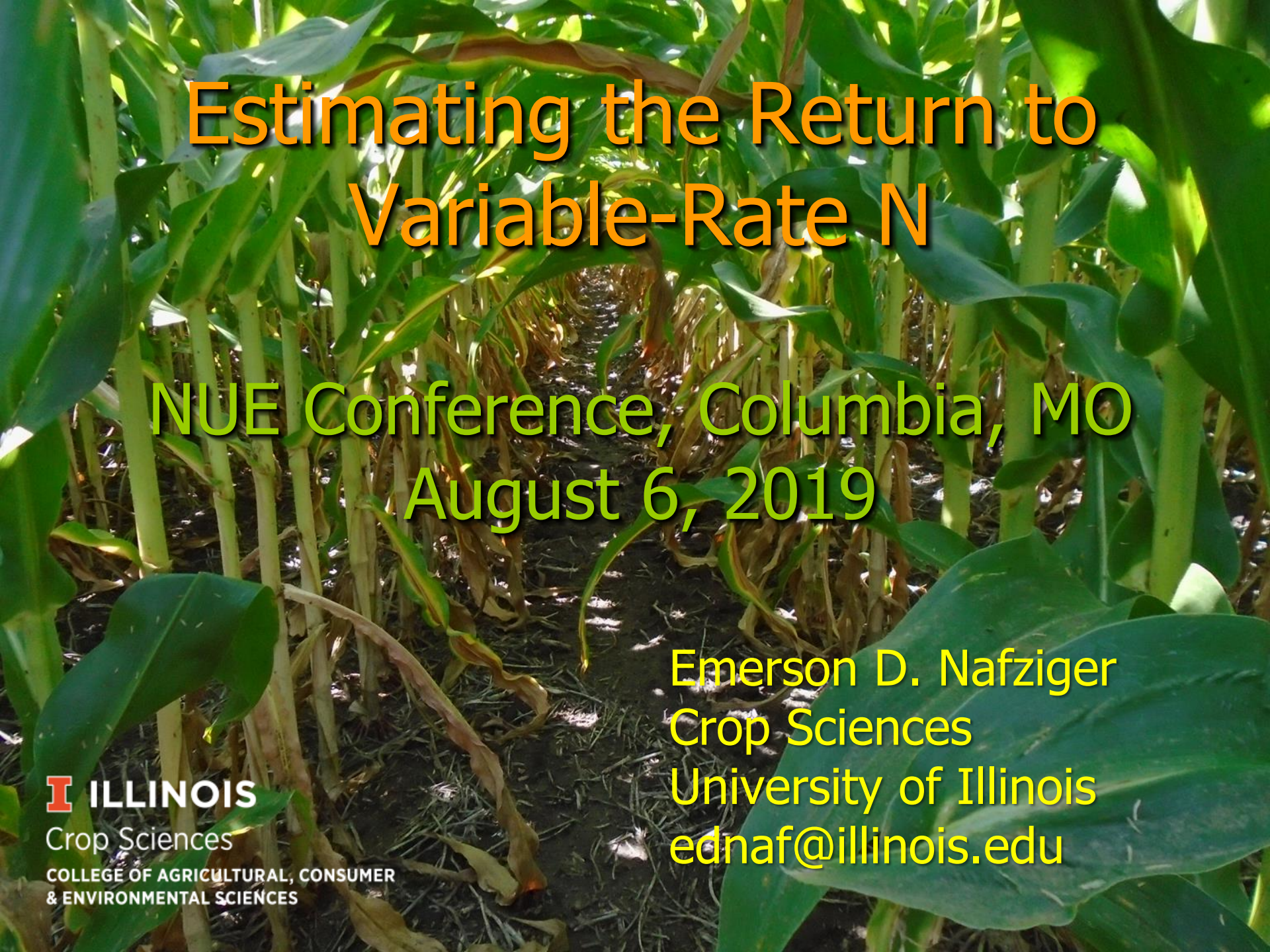

# Estimating the Return to Variable-Rate N

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Emerson D. Nafziger
Crop Sciences
University of Illinois
ednaf@illinois.edu

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COLLEGE OF AGRICULTURAL, CONSUMER & ENVIRONMENTAL SCIENCES

# Variable-rate N

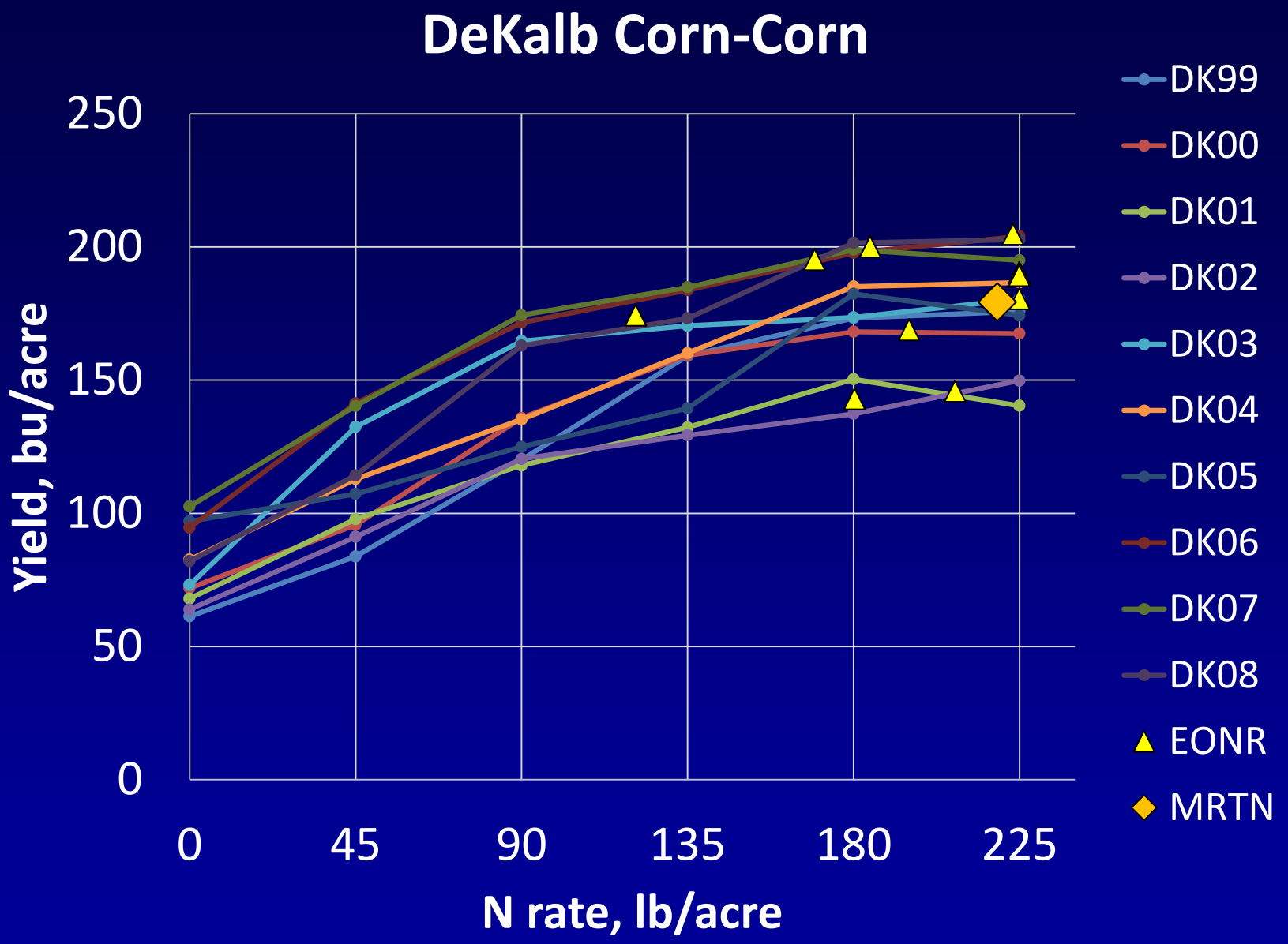
- Has attracted a lot of attention as a way to match N rate to crop need, and so to increase $ return to N and to decrease N loss
- First “editions” were based on yield goal as a set point for N rate
- But yield goal doesn’t work: higher-yielding parts of most fields (in years with no drowning or drought) have higher OM, so have a larger supply of both water and of mineralizable N
- Most current efforts focus on (modeled) N supply and/or aerial imagery; most require a yield goal

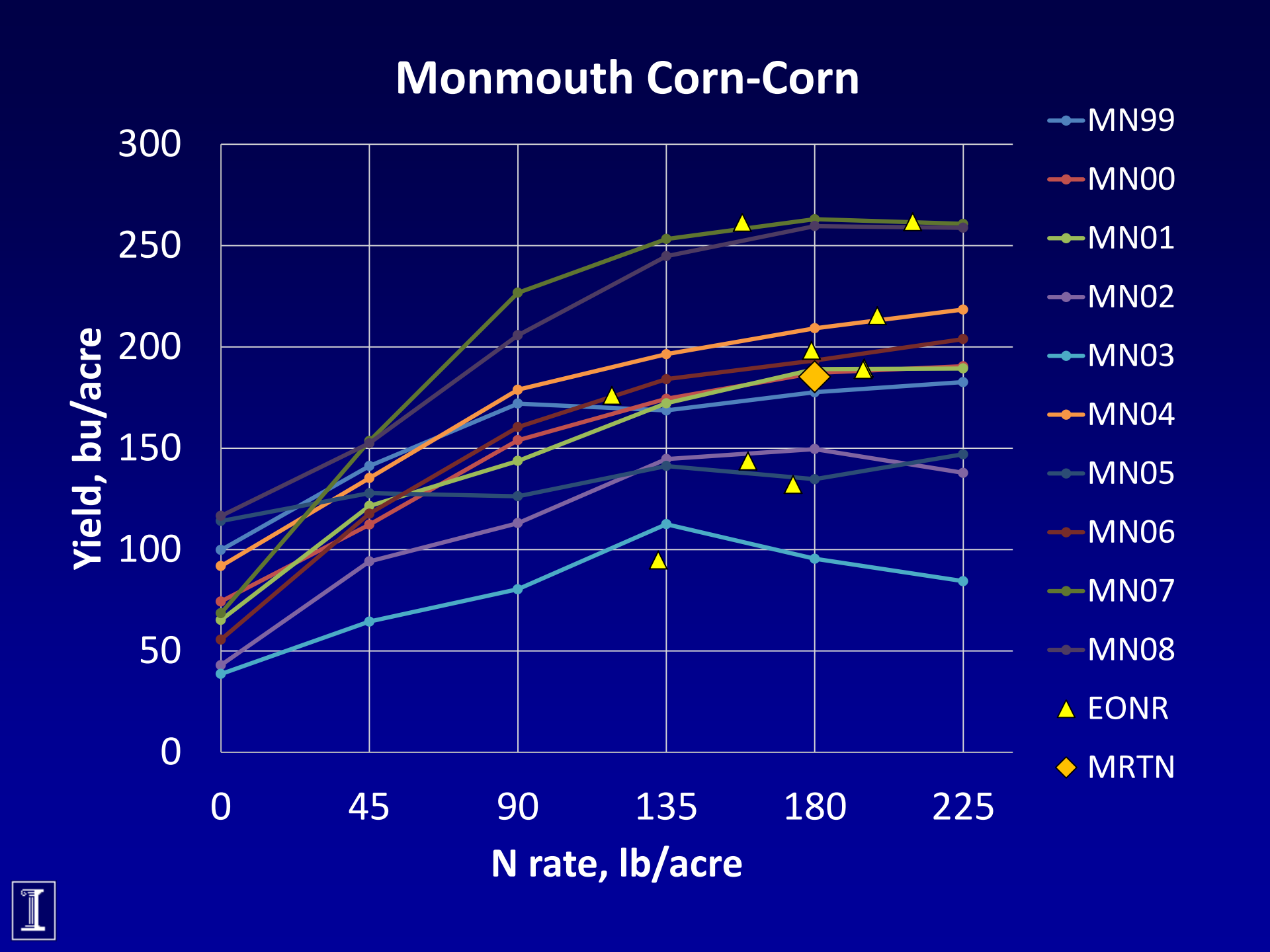
# Experiment

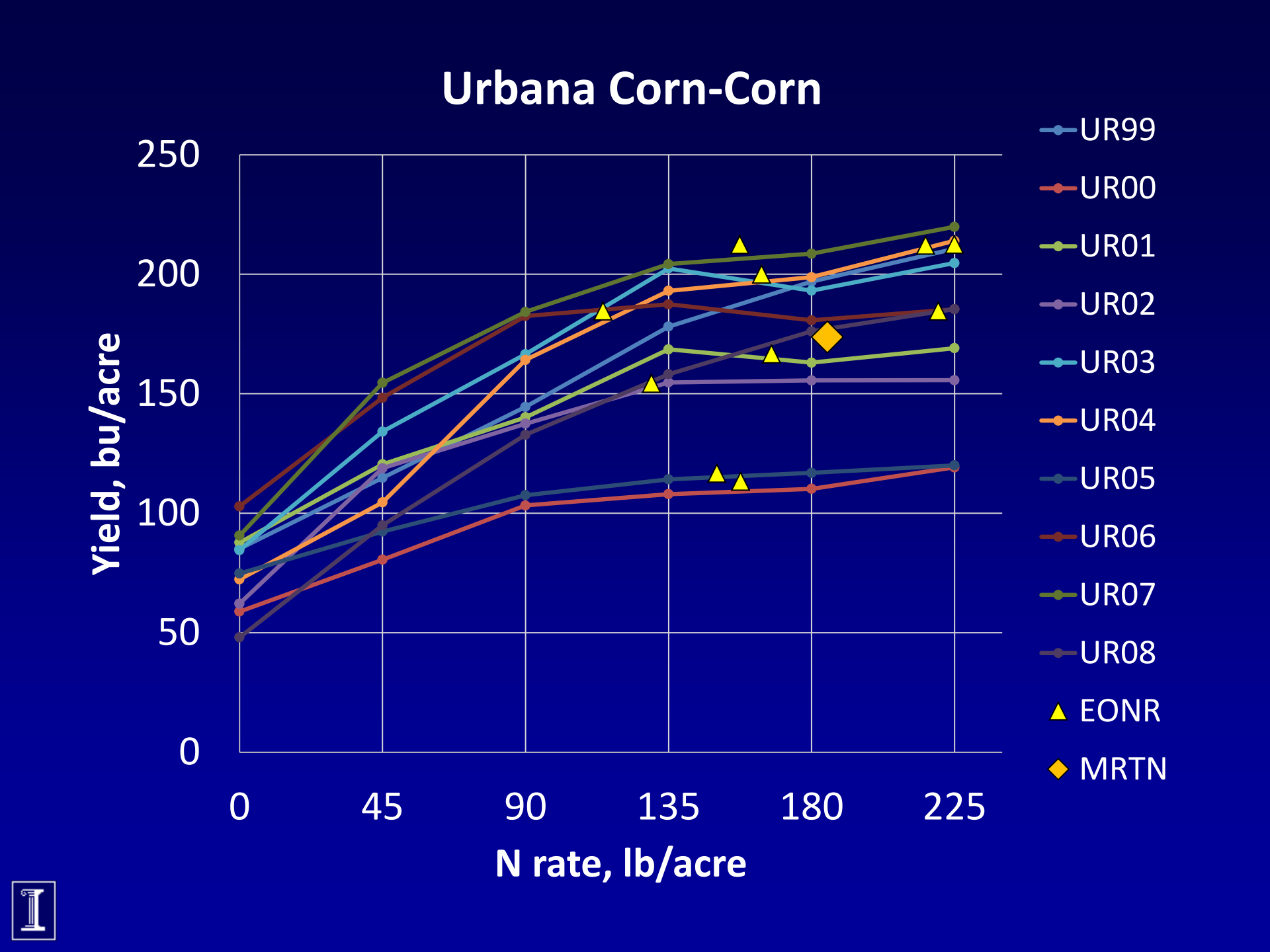
- We have 10 years of N response data (1999-2008) from 7 fields in Illinois
  - 6 N rates from 0 to 225 lb N/acre in 45-lb increments
  - Corn following corn (N rates stay in plots each year)
  - Corn following soybean (N rates in same plots in alternating years)

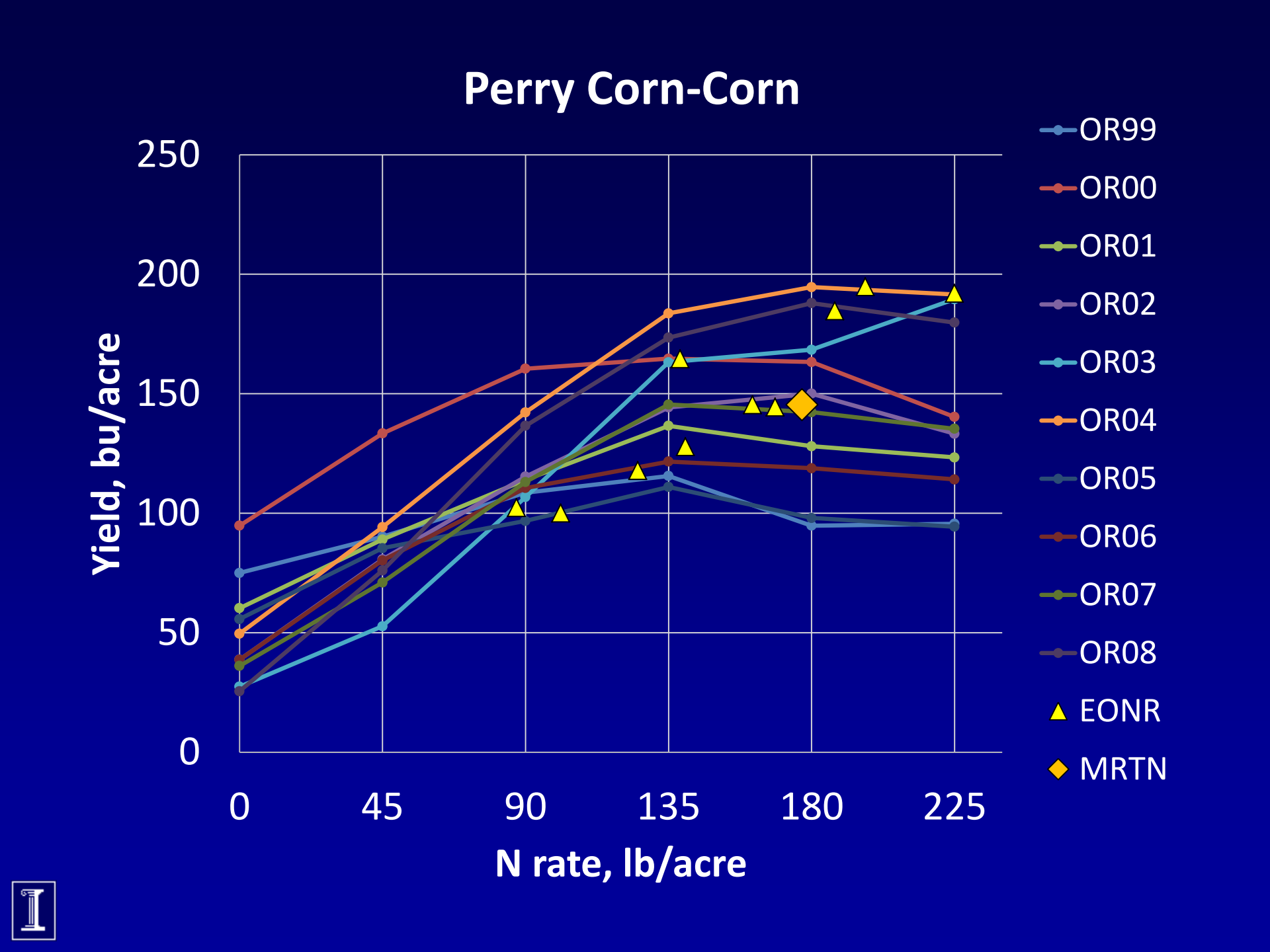
# Calculations

- Fit a response curve to each set of data: of 80 responses, 76 are fit by Q+P; 4 by Q
- EONR and yield at EONR for each trial
- MRTN using the 10 years of data for each site (4) x rotation (2)
- MRTN by rotation across all sites (40 x 2)
- Return to N = (yield at EONR or MRTN – yield with no N) x $4.25/bu – EONR x $0.425/lb N

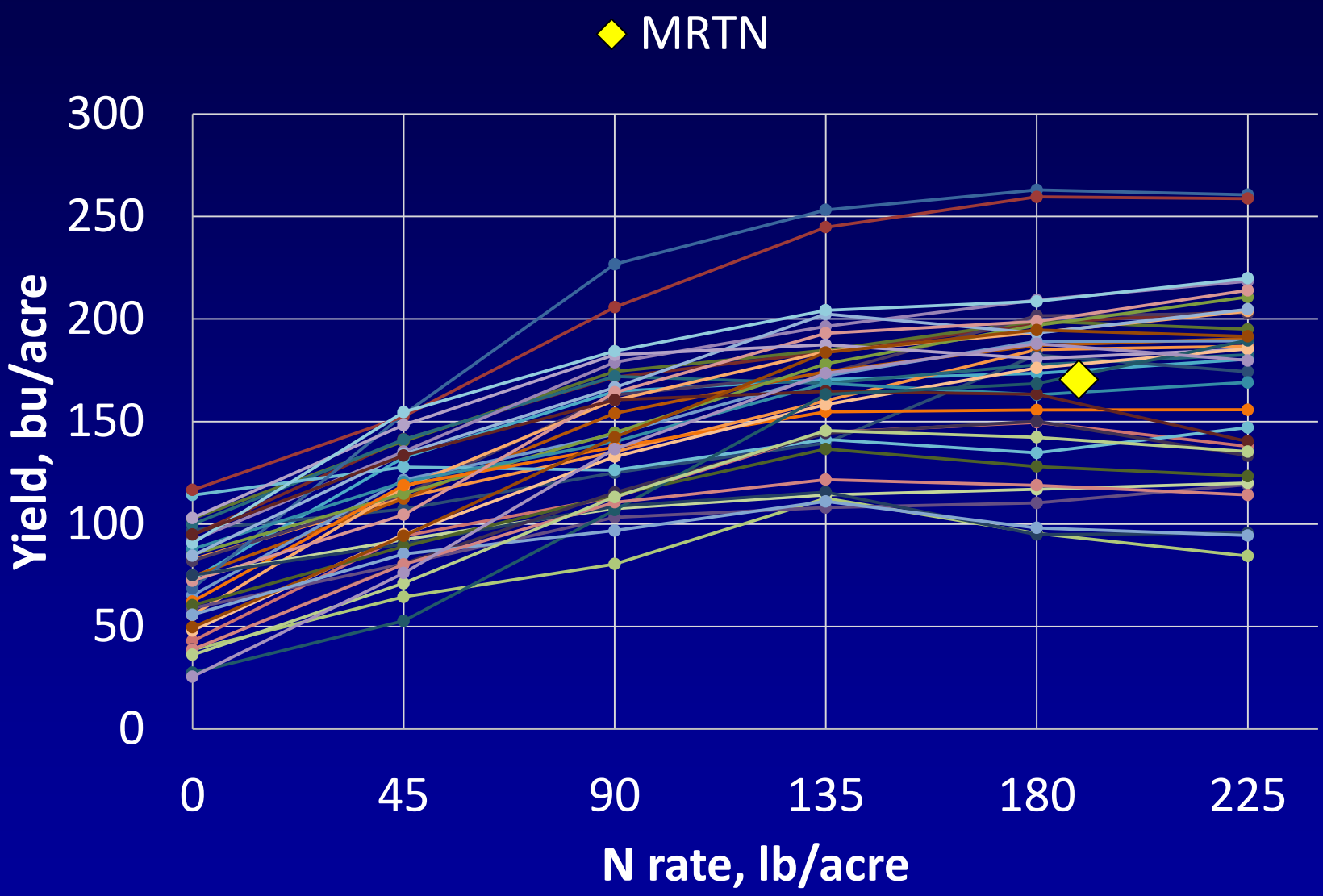

DeKalb Corn-Corn
Yield, bu/acre
250
200
150
100
50
0
0
45
90
135
180
225
N rate, lb/acre
DK99
DK00
DK01
DK02
DK03
DK04
DK05
DK06
DK07
DK08
EONR
MRTN

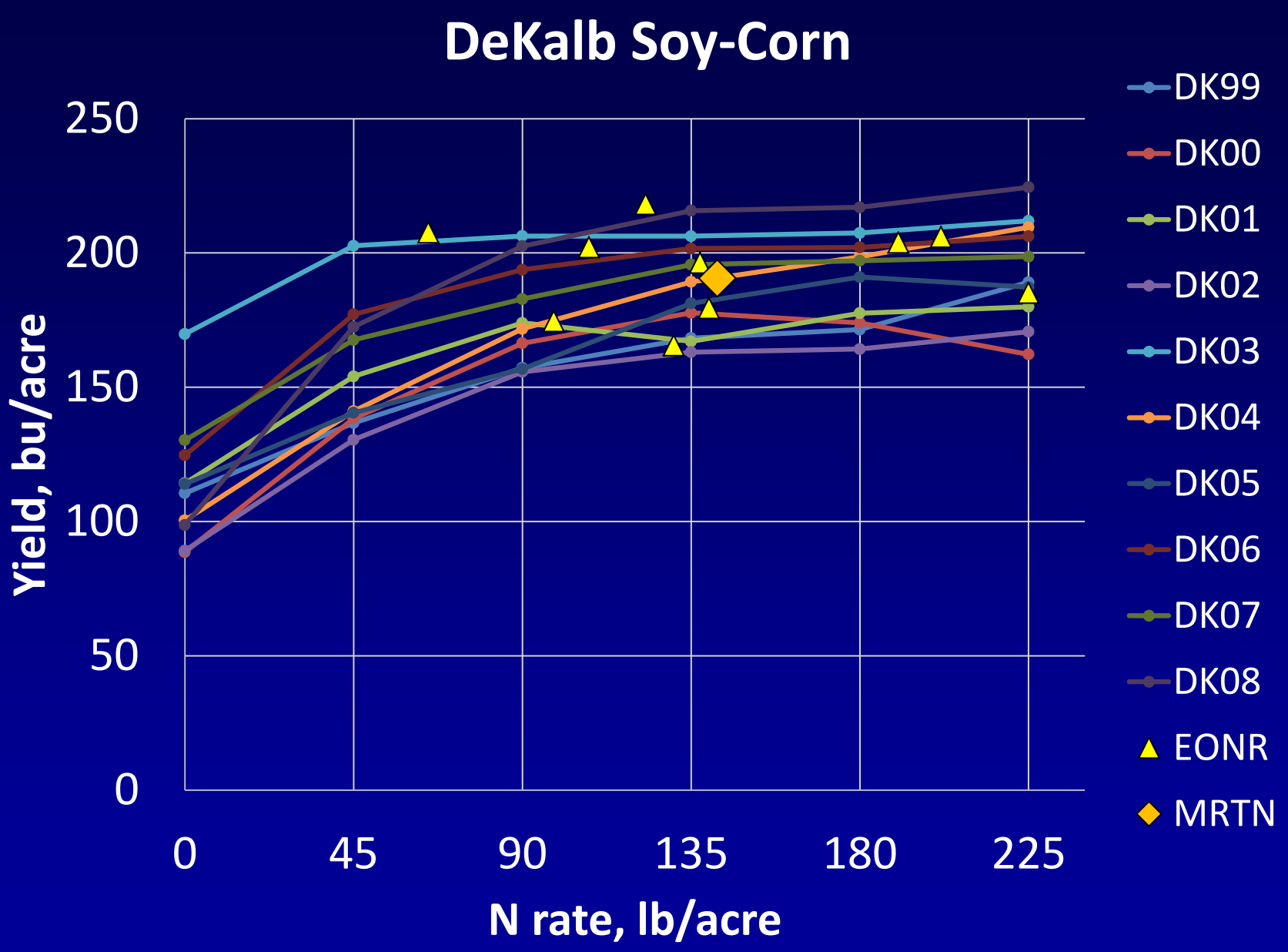

Monmouth Corn-Corn
300
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre
MN99
MN00
MN01
MN02
MN03
MN04
MN05
MN06
MN07
MN08
EONR
MRTN

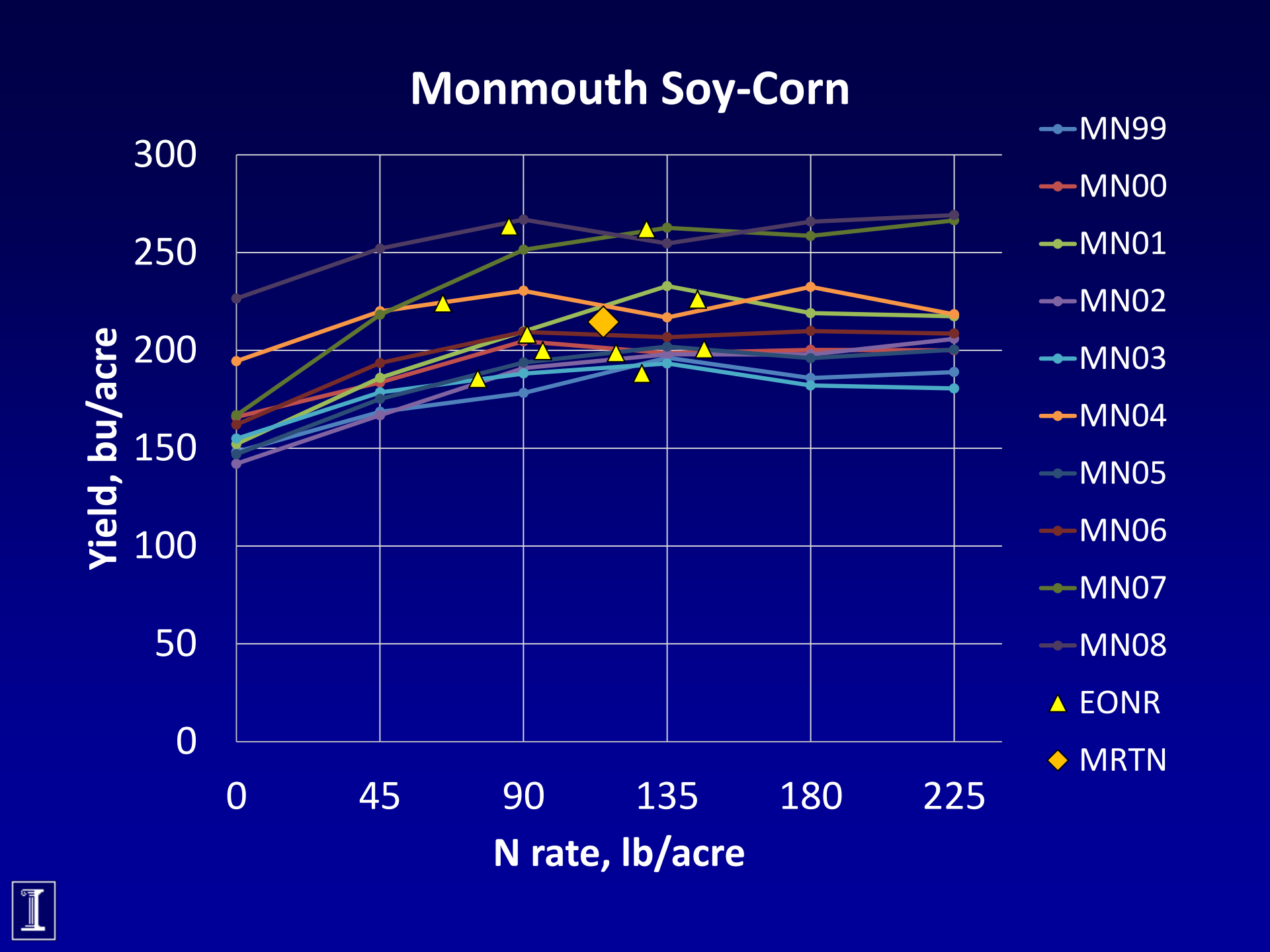

Urbana Corn-Corn
Yield, bu/acre
250
200
150
100
50
0
0
45
90
135
180
225
N rate, lb/acre
UR99
UR00
UR01
UR02
UR03
UR04
UR05
UR06
UR07
UR08
EONR
MRTN

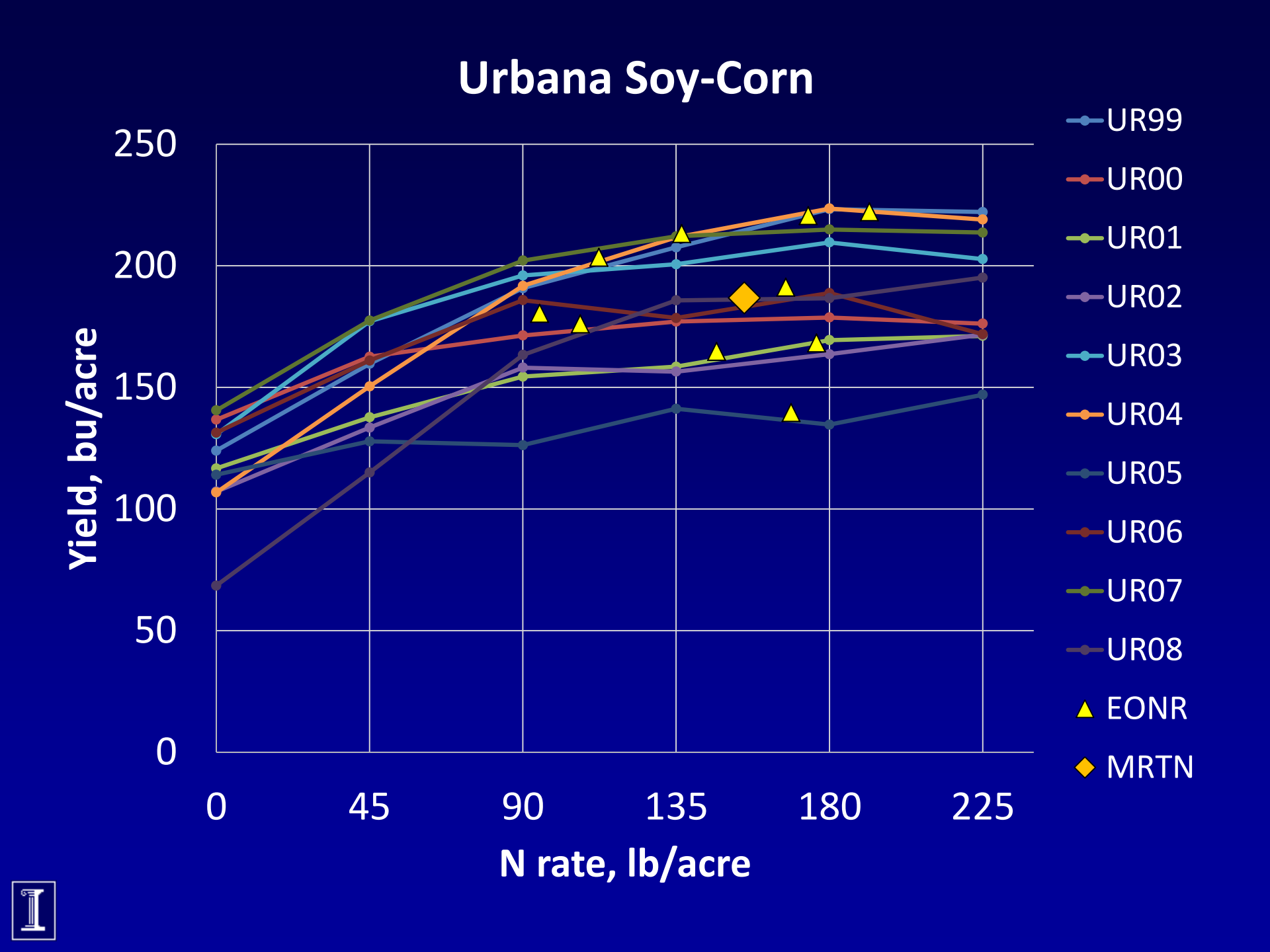

Perry Corn-Corn
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre
OR99
OR00
OR01
OR02
OR03
OR04
OR05
OR06
OR07
OR08
EONR
MRTN

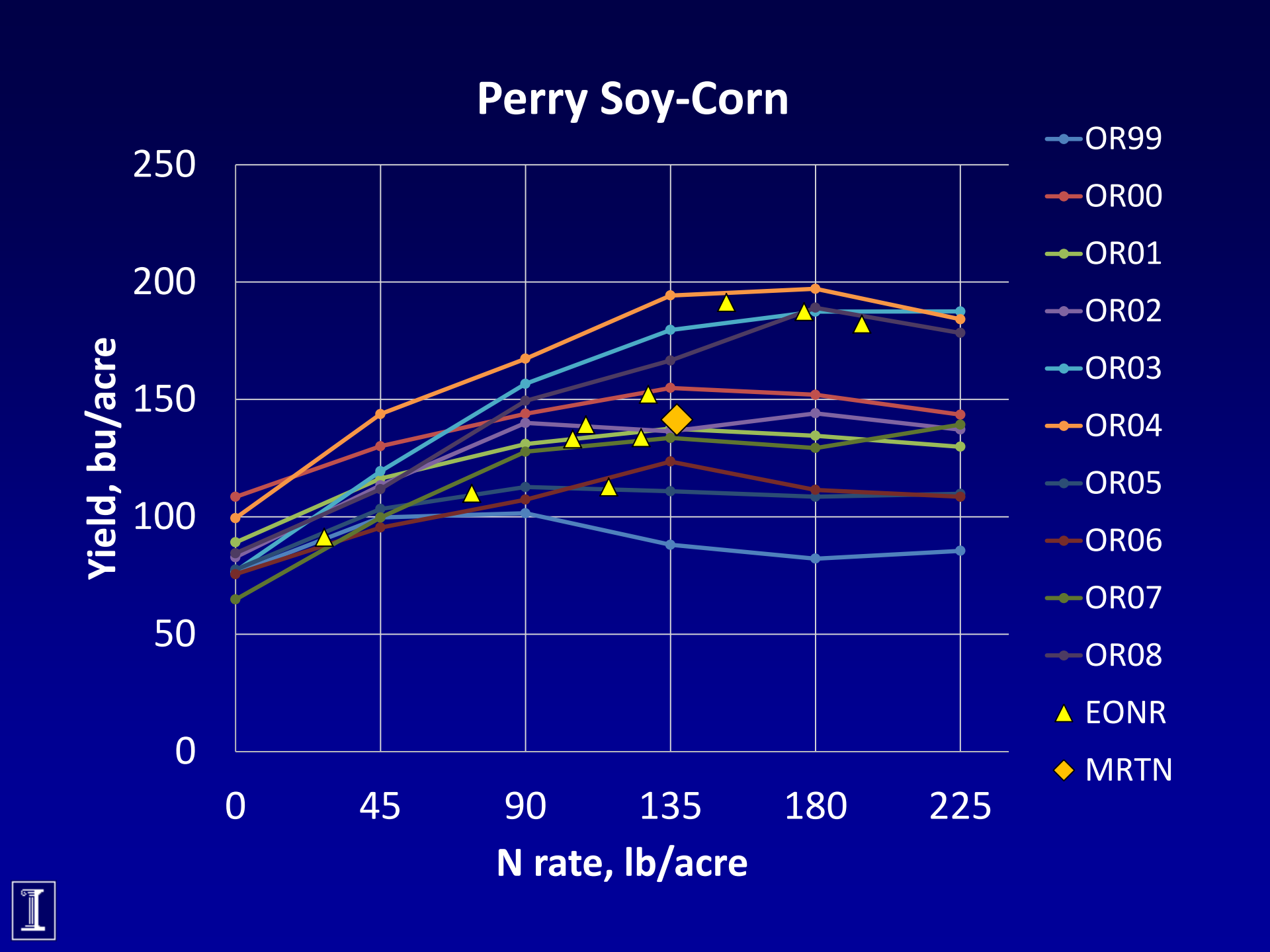
# All Corn-Corn



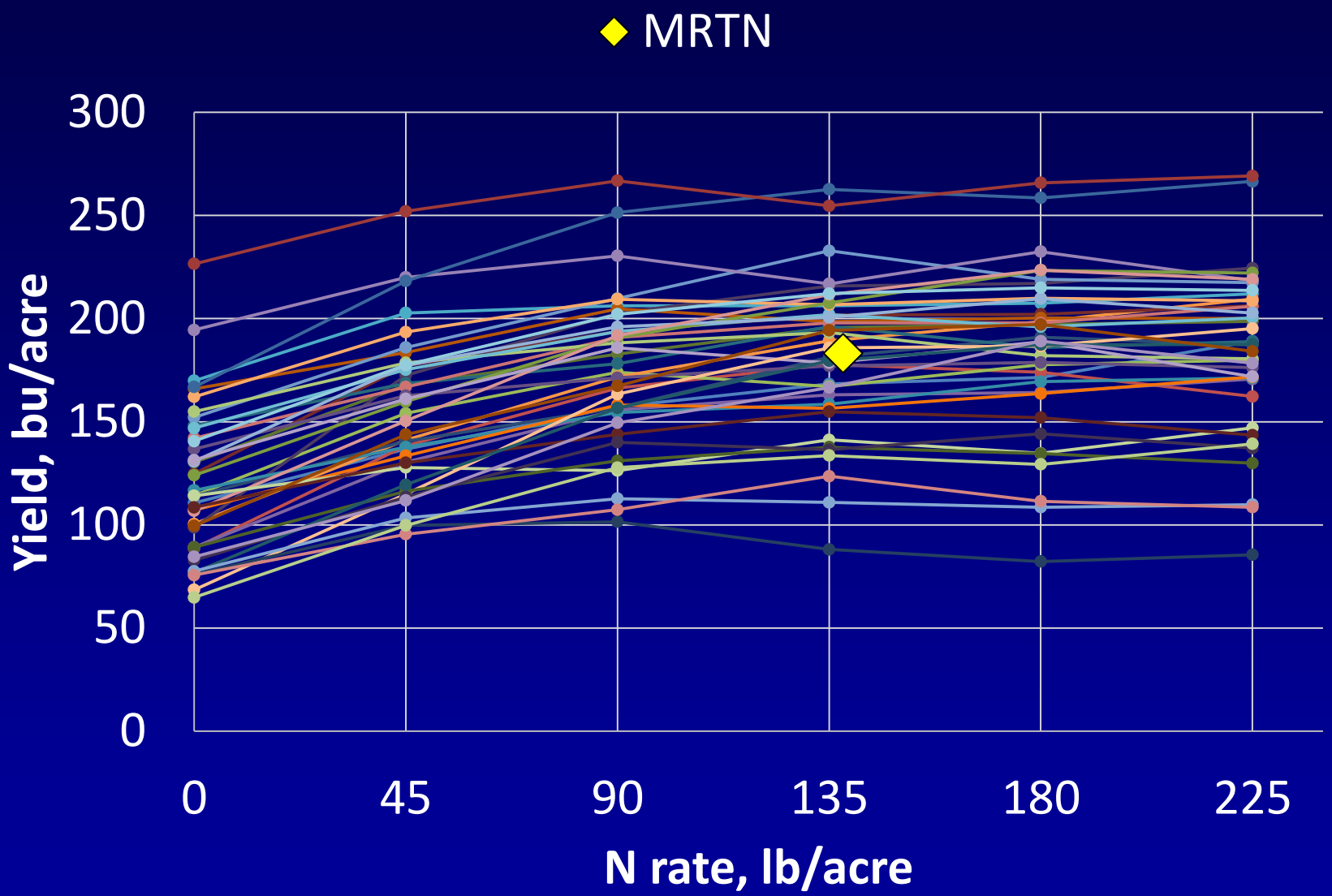

DeKalb Soy-Corn
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre
DK99
DK00
DK01
DK02
DK03
DK04
DK05
DK06
DK07
DK08
EONR
MRTN


Monmouth Soy-Corn
300
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre
MN99
MN00
MN01
MN02
MN03
MN04
MN05
MN06
MN07
MN08
EONR
MRTN


Urbana Soy-Corn
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre
UR99
UR00
UR01
UR02
UR03
UR04
UR05
UR06
UR07
UR08
EONR
MRTN


Perry Soy-Corn
Yield, bu/acre
250
200
150
100
50
0
0
45
90
135
180
225
N rate, lb/acre
OR99
OR00
OR01
OR02
OR03
OR04
OR05
OR06
OR07
OR08
EONR
MRTN

# All Soy-Corn


MRTN
300
250
200
150
100
50
0
Yield, bu/acre
0
45
90
135
180
225
N rate, lb/acre

# VRN v URN: assumptions/conditions

- The MRTN for a site is the best estimate of N rate at that site
- For VRN, imagine a field made up of equal areas of the four “sites” representing different N responses; use the site MRTN as the best rate for that part of the field
- Use the overall MRTN (40 site-years for each rotation) as the uniform rate (URN) for the whoel field
- Compare N rate, yield, and RTN from using VRN and URN in this “field”

# Corn-corn

| Site | MRTN | Yield at MRTN | RTN at MRTN |
|---|---|---|---|
| | lb N/acre | bu/acre | $/acre |
| DK | 219 | 179.4 | $337.40 |
| MN | 180 | 185.3 | $400.92 |
| UR | 185 | 173.8 | $336.16 |
| PR | 177 | 145.5 | $340.59 |
| Average (=VRN) | 190 | 171.0 | $353.77 |
| All data (=URN) | 189 | 170.6 | $352.45 |
| VRN - URN | 1.3 | 0.4 | $1.32 |

# Soy-corn

| Site | MRTN | Yield at MRTN | RTN at MRTN |
|---|---|---|---|
| | lb N/acre | bu/acre | $/acre |
| DK | 142 | 190.6 | $251.32 |
| MN | 115 | 214.6 | $158.86 |
| UR | 155 | 186.9 | $228.18 |
| PR | 137 | 141.5 | $191.10 |
| Average (="VRN") | 137 | 183.4 | $207.36 |
| All data (="URN") | 138 | 183.2 | $206.07 |
| VRN - URN | -0.8 | 0.2 | $1.29 |

# What if we could know exact EONRs?
## - we'll call this "Super-VRN"

| | MRTN/Opt | Yield at MRTN/Opt | RTN |
|---|---|---|---|
| **Corn-corn** | lb N/acre | bu/acre | $/acre |
| MRTN-URN | 189 | 170.6 | $352.45 |
| Super-VRN | 173 | 172.2 | $366.40 |
| SuVRN - URN | -16 | 14.8 | $13.95 |
| | | | |
| **Soy-corn** | | | |
| MRTN-URN | 138 | 183.2 | $206.07 |
| Super-VRN | 130 | 185.3 | $218.75 |
| SuVRN - URN | -8 | 2.1 | $12.68 |

# VRN based on response data

- N responses within the same site ("part" of a field) vary a lot over years, in ways that aren't obviously predictable
  - There is little correlation between yield level and N rate across years within (or across) sites
- VRN based on 10-year MRTN values increases RTN only slightly compared to uniform N rate
- Perfect foreknowledge of EONR and yield by site produces only modest ($10-15/acre) increases in RTN
- Return to VRN might be greater in more variable fields, but only if N responses can be predicted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