Managing Soil Fertility in Strip-Till Fields for Corn & Soybean Production

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2024 AGVISE Soil Fertility Seminar

UNIVERSITY OF MINNESOTA
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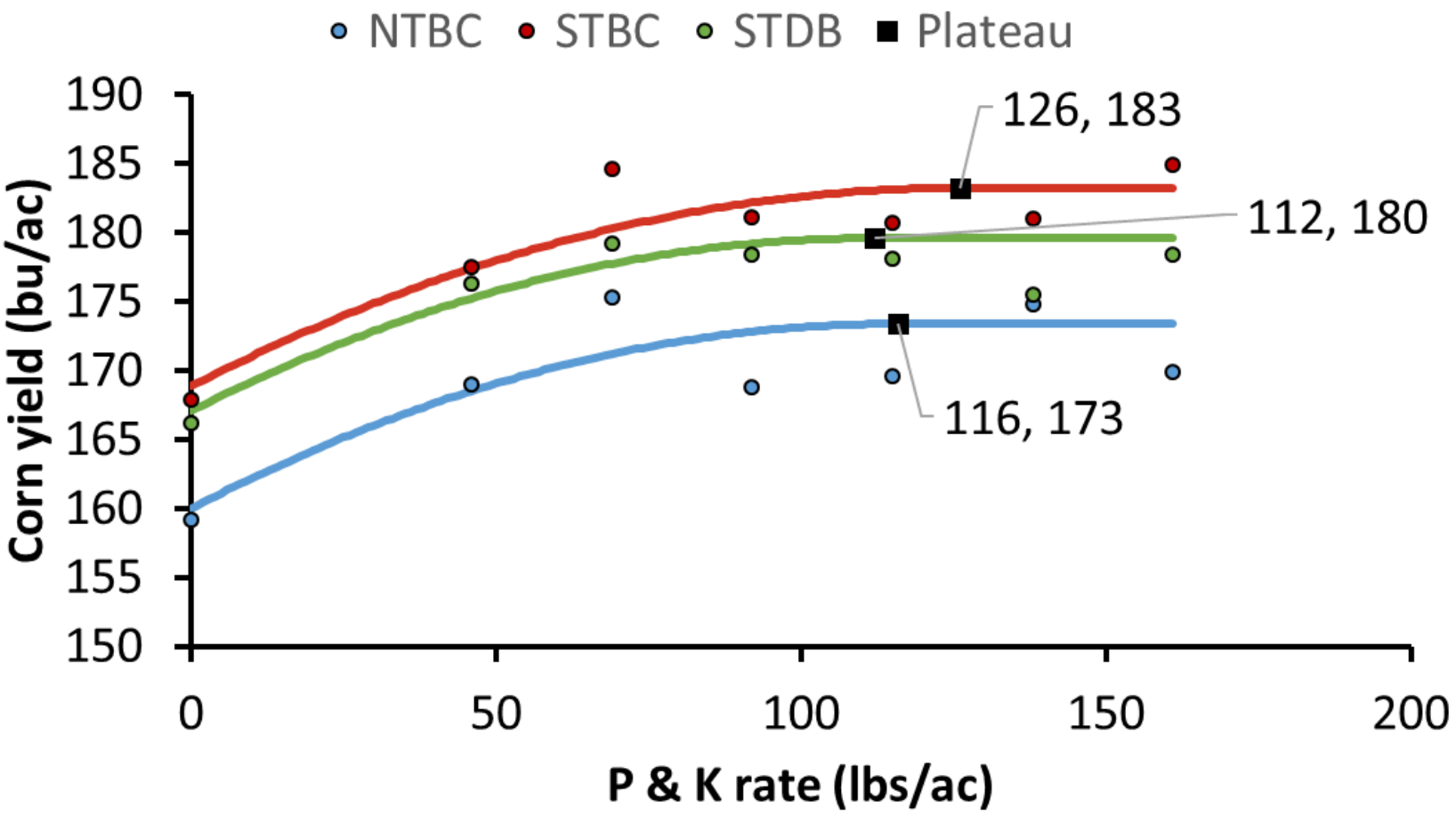
Overview

- Agronomically, is subsurface banding better than broadcast, or can I reduce P and K applications with banding?
  - Where are the active roots?
  - Where is the water?

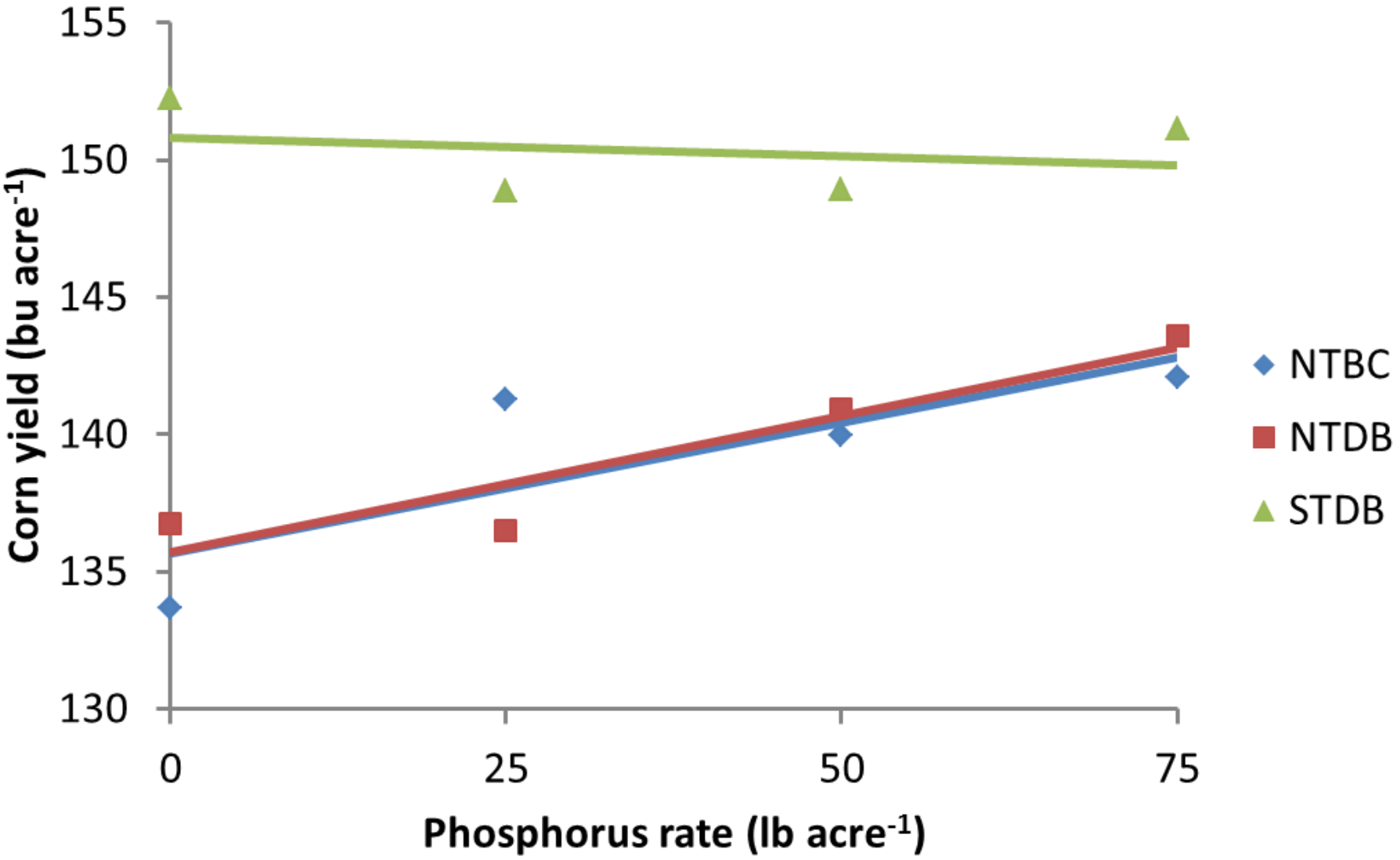
  } Nutrient availability (uptake)

- How does tillage/placement and P and K rates impact soil test values?
- Are there environmental benefits to subsurface banding P?
- How to take a soil sample when P & K are banded?
- Soil drainage, tillage, and nitrogen

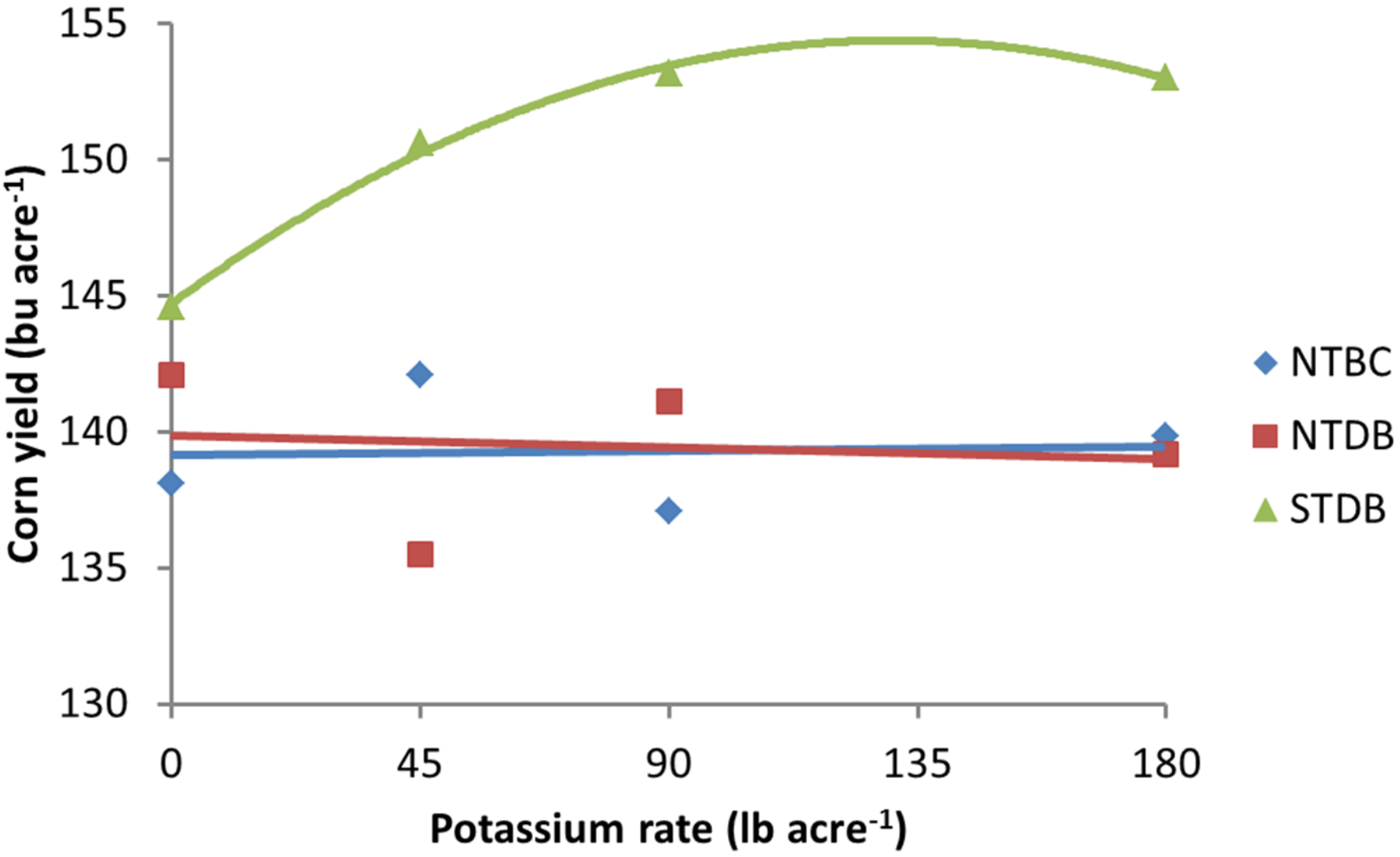
12 site-yr, Corn Yield



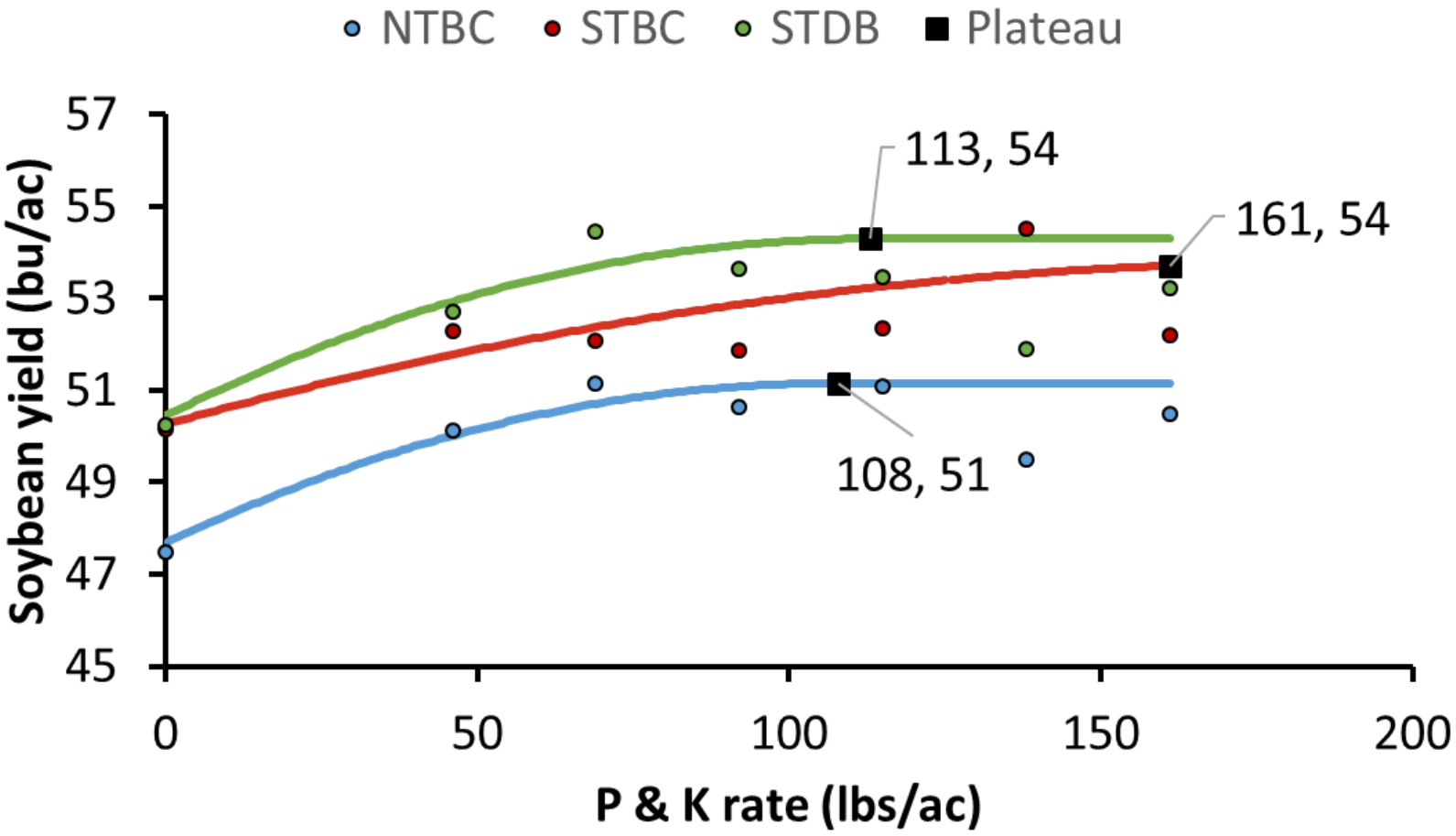
3 yr, Tillage/Placement x P



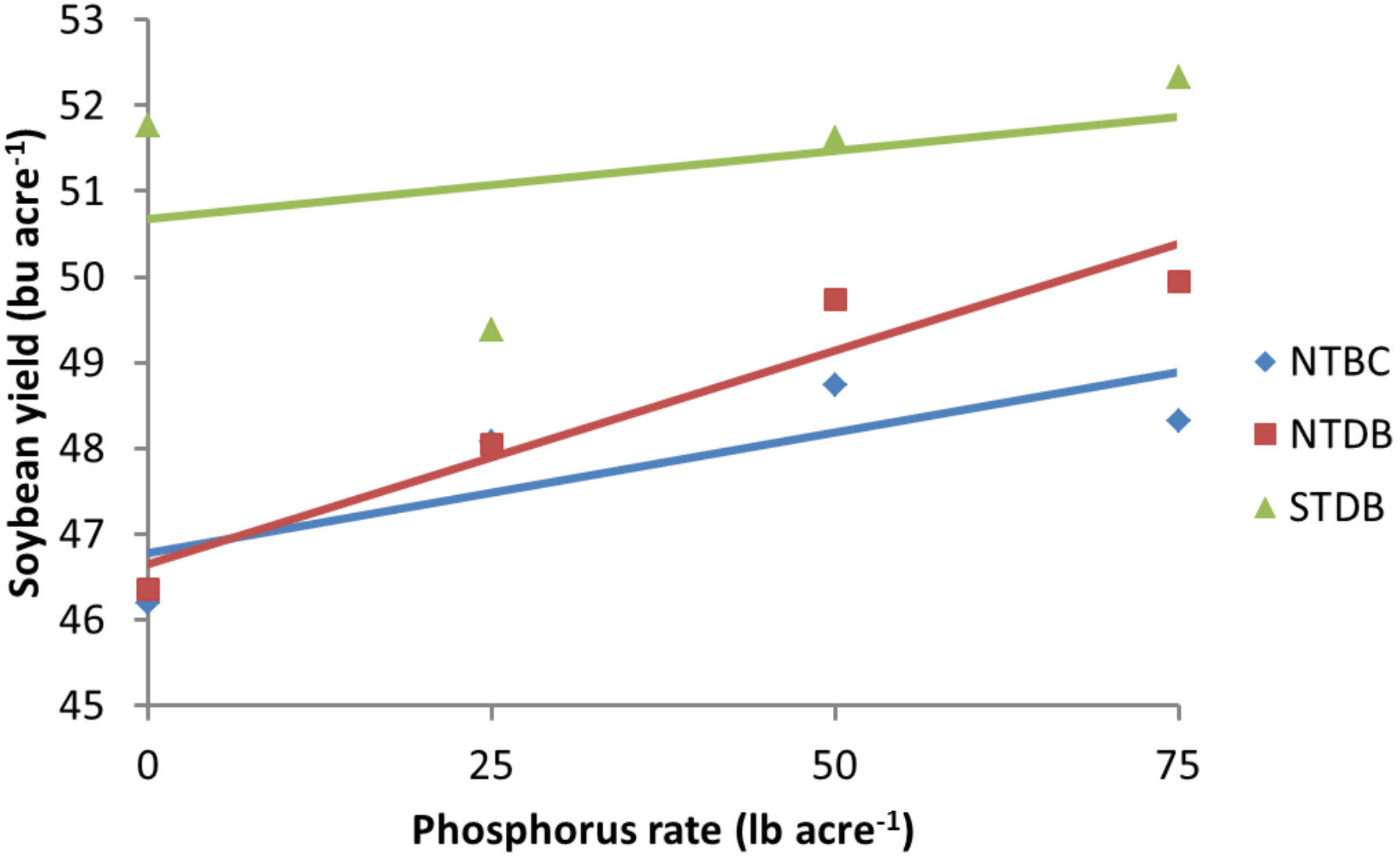
3 yr, Tillage/Placement x K



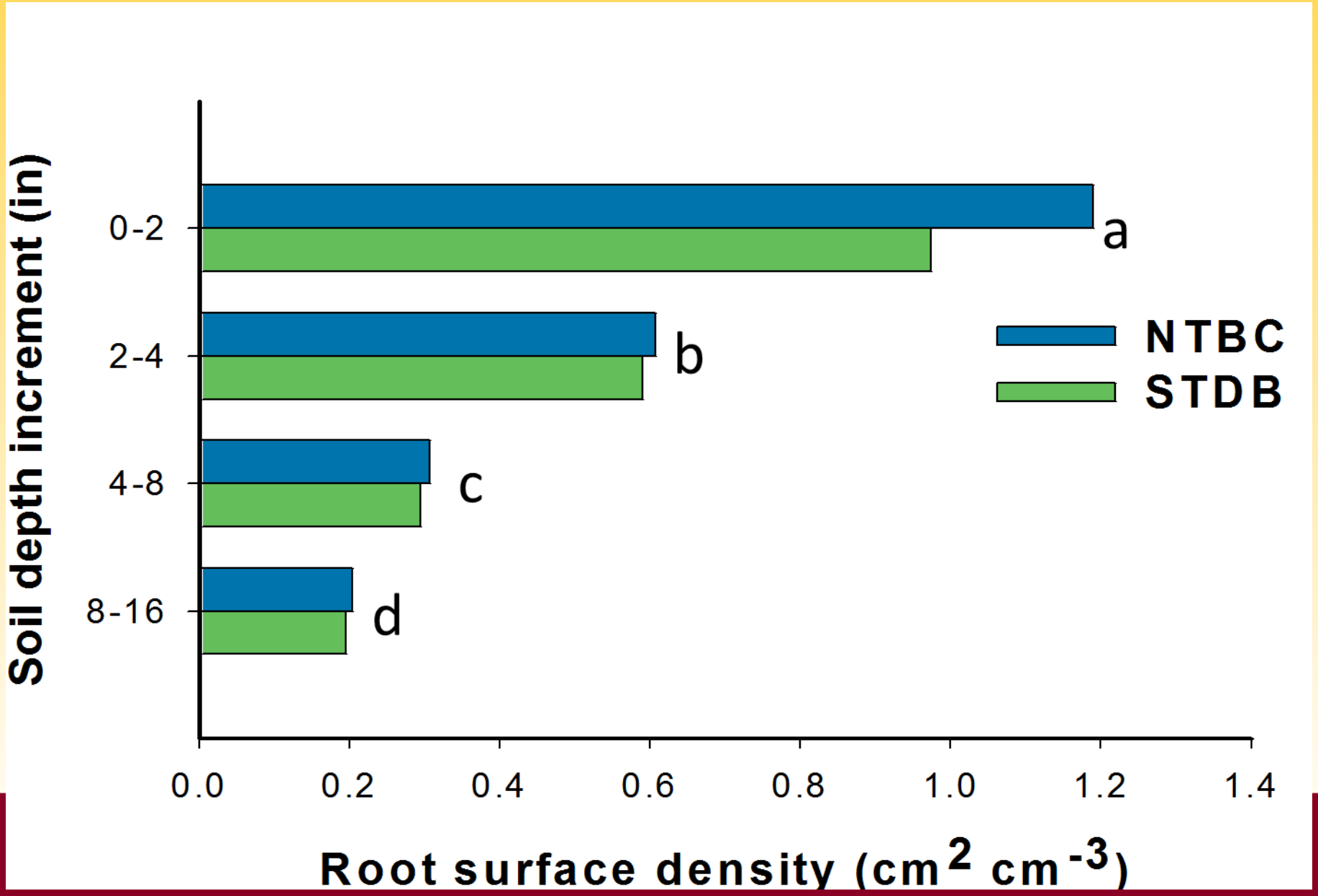
12 site-yr, Soybean Yield



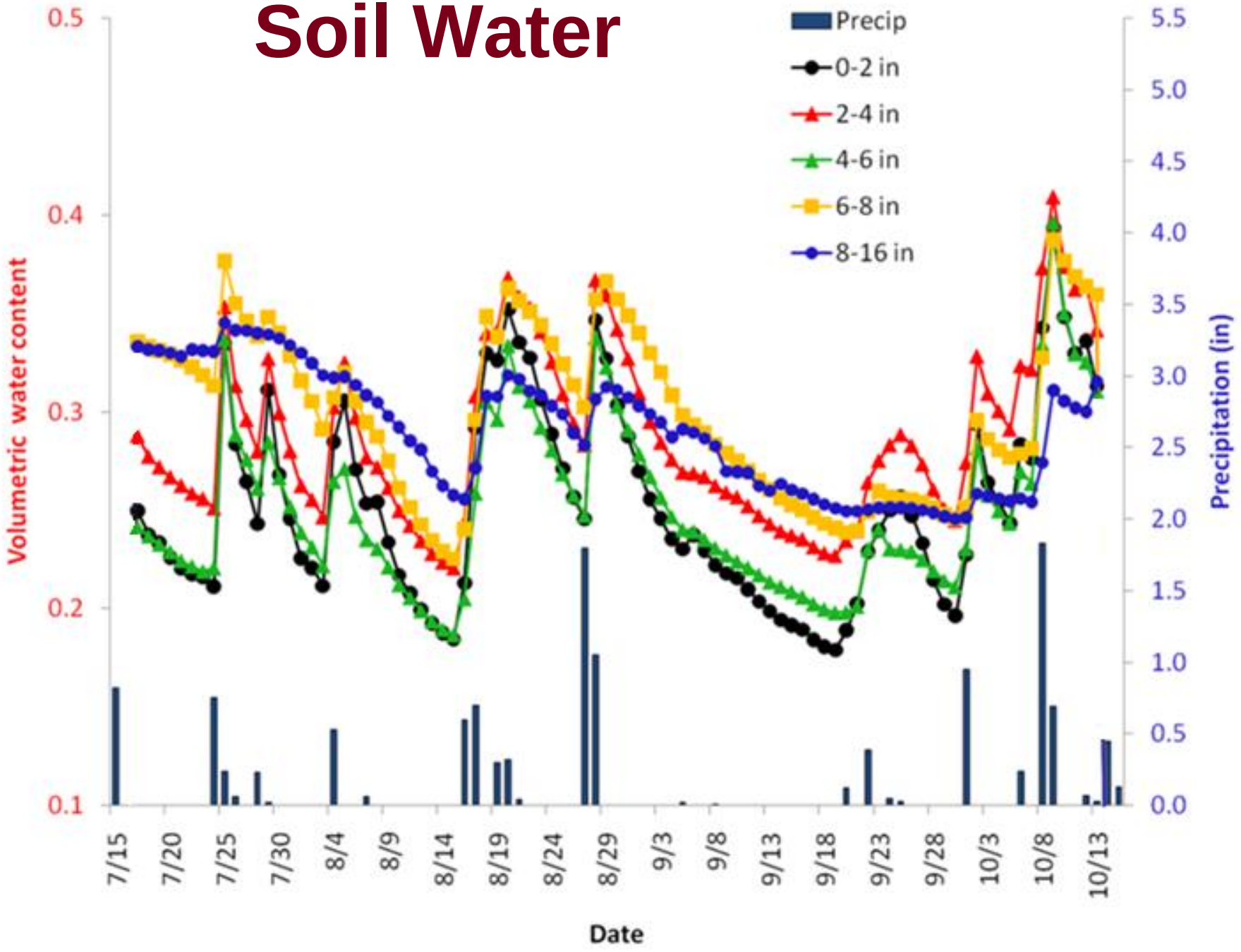
3 yr, Tillage/Placement x P



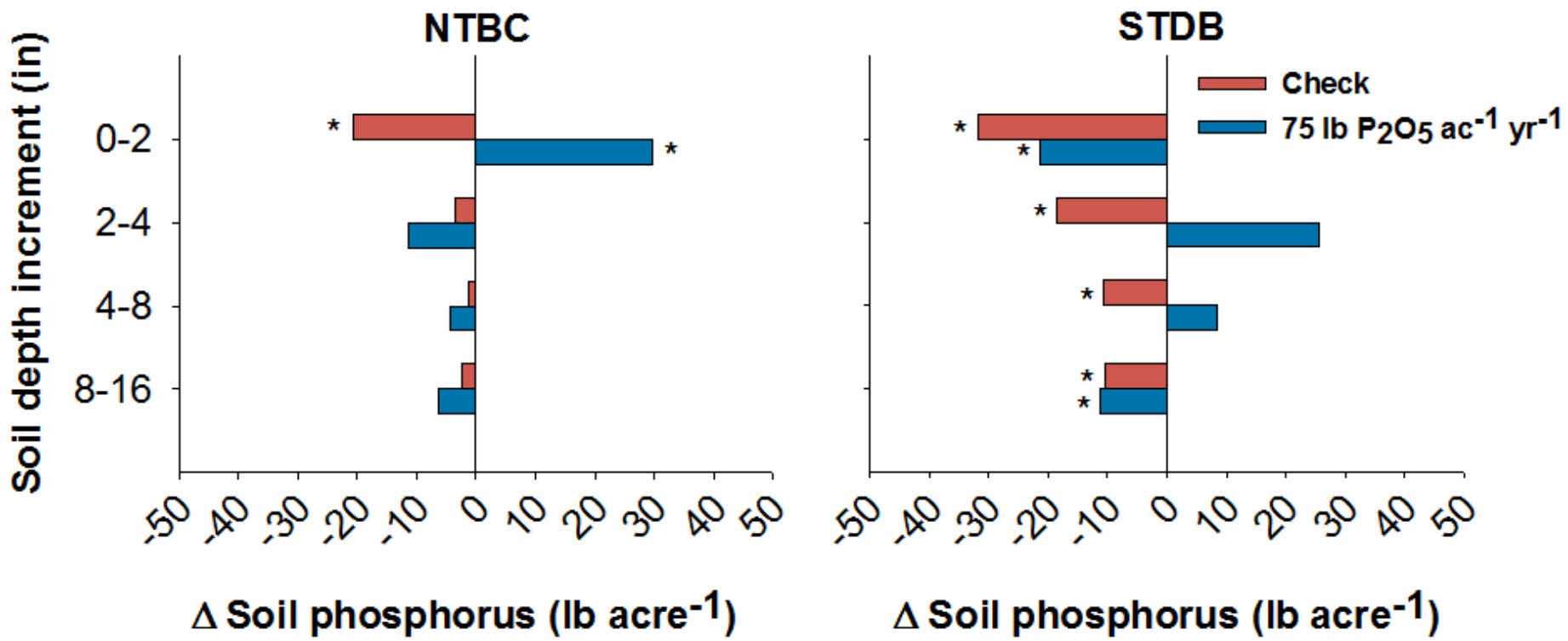
Roots Not Impacted by Nutrient Placement



Soil Water

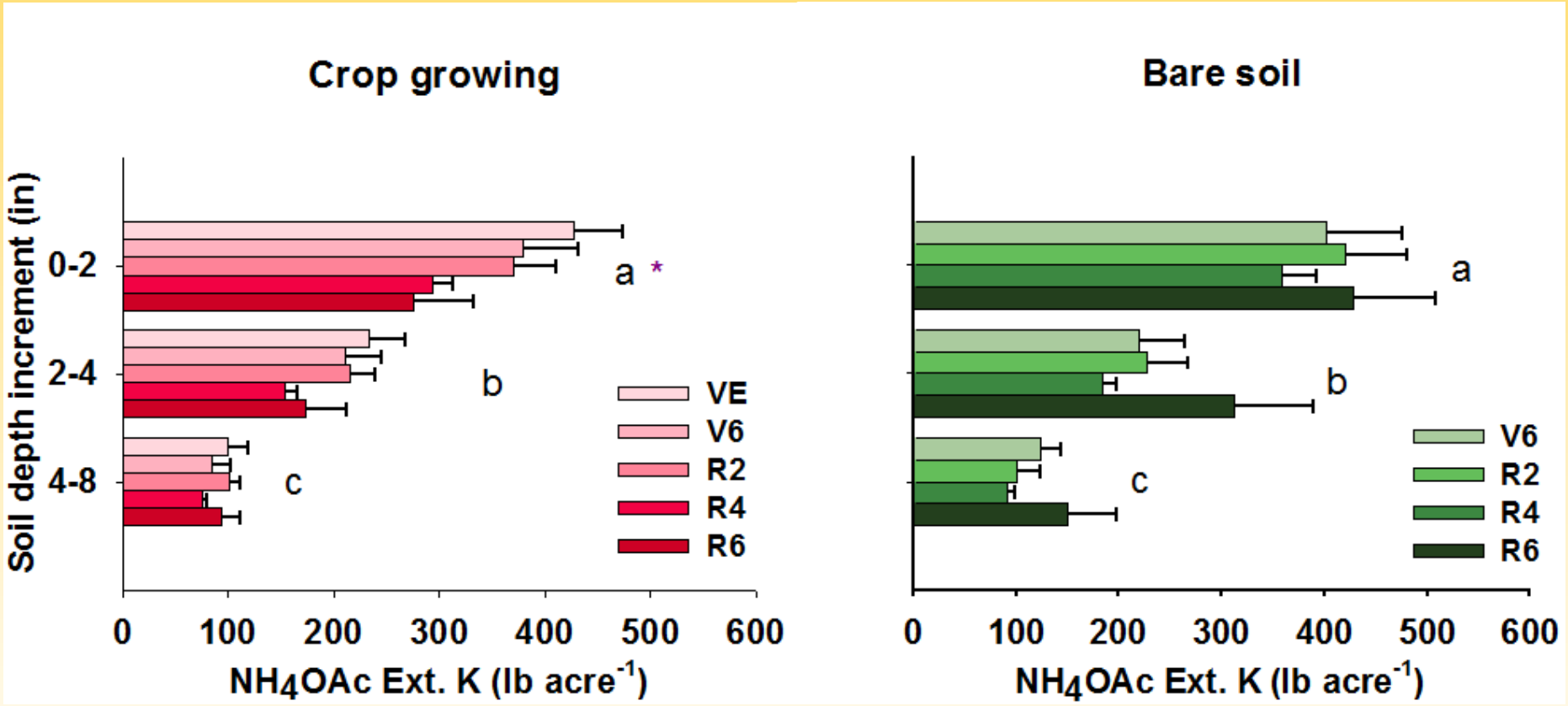

Precip
0-2 in
2-4 in
4-6 in
6-8 in
8-16 in
Volumetric water content
Precipitation (in)
0.5
0.4
0.3
0.2
0.1
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
7/15
7/20
7/25
7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8
9/13
9/18
9/23
9/28
10/3
10/8
10/13
Date

Placement Has Little to Do With Where Roots Take Up Nutrients

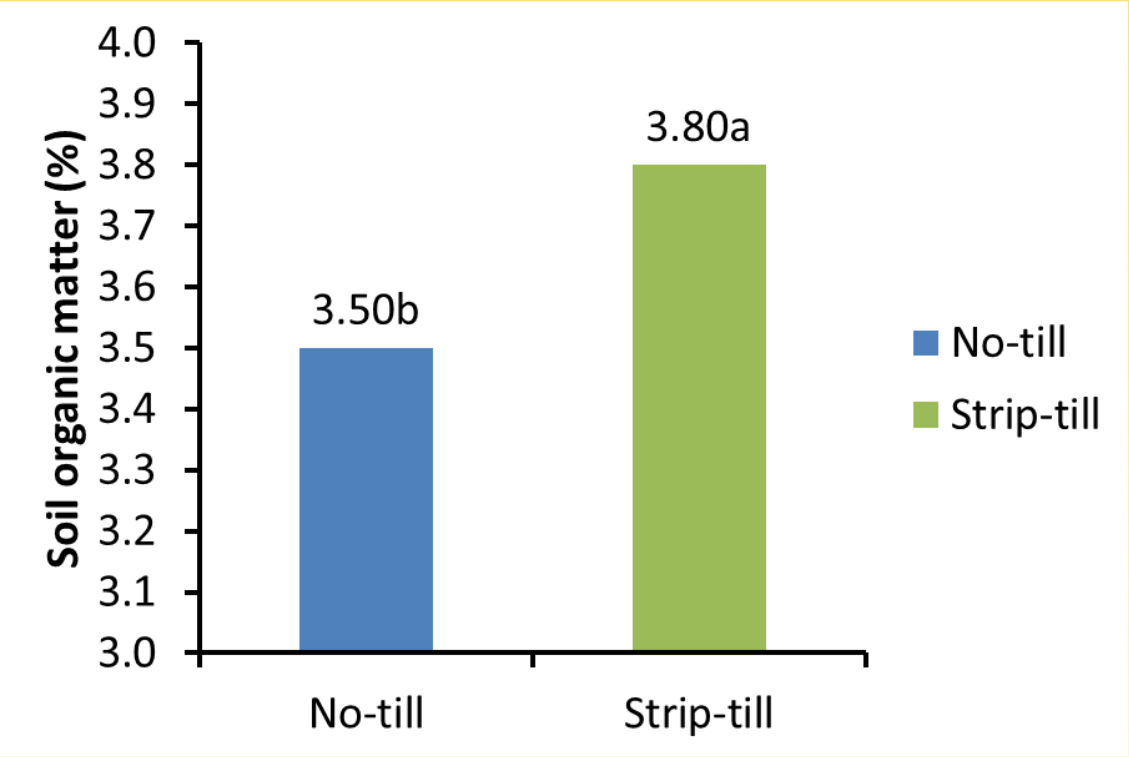


Change in soil test P over a three-year period
Averaged across IR BR at R1 development stage
* indicate $P \leq 0.1$

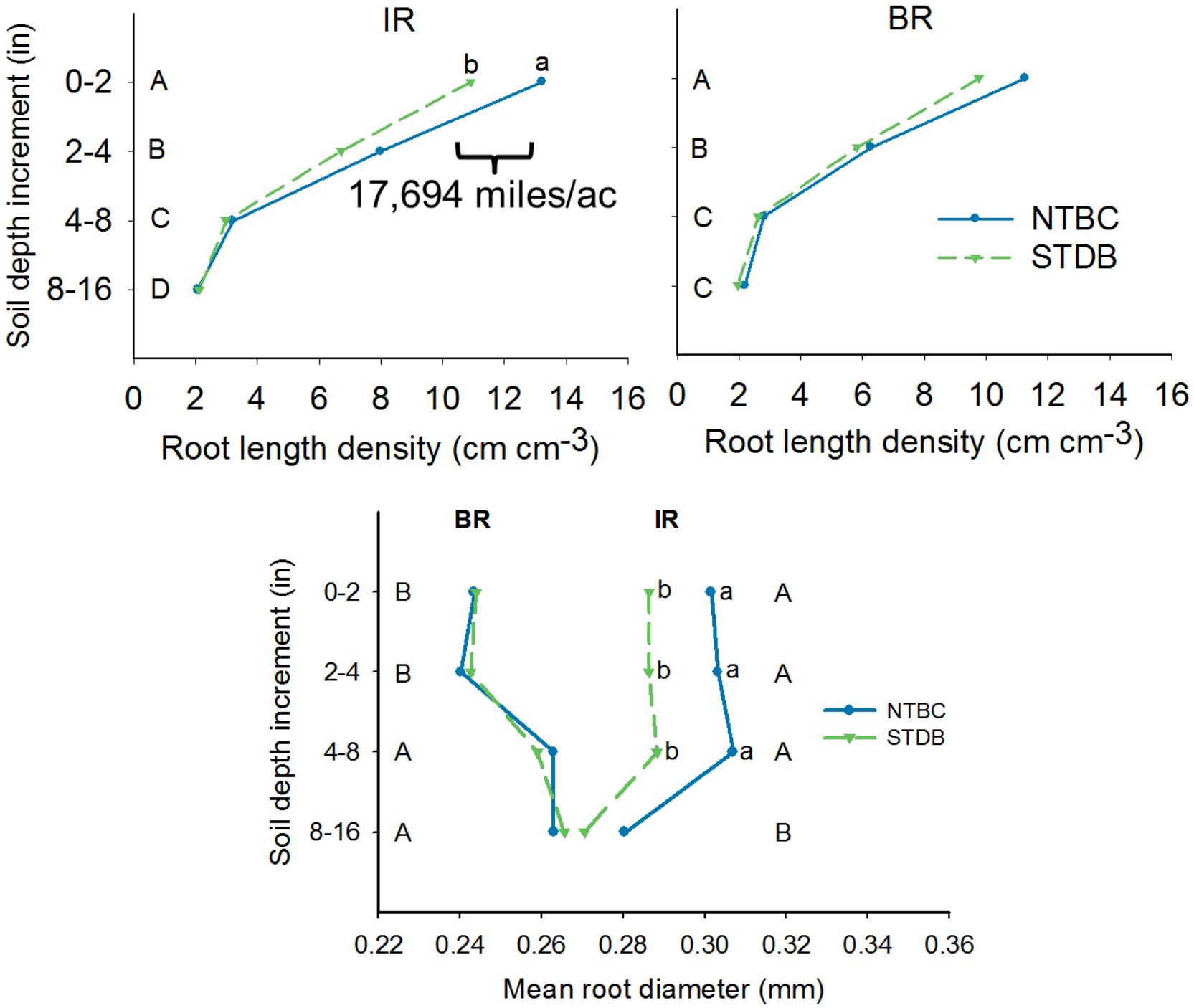
Changes in Soil Test Levels are Related to Crop Uptake (no-till field)



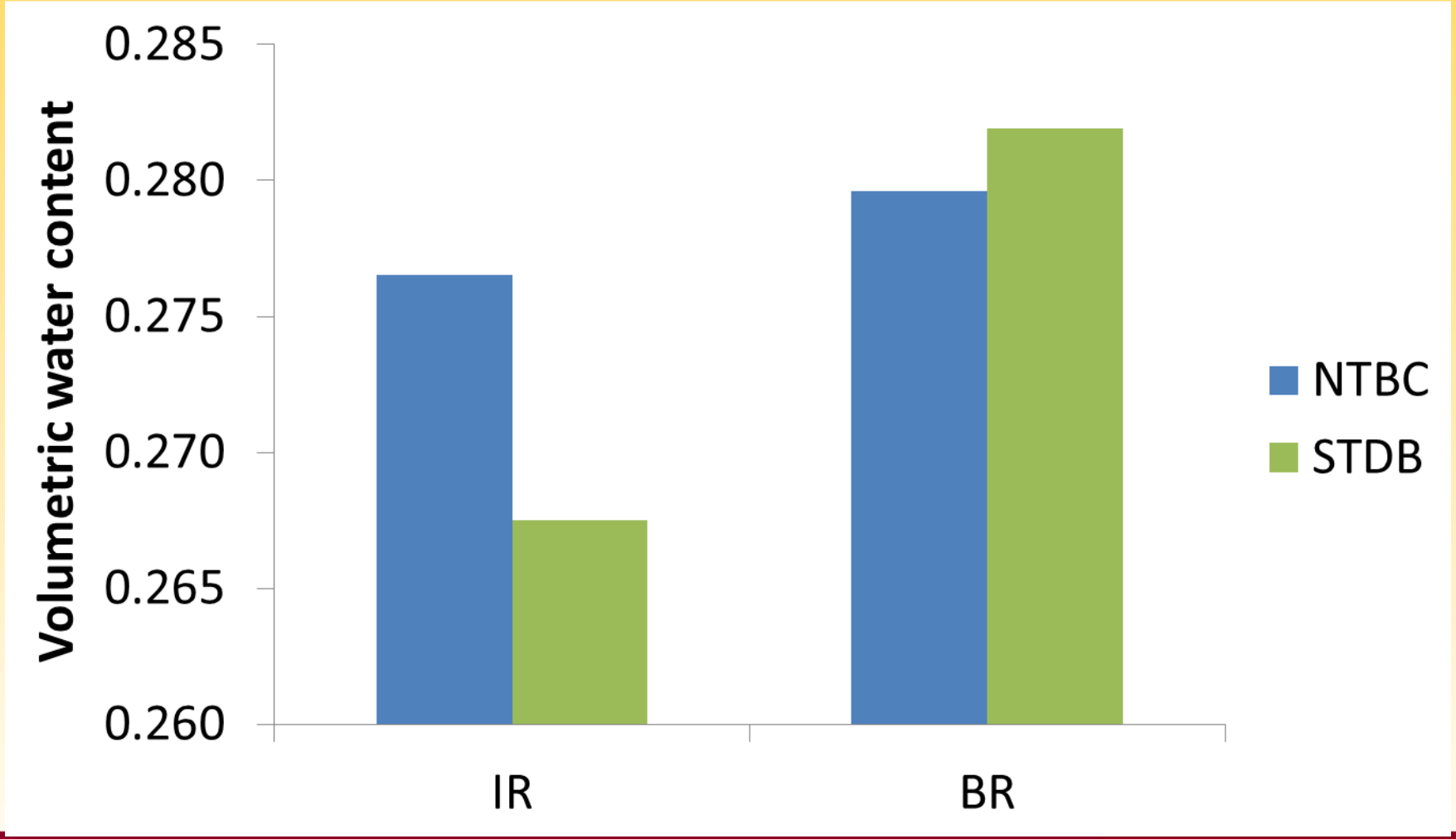
Soil Physical Properties



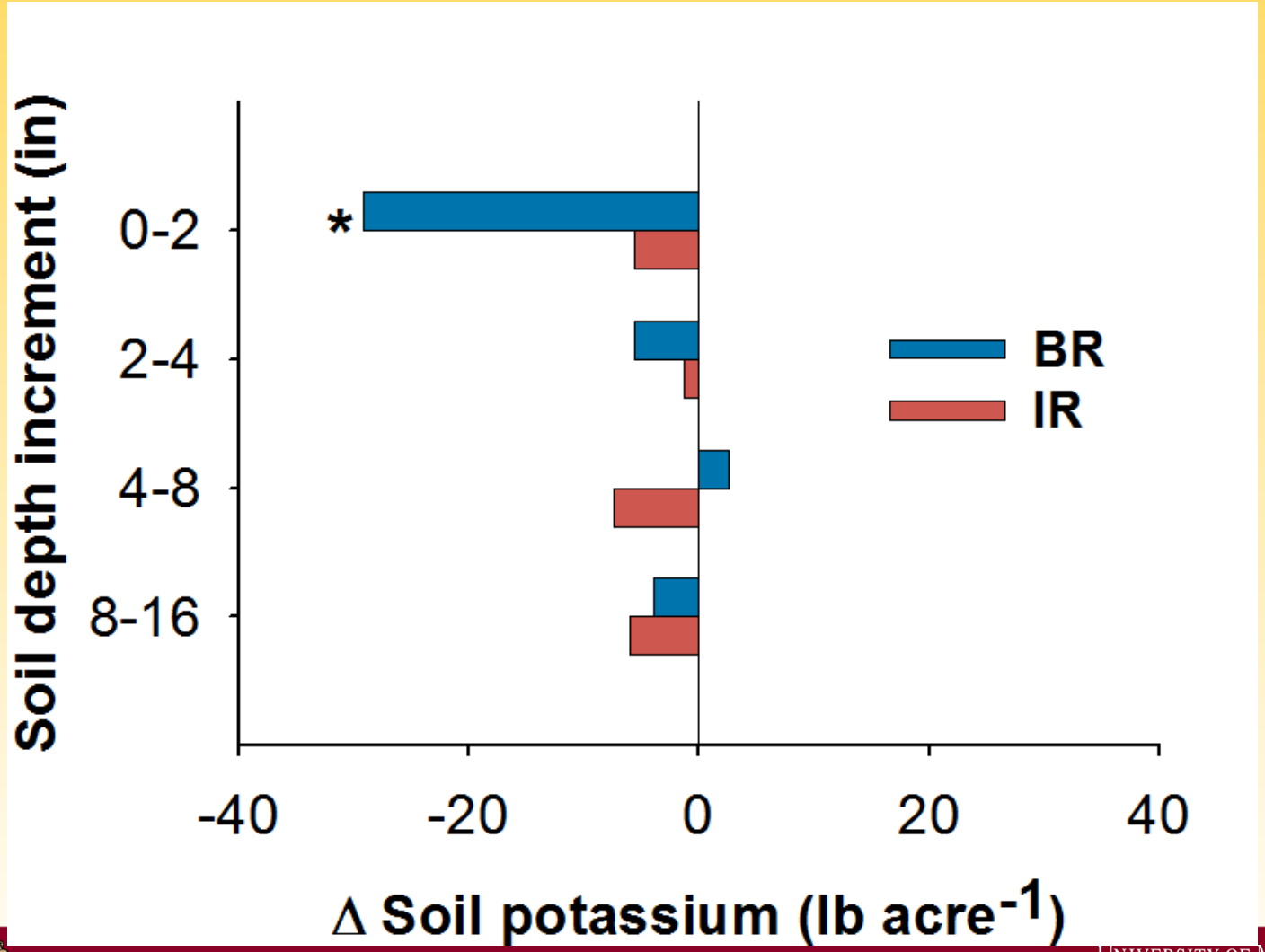
Strip-till also improved soil water, bulk density, and root penetration resistance


IR
BR
Soil depth increment (in)
0-2
2-4
4-8
8-16
A
B
C
D
b
a
17,694 miles/ac
NTBC
STDB
0 2 4 6 8 10 12 14 16
Root length density (cm cm-3)
BR
IR
0.22 0.24 0.26 0.28 0.30 0.32 0.34 0.36
Mean root diameter (mm)

Soil-Water Content With Respect to the Crop-Row (season average, top 16 in)

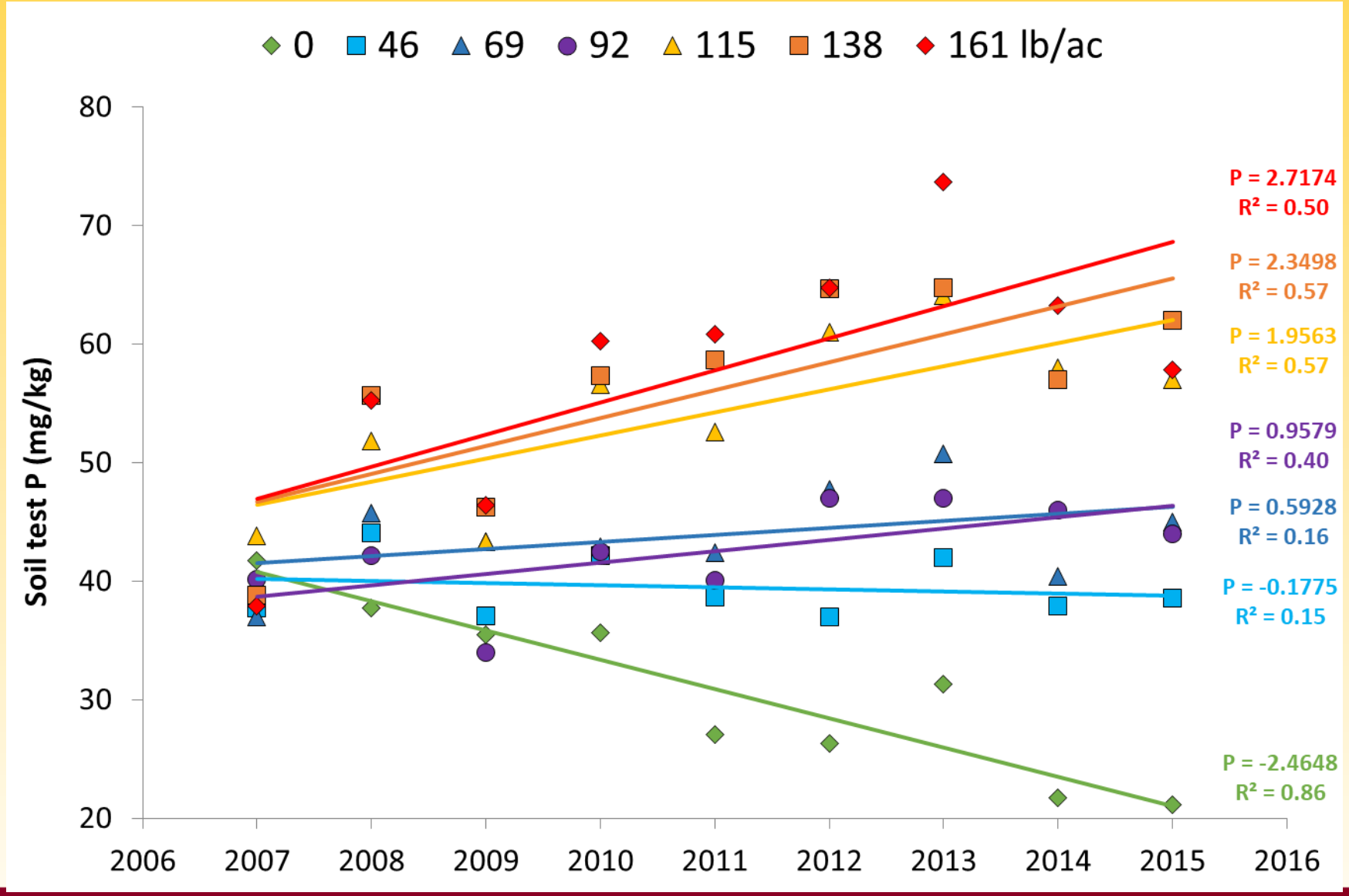


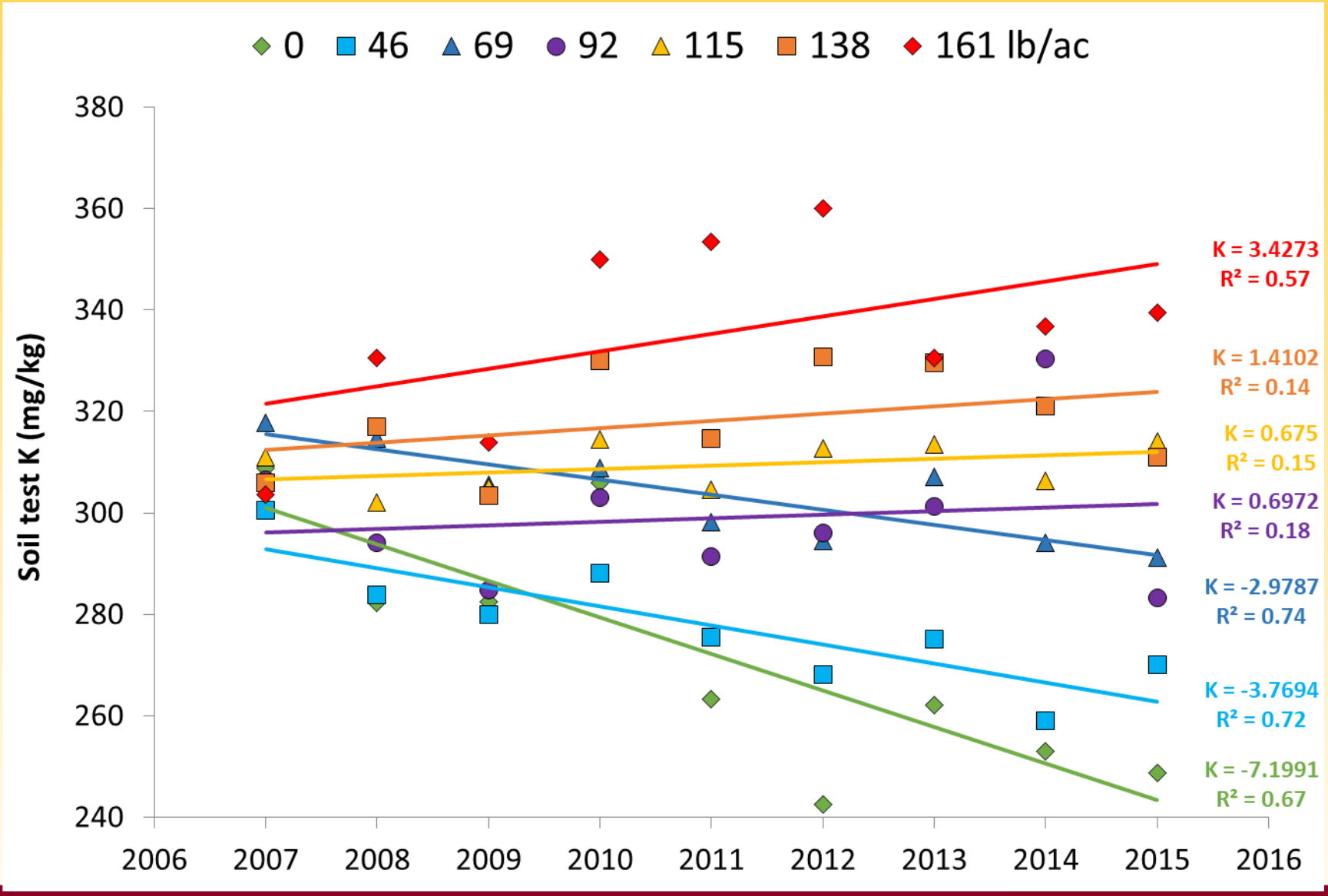
In-Season Soil K Change, V12-R2 (±70% of K uptake)



Efficiency

Tillage/fert. placement	RSD	Apparent uptake rate	
		P	K
	$cm^2\ cm^{-3}$	$mg\ m^{-2}\ day^{-1}$	
NTBC	0.47a	3.02b	26.58b
STDB	0.40b	3.74a	32.67a


0
46
69
92
115
138
161 lb/ac
Soil test P (mg/kg)
80
70
60
50
40
30
20
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
P = 2.7174
R² = 0.50
P = 2.3498
R² = 0.57
P = 1.9563
R² = 0.57
P = 0.9579
R² = 0.40
P = 0.5928
R² = 0.16
P = -0.1775
R² = 0.15
P = -2.4648
R² = 0.86


0
46
69
92
115
138
161 lb/ac
Soil test K (mg/kg)
380
360
340
320
300
280
260
240
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
K = 3.4273
R² = 0.57
K = 1.4102
R² = 0.14
K = 0.675
R² = 0.15
K = 0.6972
R² = 0.18
K = -2.9787
R² = 0.74
K = -3.7694
R² = 0.72
K = -7.1991
R² = 0.67

Take Home Message

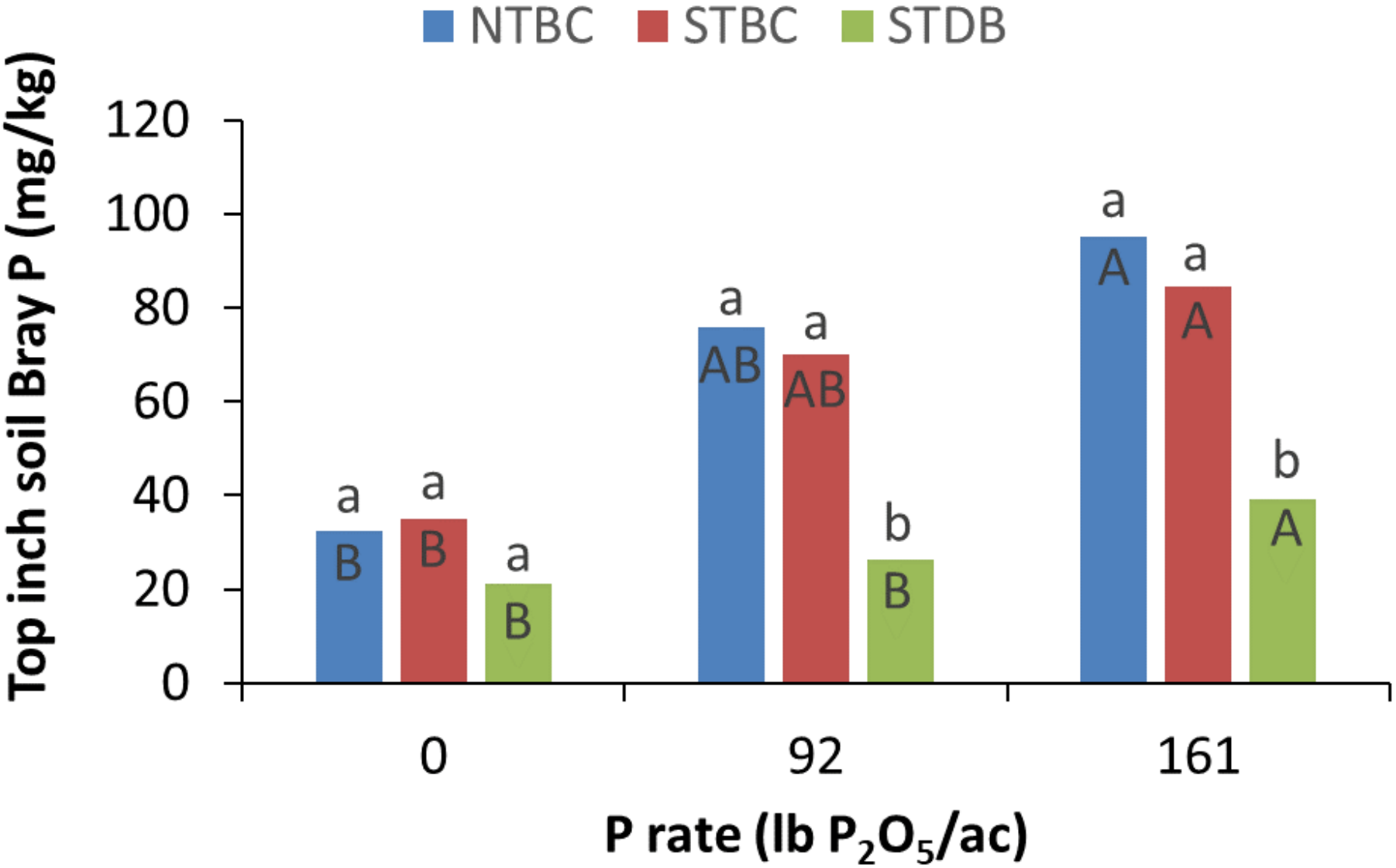
- Tillage and not P and K placement had an important effect in corn and soybean yields.
- No evidence that P and K rates can be reduced when banding the fertilizer.
- Adequate P and K levels are more important than fertilizer placement.
- Regardless of placement or tillage, soil test values will get:
  - Reduced with under application
  - Maintained to slightly increased with removal rates
  - Increased with build up rates

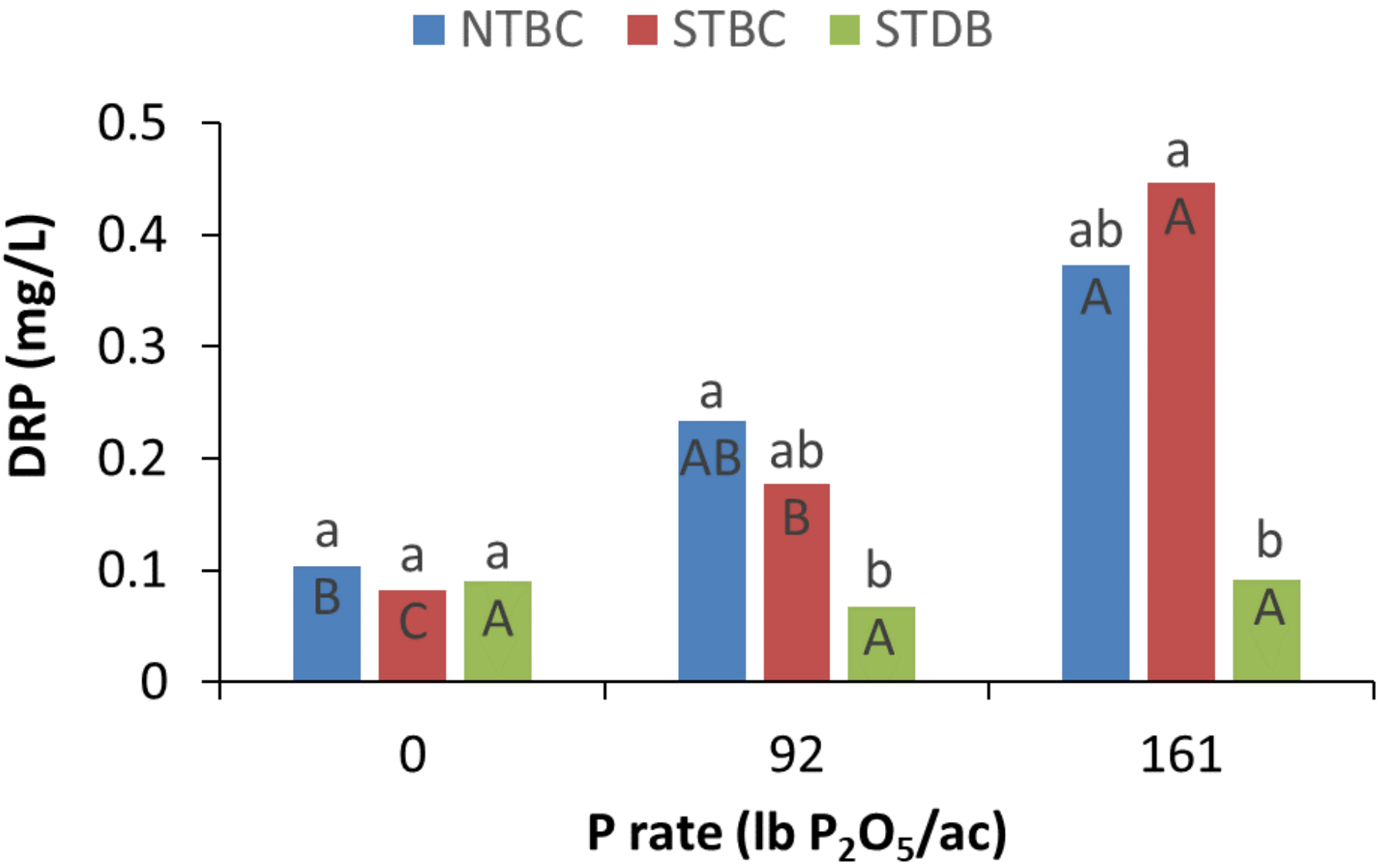
Water Quality

P Runoff Study

Large number of acres in flat fields

J. Environ. Qual. 47: 462-470


NTBC
STBC
STDB
Top inch soil Bray P (mg/kg)
120
100
80
60
40
20
0
a
B
a
B
a
B
a
AB
a
AB
b
B
a
A
a
A
b
A
0
92
161
P rate (lb P_2O_5/ac)


NTBC
STBC
STDB
DRP (mg/L)
0.5
0.4
0.3
0.2
0.1
0
a
B
a
C
a
A
a
AB
ab
B
b
A
ab
A
a
A
b
A
0
92
161
P rate (lb P_2O_5/ac)

Take Home Message

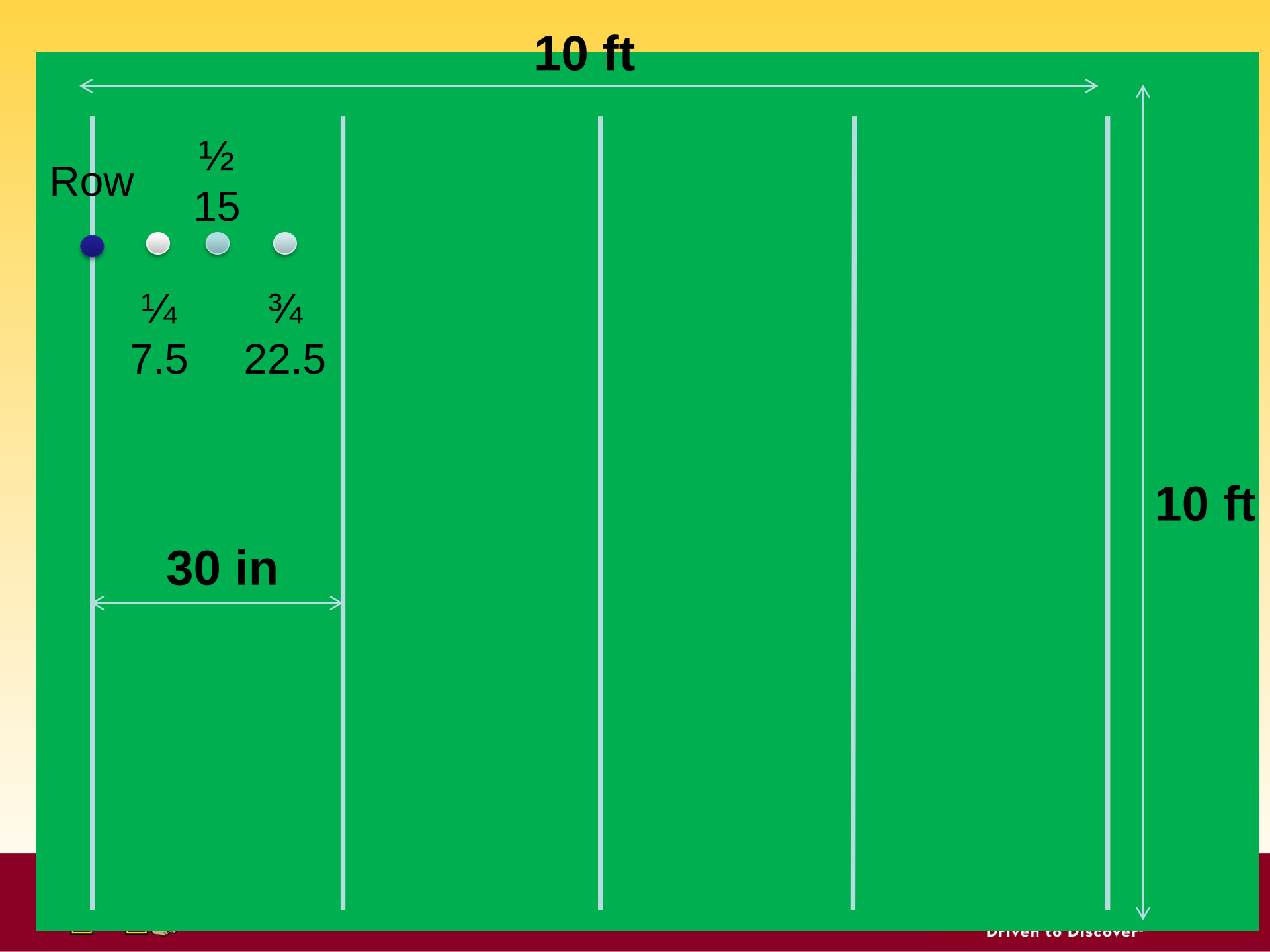
- While subsurface band P may have no agronomic benefit it can reduce P runoff potential.

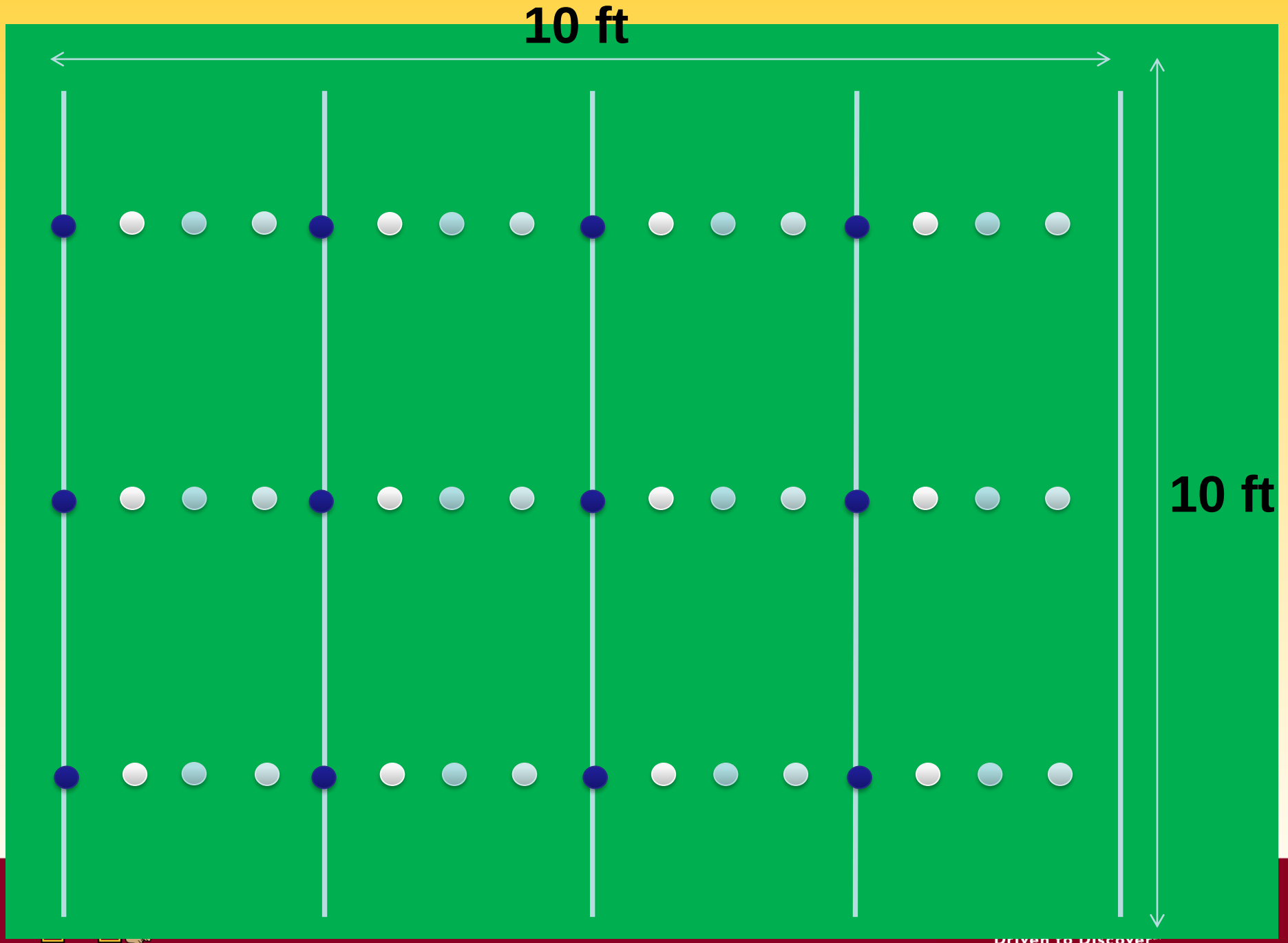
- Optimum P rates are important for agronomic and environmental reasons.

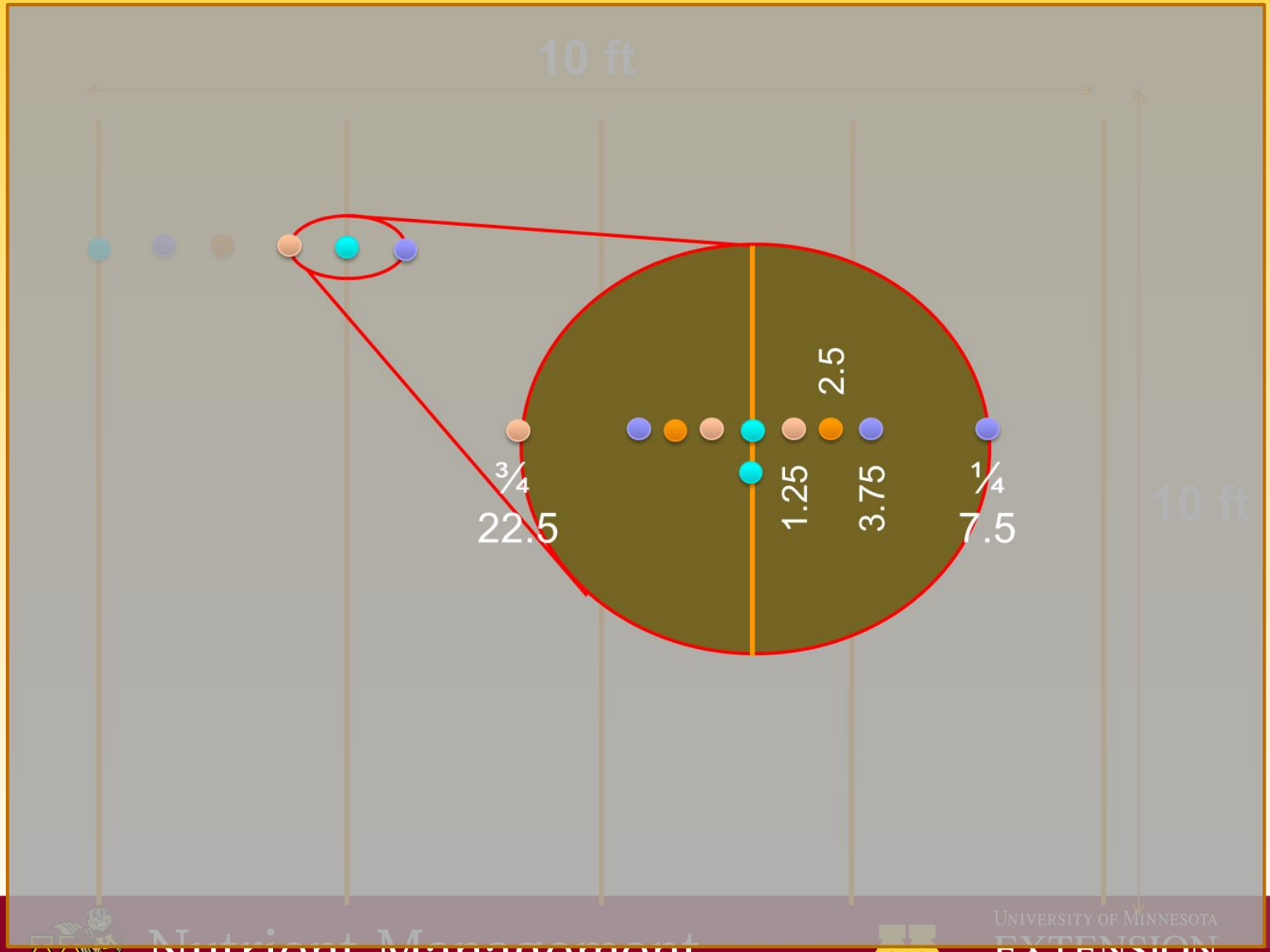
Soil Sampling When P and K are Banded

	Fertilizer rate (lb P_2O_5 $acre^{-1}$)		
Depth	0	115	161
inch	—Soil P test level (ppm) —		
2	16	35	41
3	13	31	34
4	12	29	31
5	11	26	27
6	**10**	**24**	**25**
7	10	22	22
8	9	20	21
9	9	19	19
10	8	17	18
11	8	16	17
12	7	15	16

	Fertilizer rate (lb K_2O $acre^{-1}$)		
Depth	0	115	161
inch	—Soil K test level (ppm) —		
2	158	237	221
3	138	209	196
4	128	195	183
5	119	177	166
6	**113**	**164**	**154**
7	108	153	144
8	104	144	136
9	101	137	131
10	99	131	126
11	98	128	123
12	98	126	120

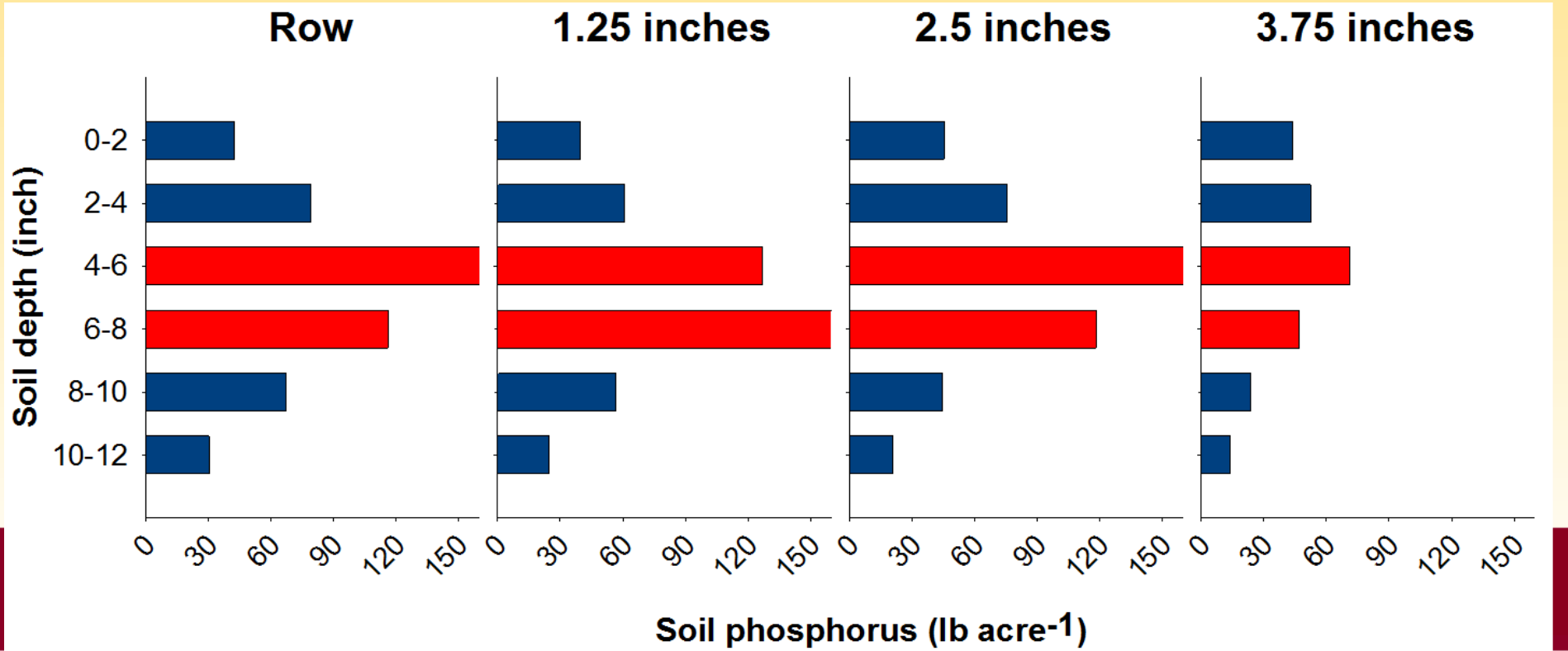

10 ft
Row
½
15
¼
7.5
¾
22.5
30 in
10 ft


10 ft
10 ft

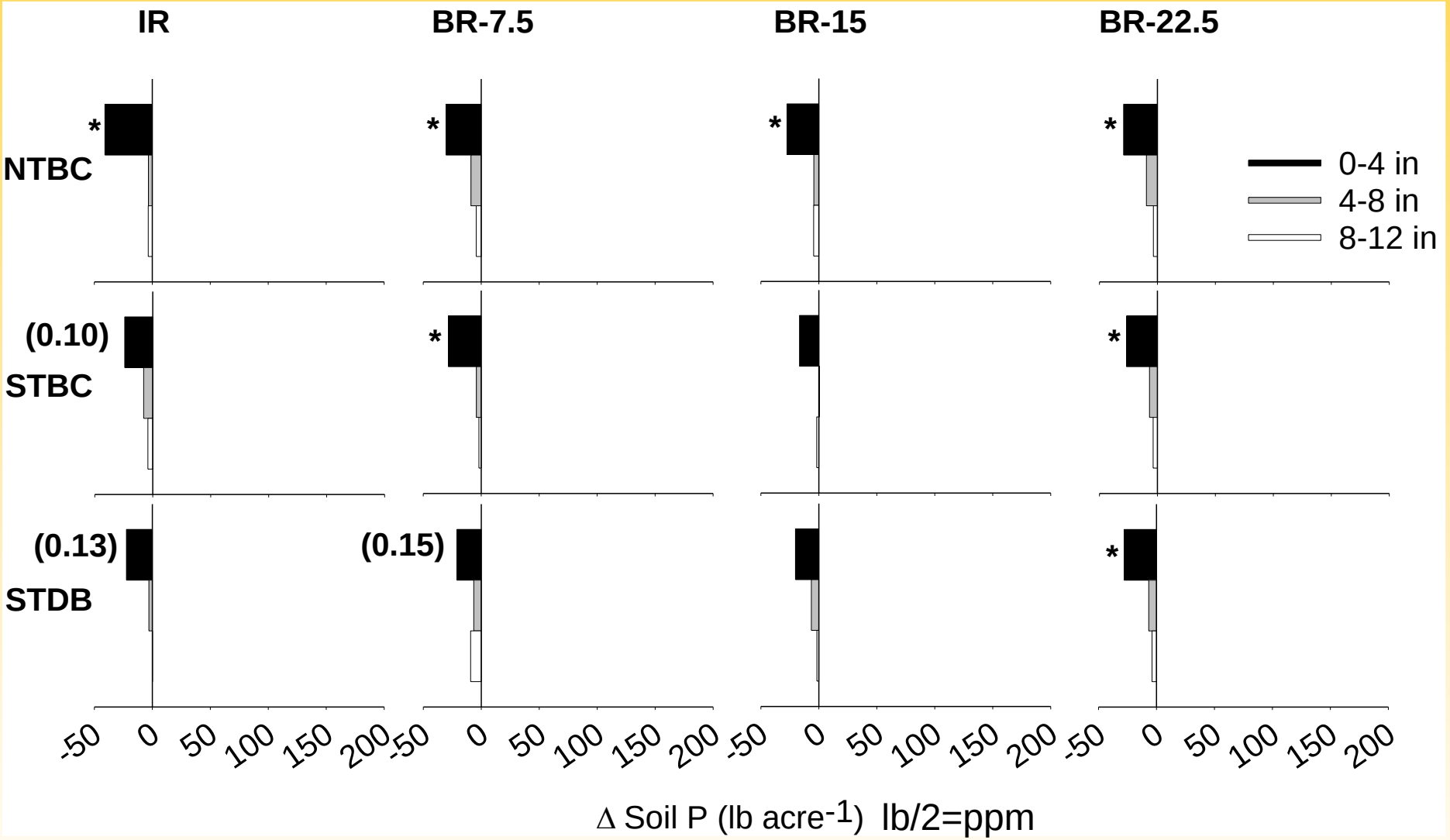

10 ft
2.5
¾
22.5
1.25
3.75
¼
7.5
10 ft

Small-Scale Fertilizer Movement/Application Variability (STDB, 161 lb P_2O_5)

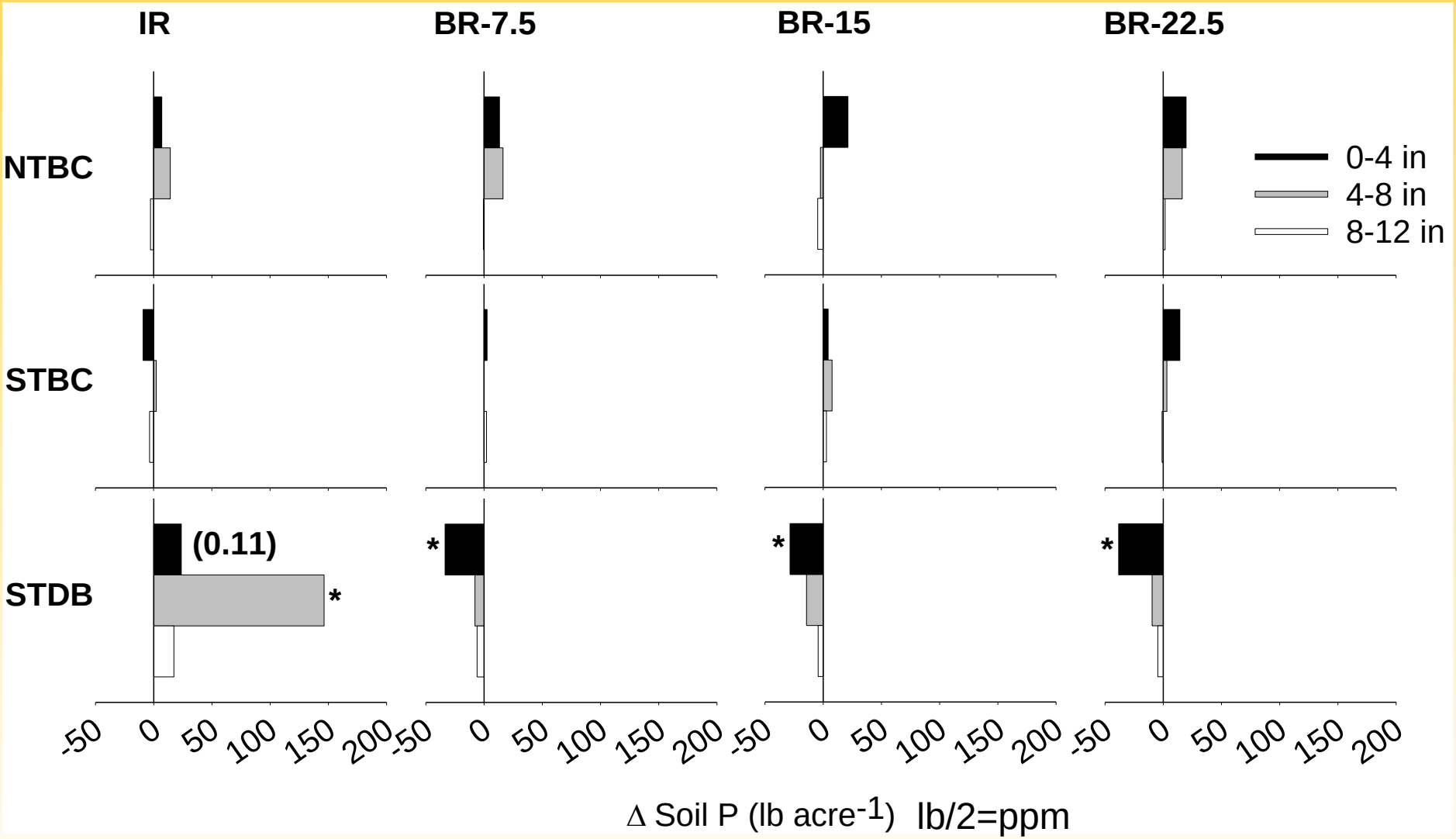
Trimble Field Manager Soft ware with two GPS receivers (tractor and tillage bar)



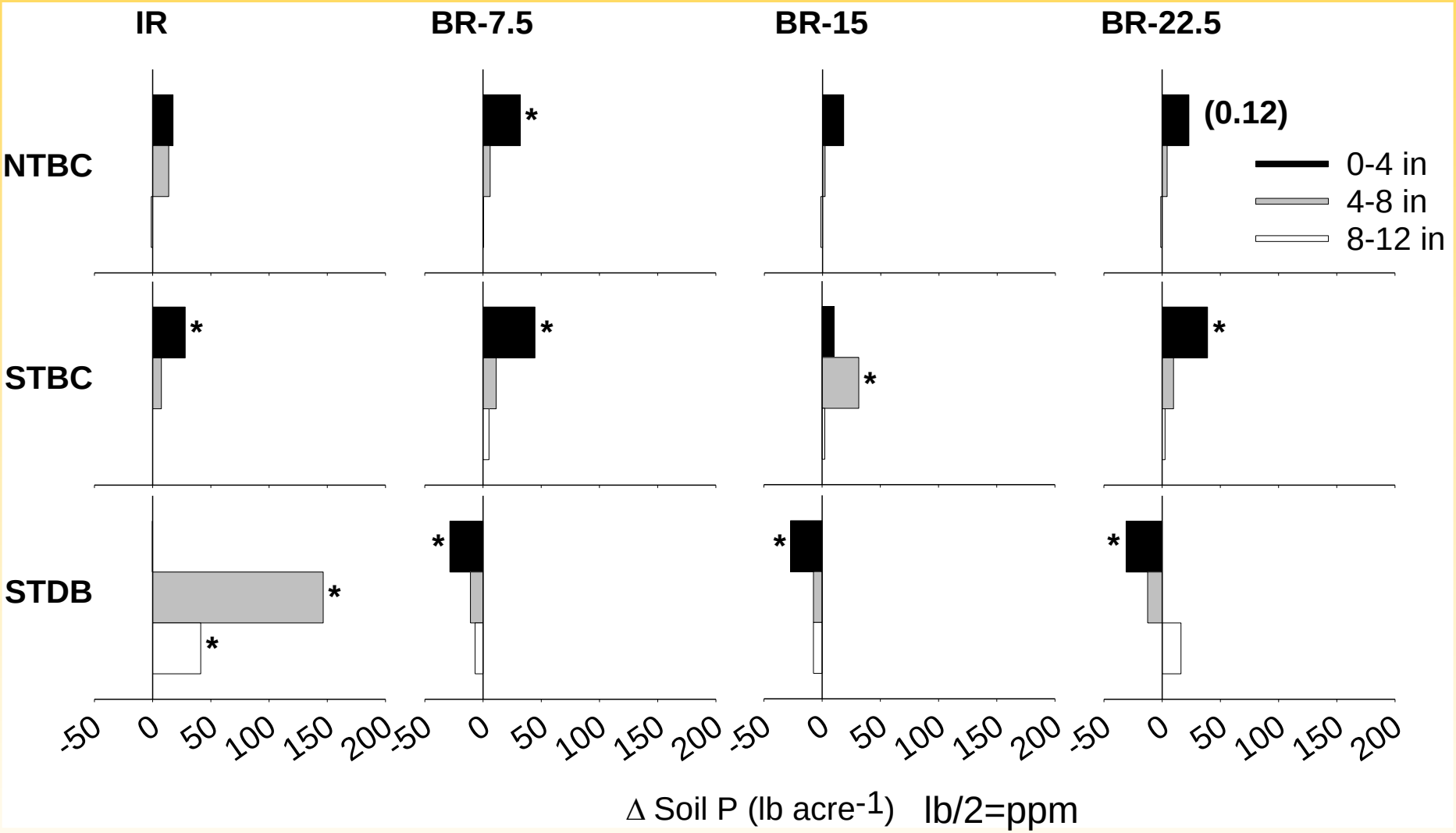
Check (0 lb P_2O_5)



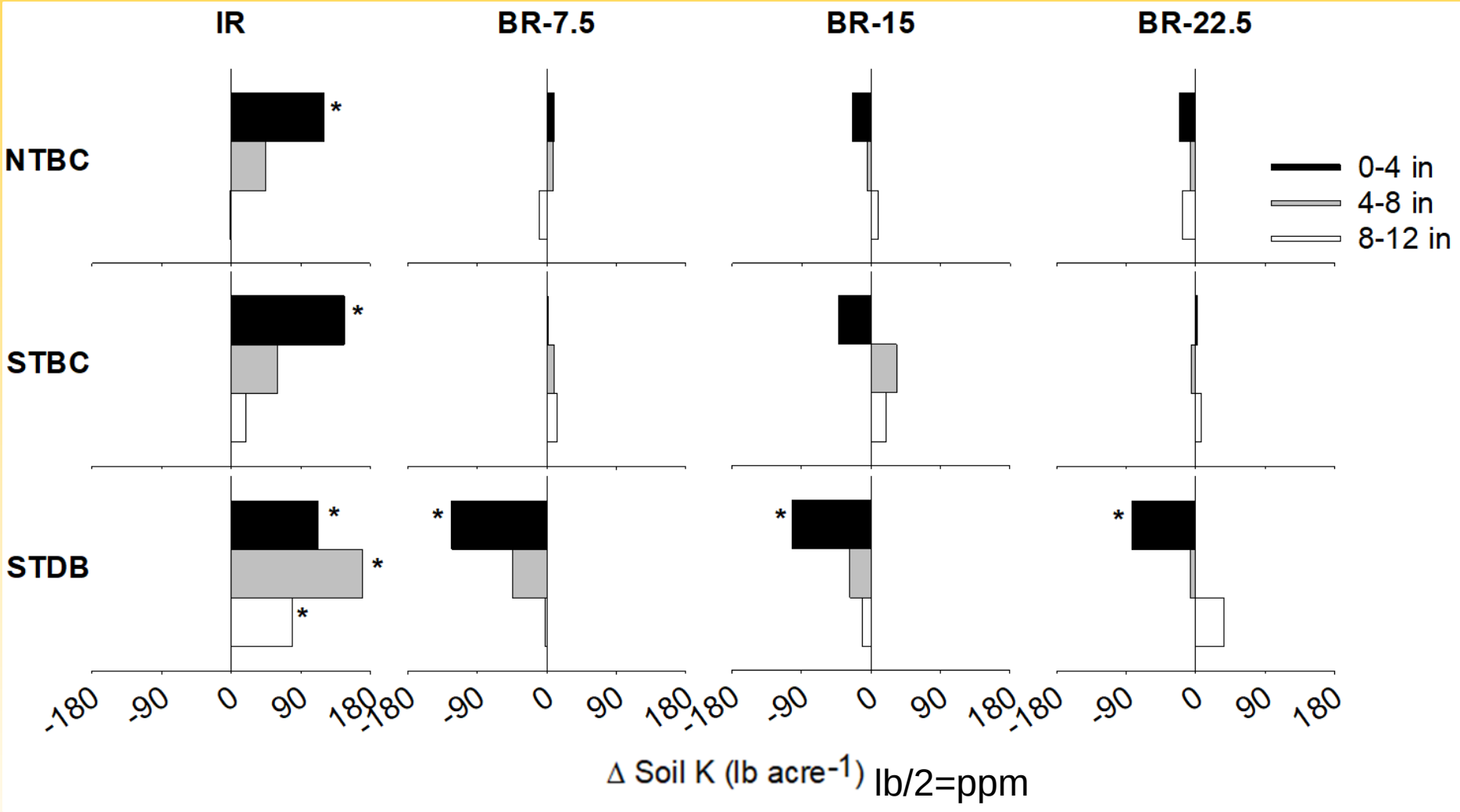
Maintenance (115 lb P_2O_5)



Highest Rate (161 lb P_2O_5)



Highest Rate (161 lb K_2O)



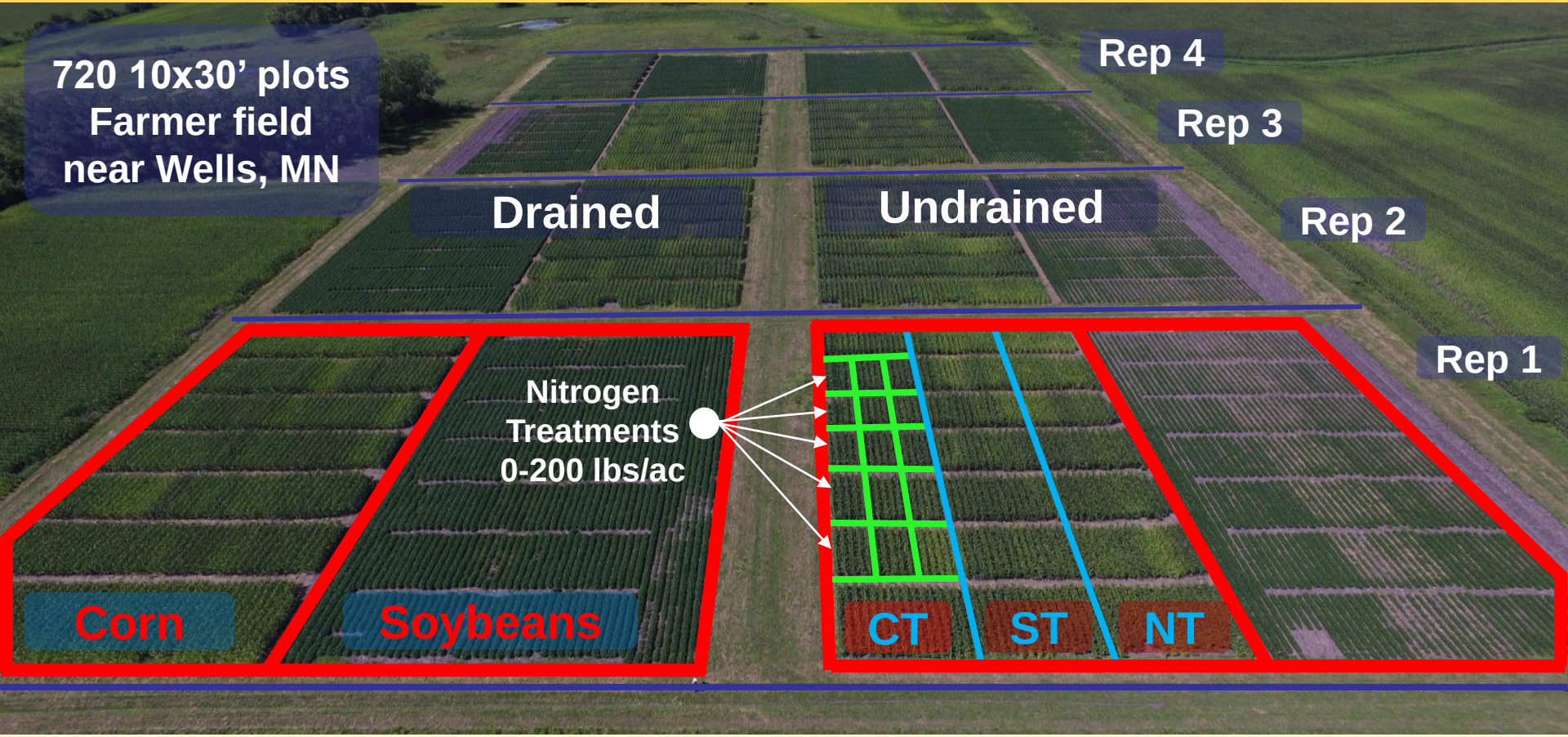
P&K	"True"	STBC				
	1:3	1:3	1:2	1:1	1:0	0:3
lb acre^{-1}	P (ppm)					
0	12	18	17	17	15	19
46	21	20	19	19	18	20
69	20	21	21	20	16	23
92	16	22	22	21	18	23
115	26	24	24	23	21	26
138	24	30	30	28	24	33
161	26	33	33	32	31	34
	K (ppm)					
0	128	125	127	131	144	119
46	140	132	136	143	164*	122
69	143	148	152	161*	187*	135
92	135	136	138	143	157*	129
115	151	147	150	157	177*	137
138	158	151	155	163	188*	138
161	155	161	165	172	193*	149

P&K	"True"	STDB				
	1:3	1:3	1:2	1:1	1:0	0:3
lb acre^{-1}	——————————P (ppm)——————————					
0	23	12	12	12	12	11
46	41	21	15	17	19	26*
69	39	20	20	21	25*	35*
92	32	16*	25*	29*	37*	63
115	51	26	25	30*	38*	64*
138	47	24	26	30*	39*	67*
161	52	26	23	27	34*	56*
	——————————K (ppm)——————————					
0	128	120	122	125	135	115*
46	140	131	136	144	170*	118*
69	143	138	143	153	183*	123*
92	135	149*	155*	168*	206*	130
115	151	146	153	168*	211*	125*
138	158	162	172*	191*	249*	133*
161	155	153	162	179*	230*	127*

Take Home Message

- When banding P and K or planting on the same row position year after year, for each core taken at the row, take 2 to 3 cores between rows

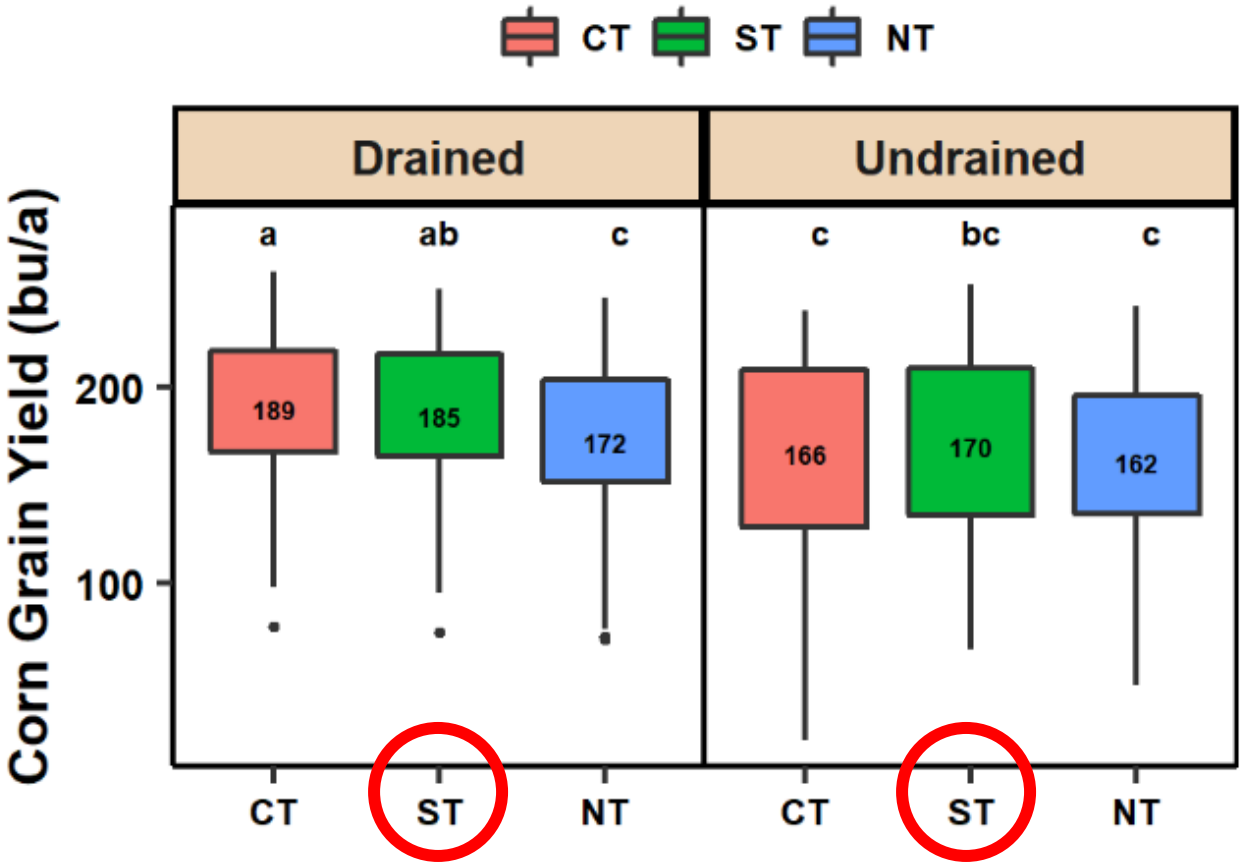
Materials and Methods



Year	Timing	EONR (lbs N/ac)		Yield @ EONR (bu/ac)	
		Drained	Undrained	Drained	Undrained
2014	PL	149	128	188	186
2015	PL	108	200	214	212
2016	PL	92	121	217	223
2017	PL	155	200	217	214
2018	PL	200	200	237	204
2019	PL	120	200	177	196
Mean	PL	138	175	209	206
2014	SP	--	--	--	--
2015	SP	140	160	217	209
2016	SP	78	160	215	226
2017	SP	200	200	225	206
2018	SP	173	167	228	210
2019	SP	157	157	204	186
Mean	SP	150	169	218	207

- Regardless of timing, undrained soils need additional N.
- Pre-plant applications are adequate for drained soils
- Split applications can be better for undrained soils

Season-long soil water and temperature mostly influenced by drainage



Effect of Tillage on Soybean

Tillage	Soybean Grain Yield
	Bu/ac
Conventional	68a
Strip-till	68a
No-till	67a

Take Home Message

- Soil drainage is important for N management.
  - Overall drainage reduces N needed by 16% and increases grain yield by 8% relative to undrained soils. Especially in wet and warm springs.
  - Undrained soils: split applications tend to be better.
  - Drained soils: a pre-plant application produces lower EONR and maintains similar grain yield to split.
- Strip-till is a viable conservation tillage alternative to conventional tillage.
- Soil drainage has a larger influence on the soil water and N fertilizer requirement than tillage practice.
- Soybean is less influenced by soil drainage and tillage practice than corn.

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- Instinct
- SMBSC
- AgriGrowth
- mcpr Minnesota Crop Production Retailers
- MAWRC Minnesota Agricultural Water Resource Center
- NRCS Natural Resources Conservation Service
- MinnesotaCorn Growers Association
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