Nutrients in Conservation Tillage Systems

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University of Minnesota
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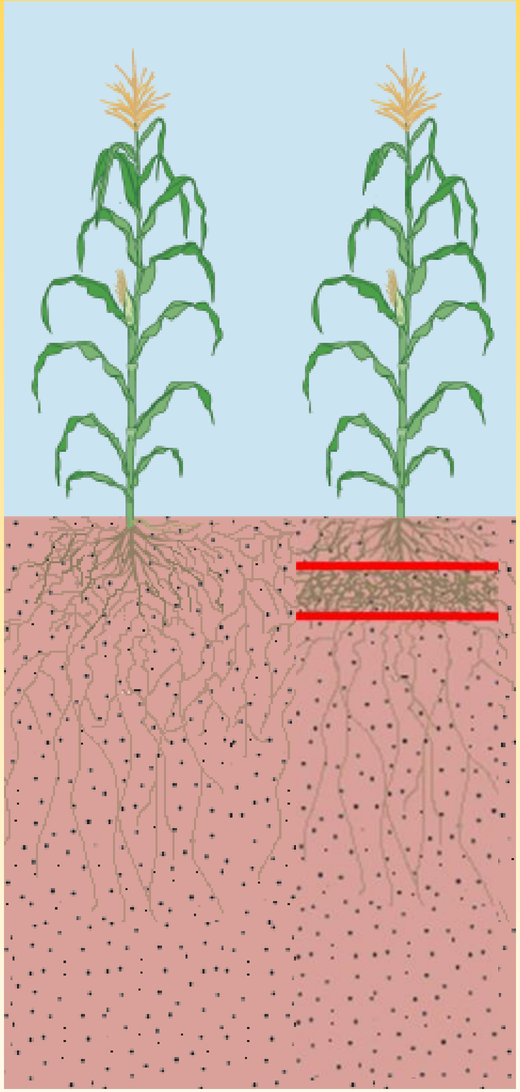
Where Should I Place Nutrients?

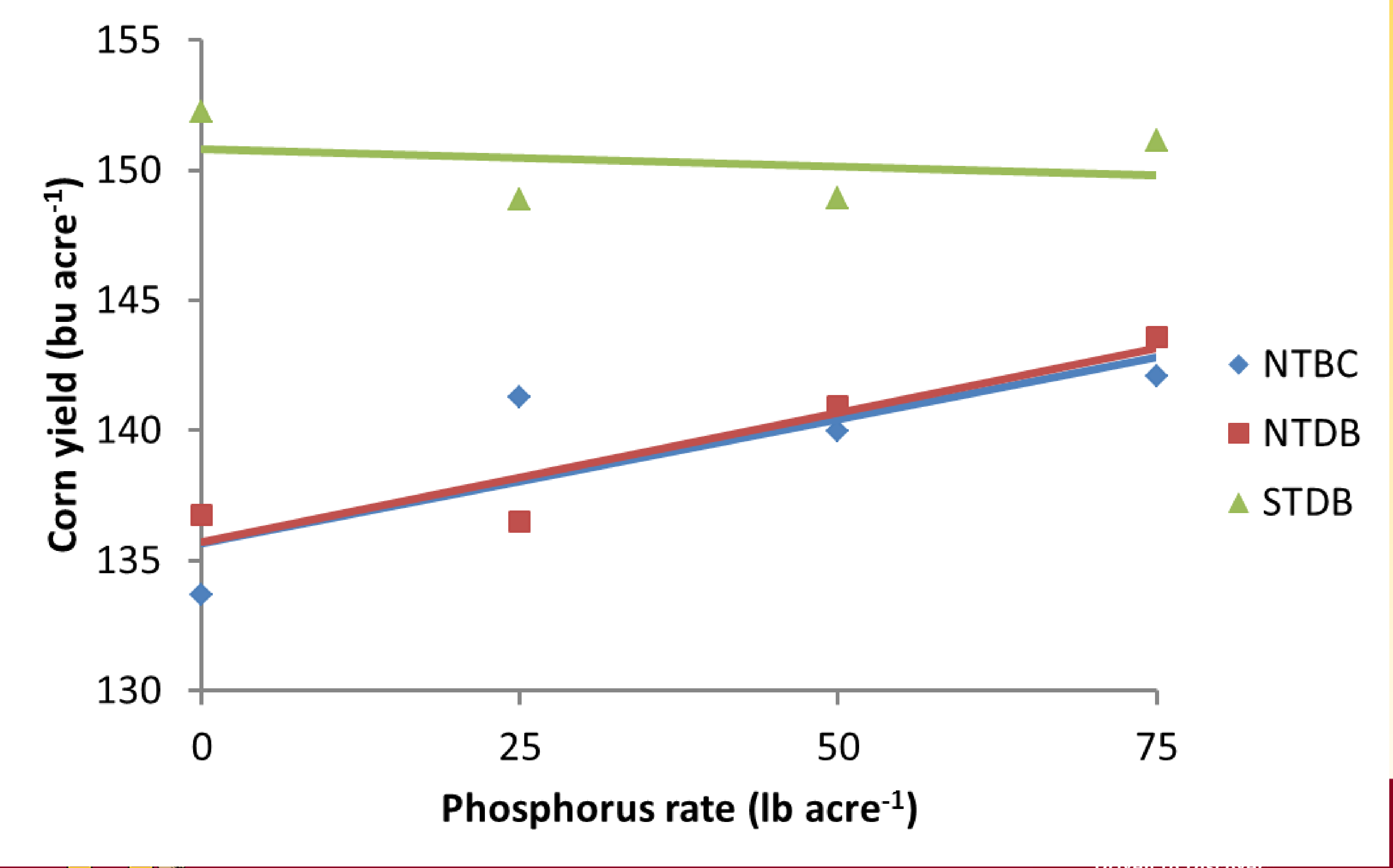


- Can we get by with less?
- Where are the active roots?
- Where is the water?

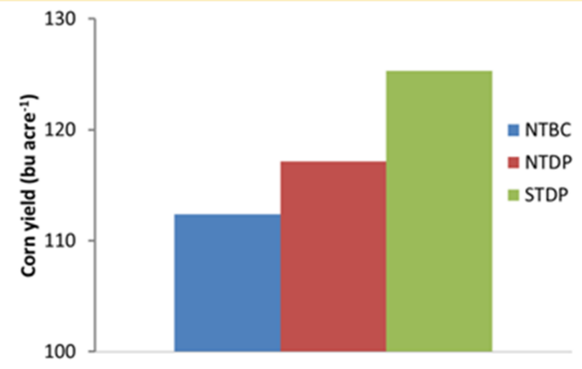
Nutrient availability (uptake)

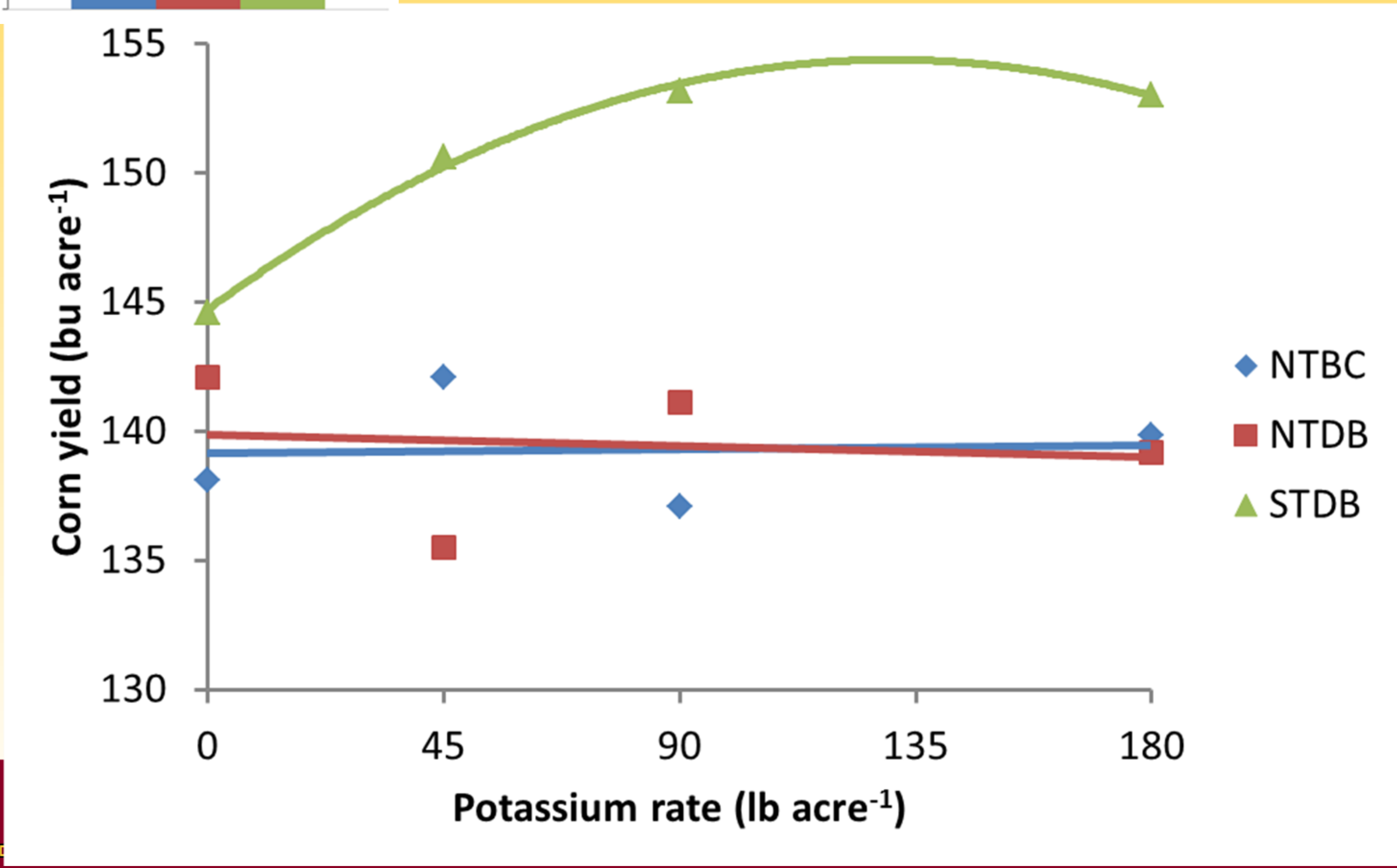
- Are there environmental benefits to subsurface banding?
- How to take a soil sample?

Tillage/Placement x P

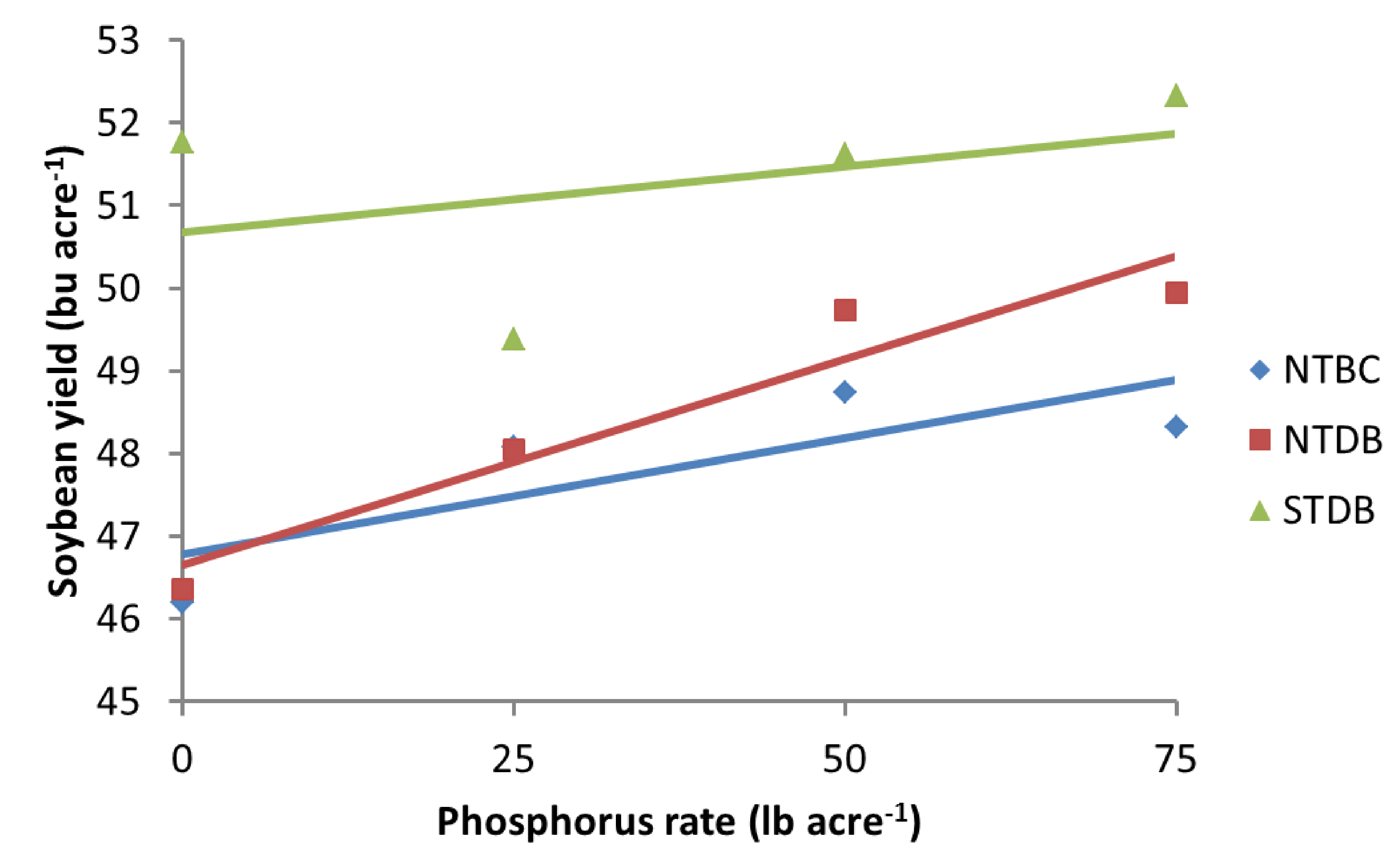


Tillage/Placement x K

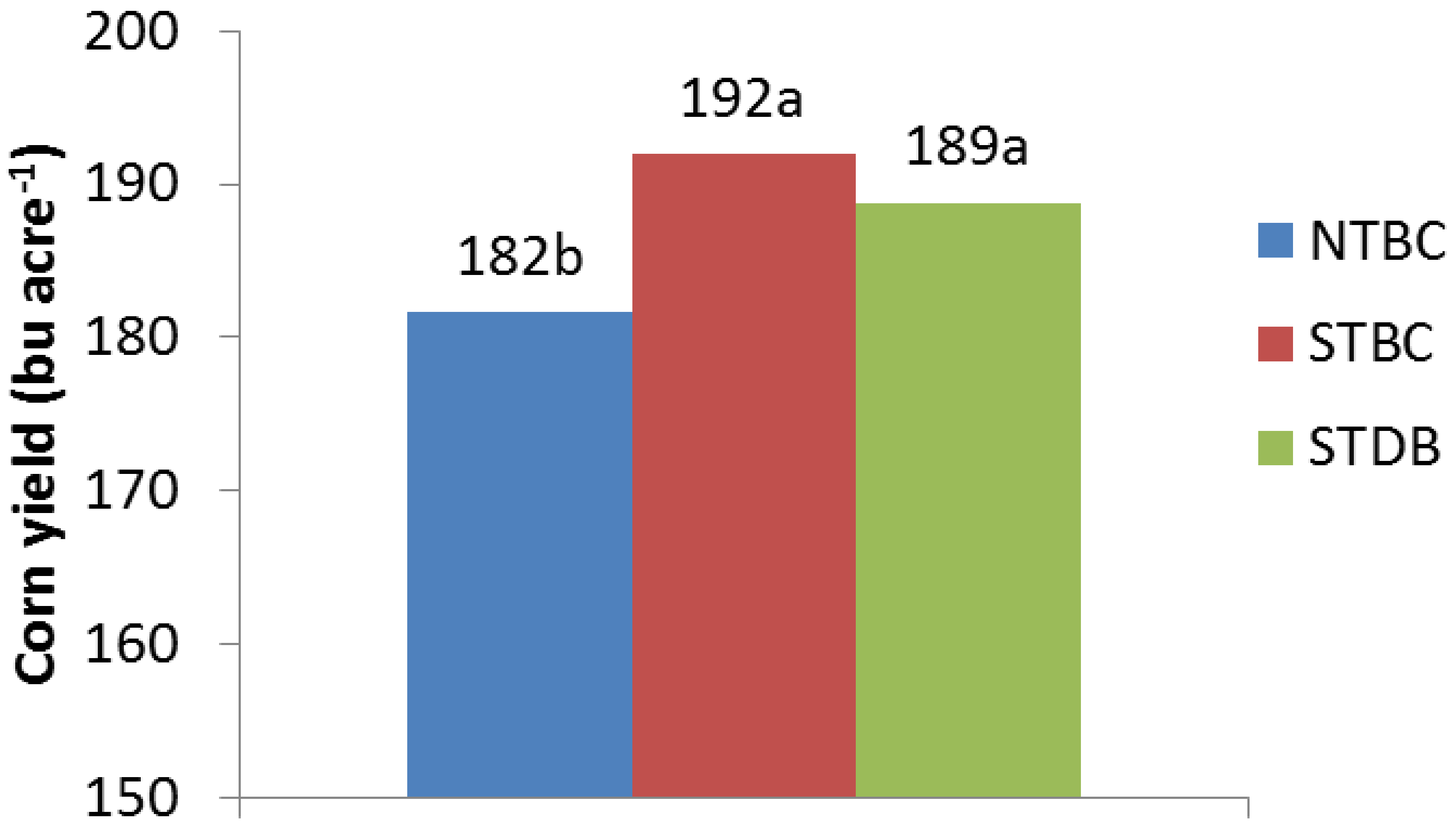




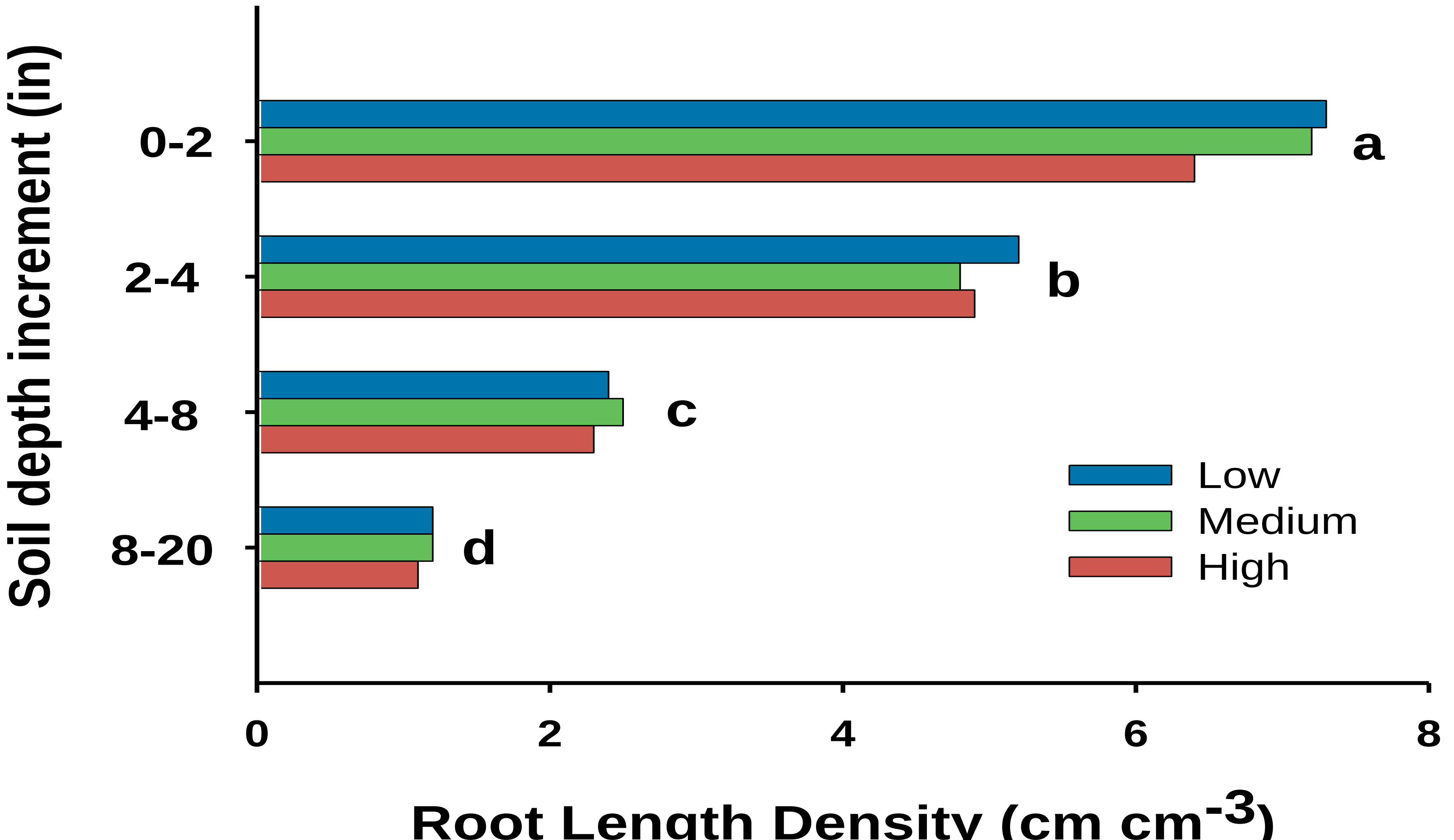
Tillage/Placement x P



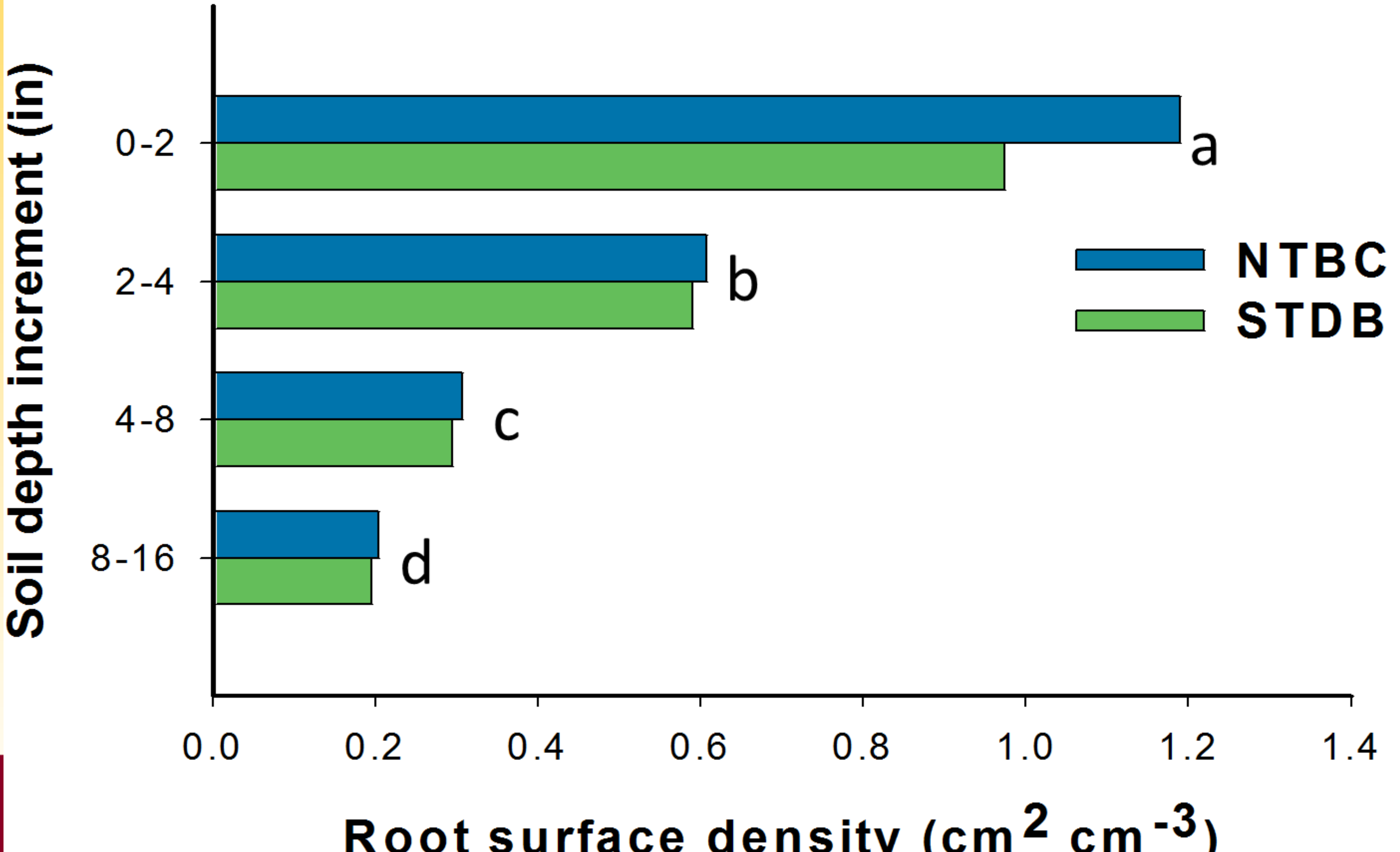
Corn Yield, Farmers' Fields



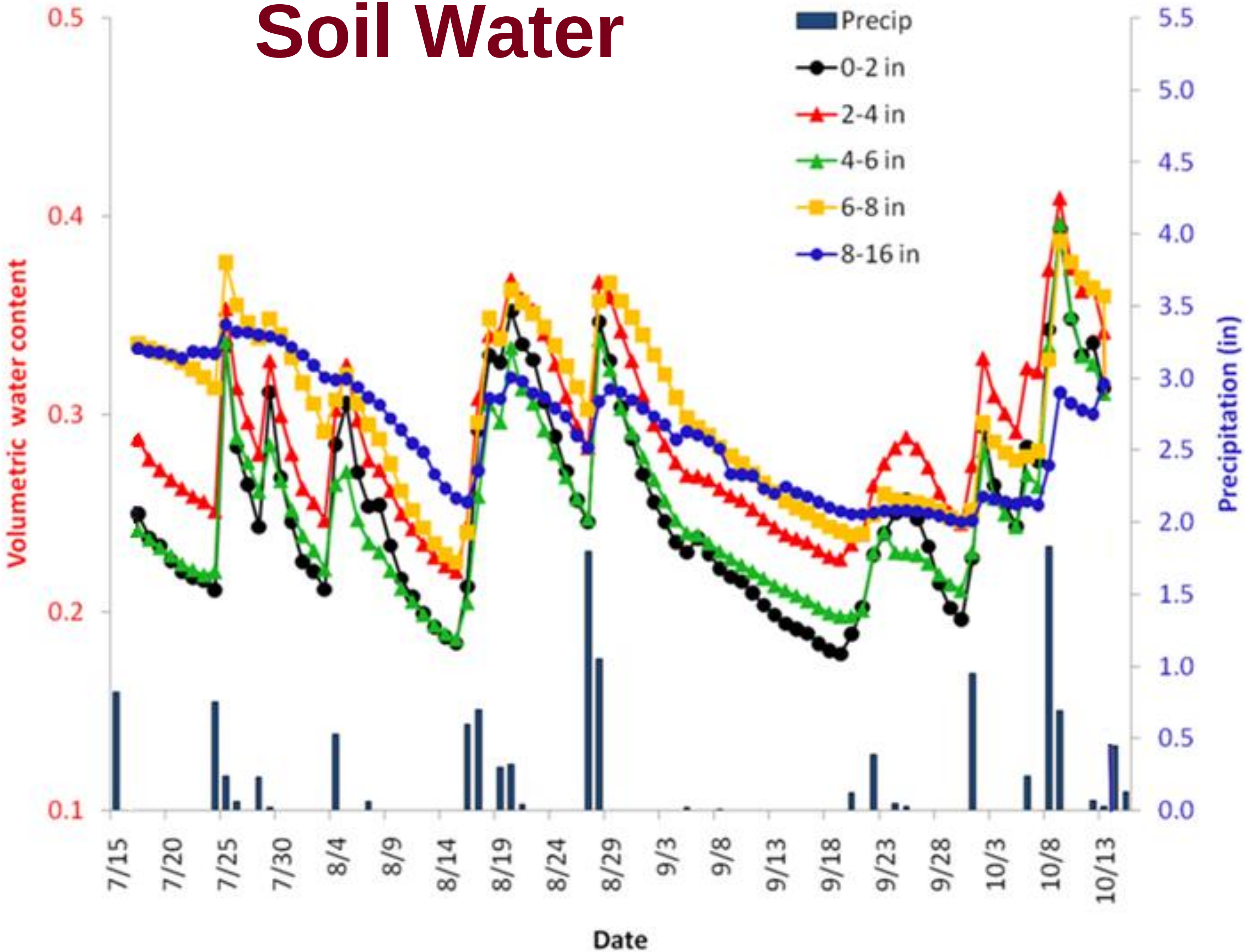
Roots Not Impacted by Nutrient Level



Roots Not Impacted by Nutrient Placement

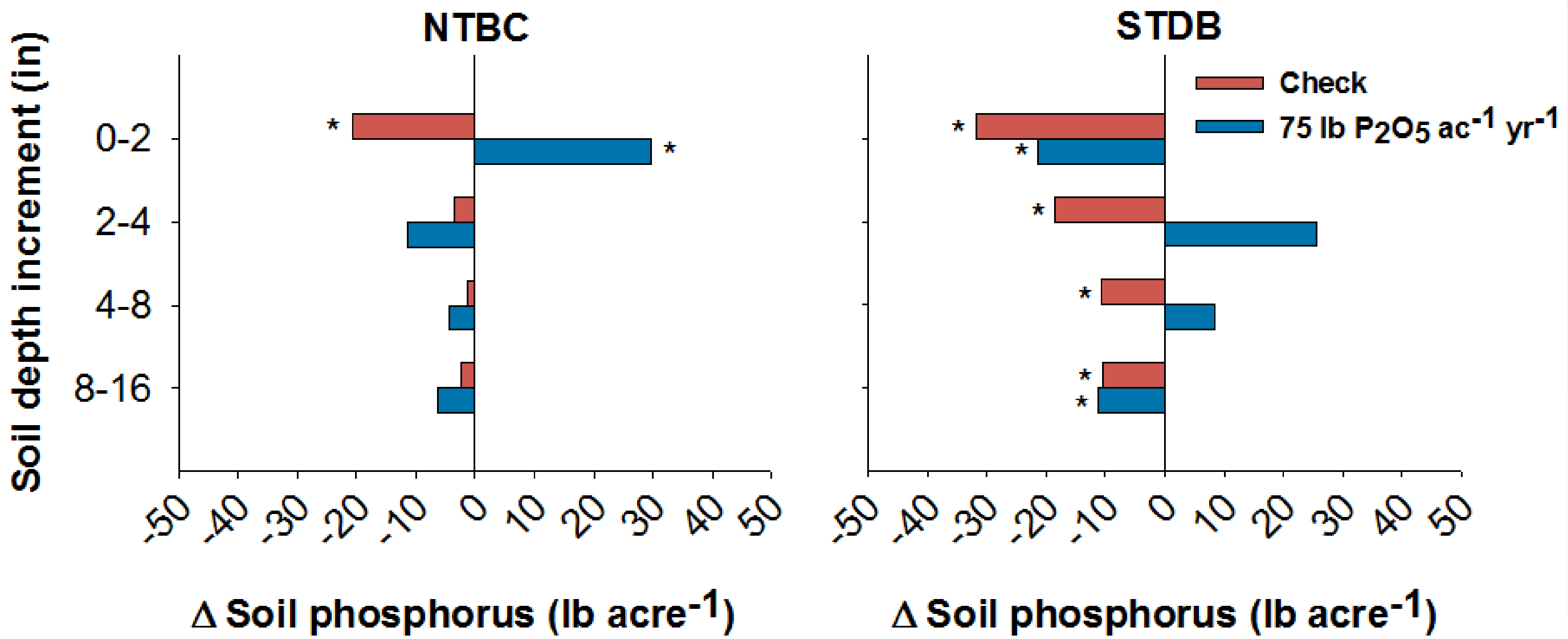


Soil Water



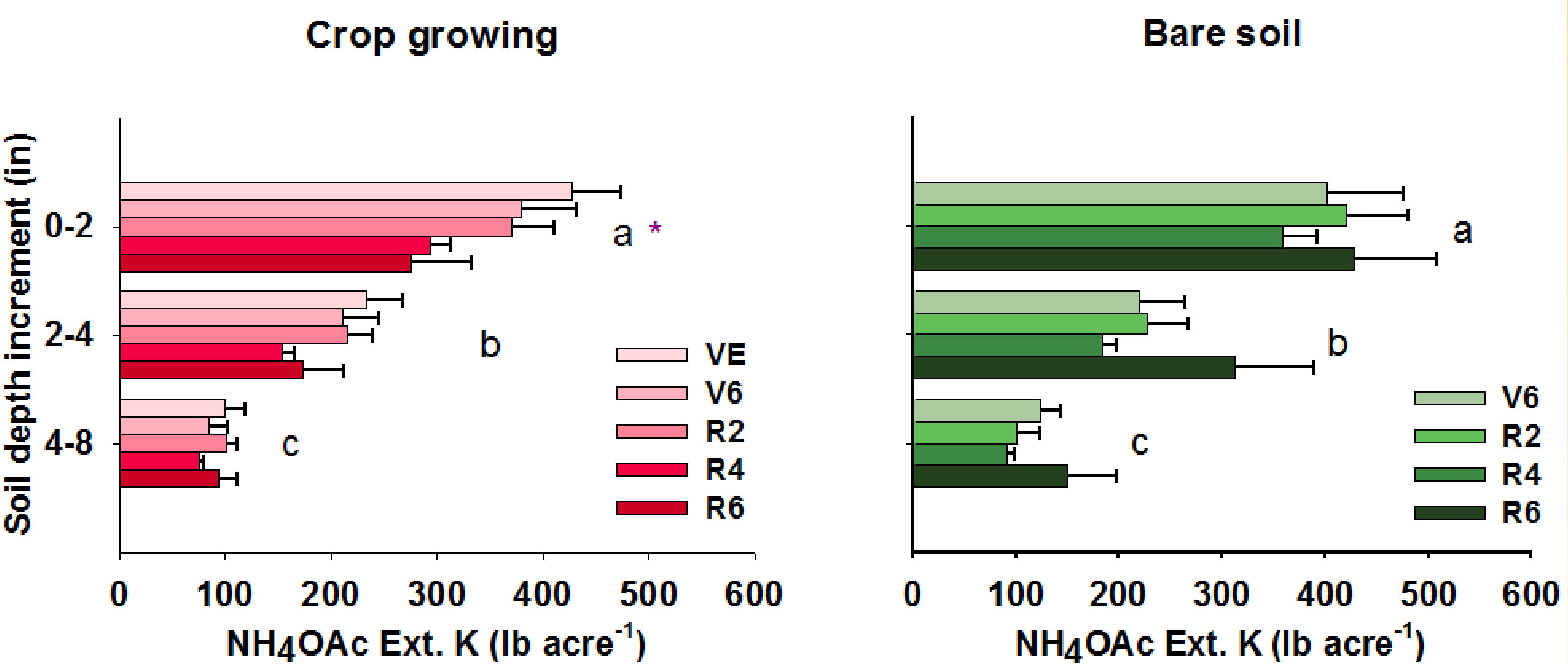
Precip
0-2 in
2-4 in
4-6 in
6-8 in
8-16 in
Volumetric water content
0.1
0.2
0.3
0.4
0.5
Precipitation (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
7/15
7/20
7/25
7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8
9/13
9/18
9/23
9/28
10/3
10/8
10/13
Date

Placement Has Little to Do With Where Roots Take Up Nutrients

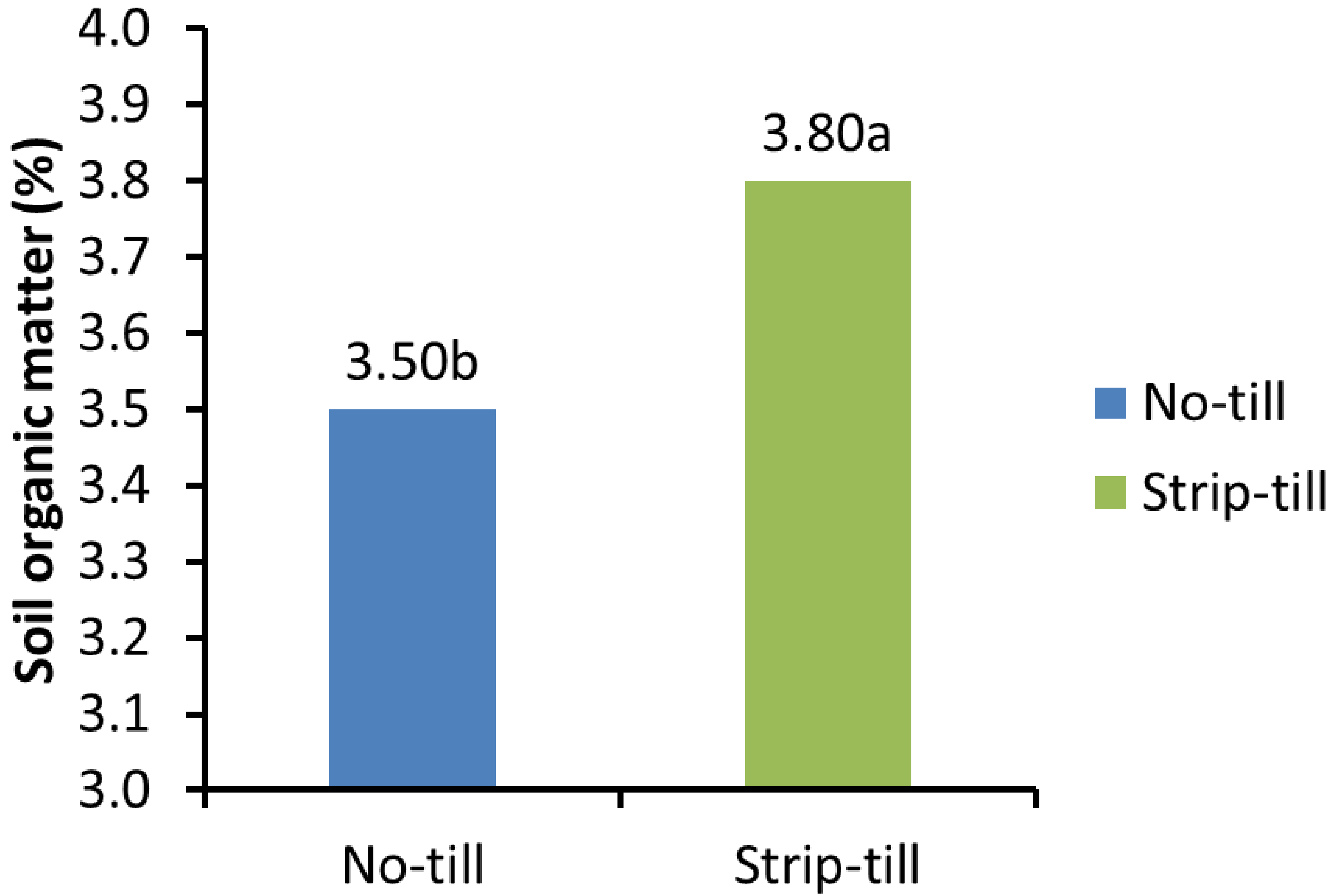


Change in soil test P over a three-year period
Averaged across IR BR at R1 development stage
* indicate $P \leq 0.1$

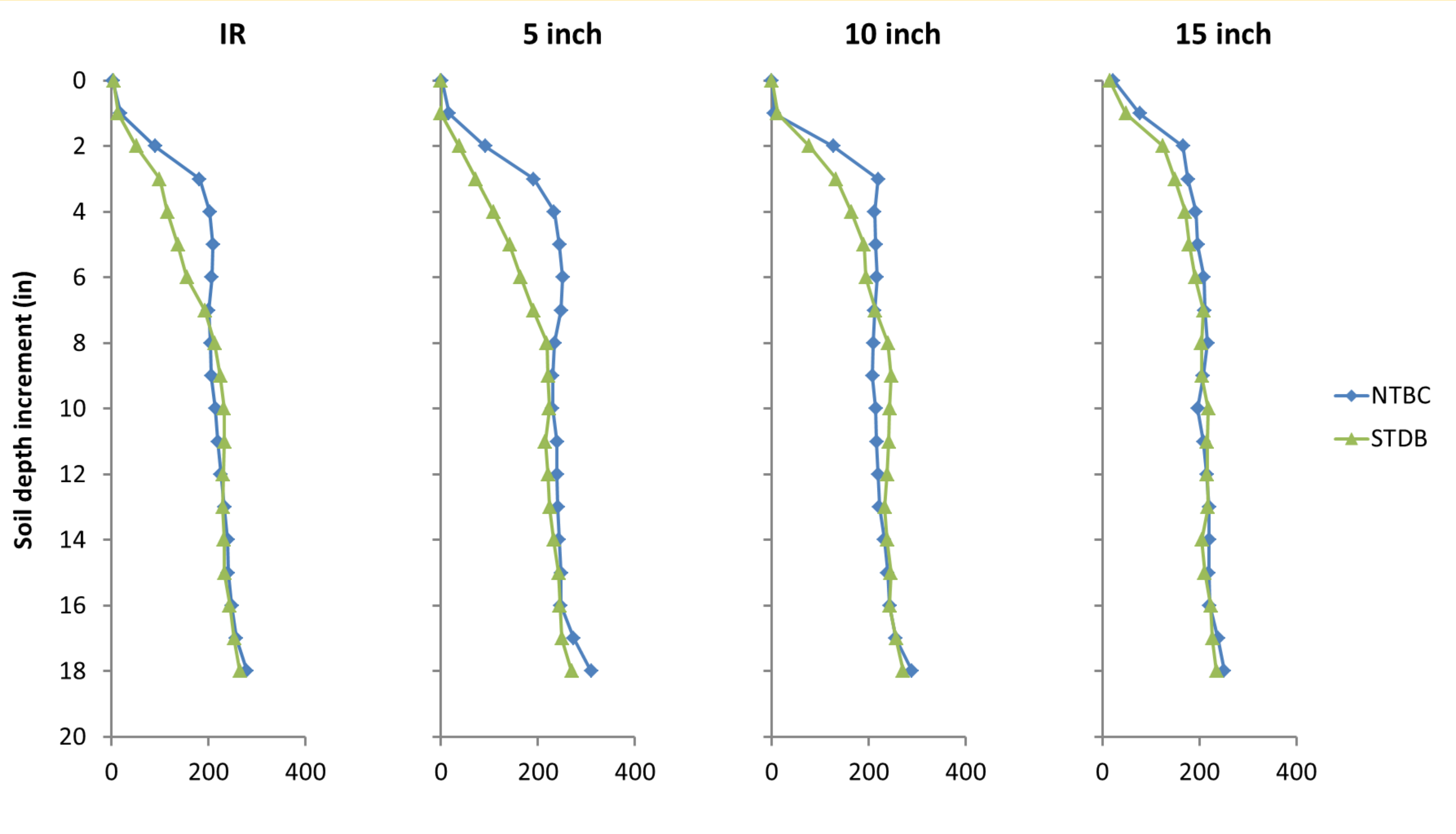
Changes in Soil Test Levels are Related to Crop Uptake (no-till field)

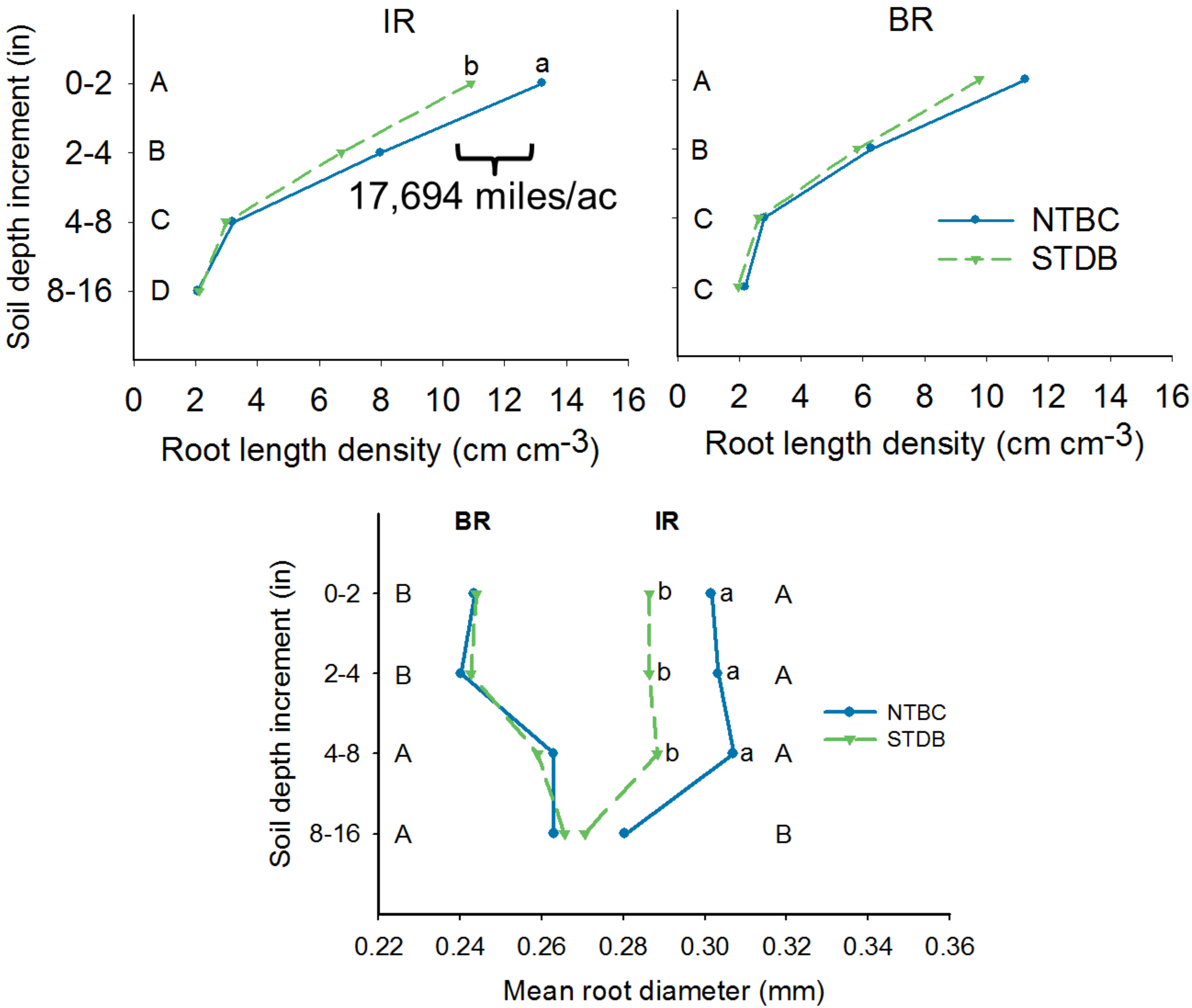


Soil Organic Matter

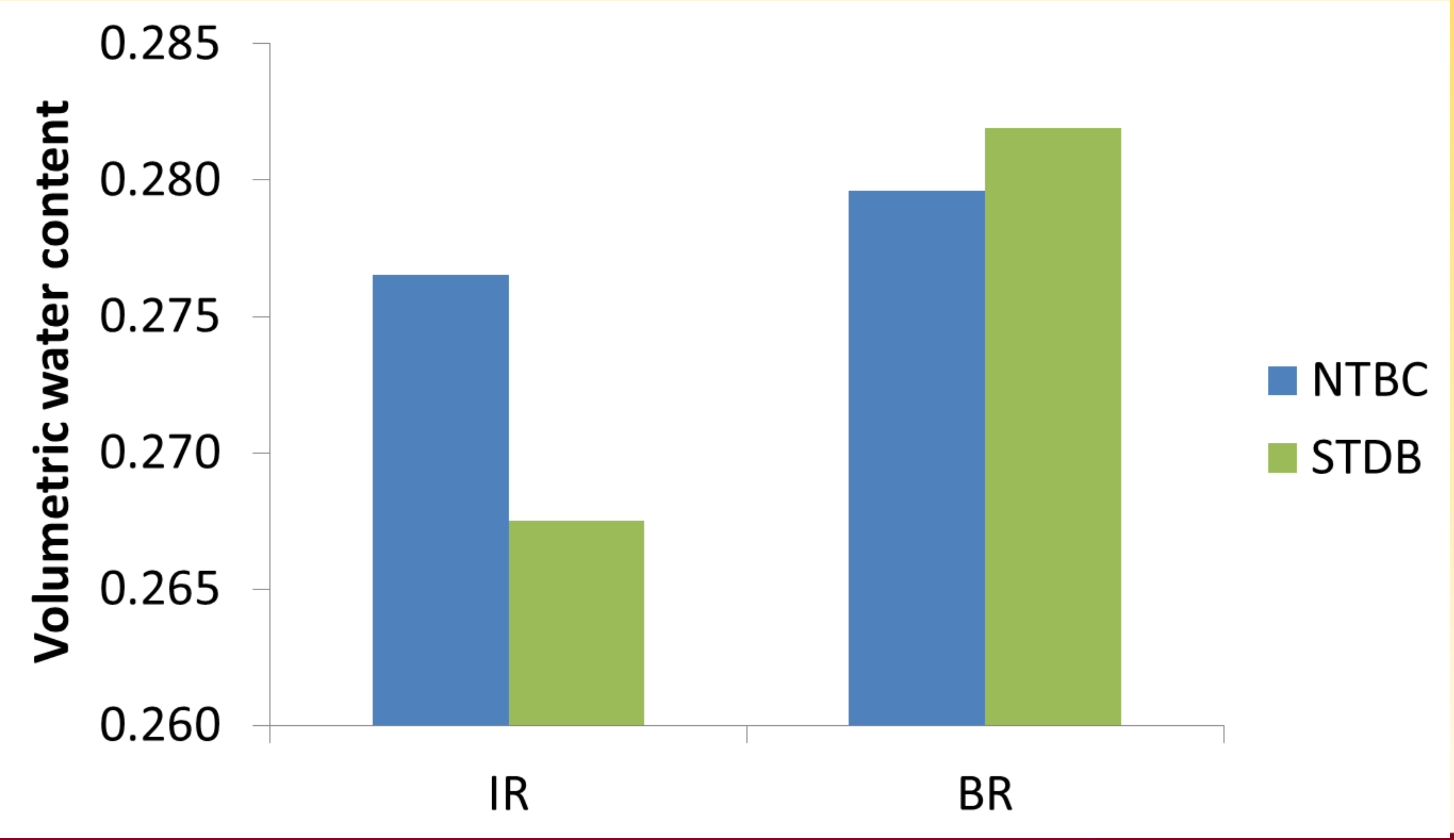


Soil Penetration Resistance (PSI)

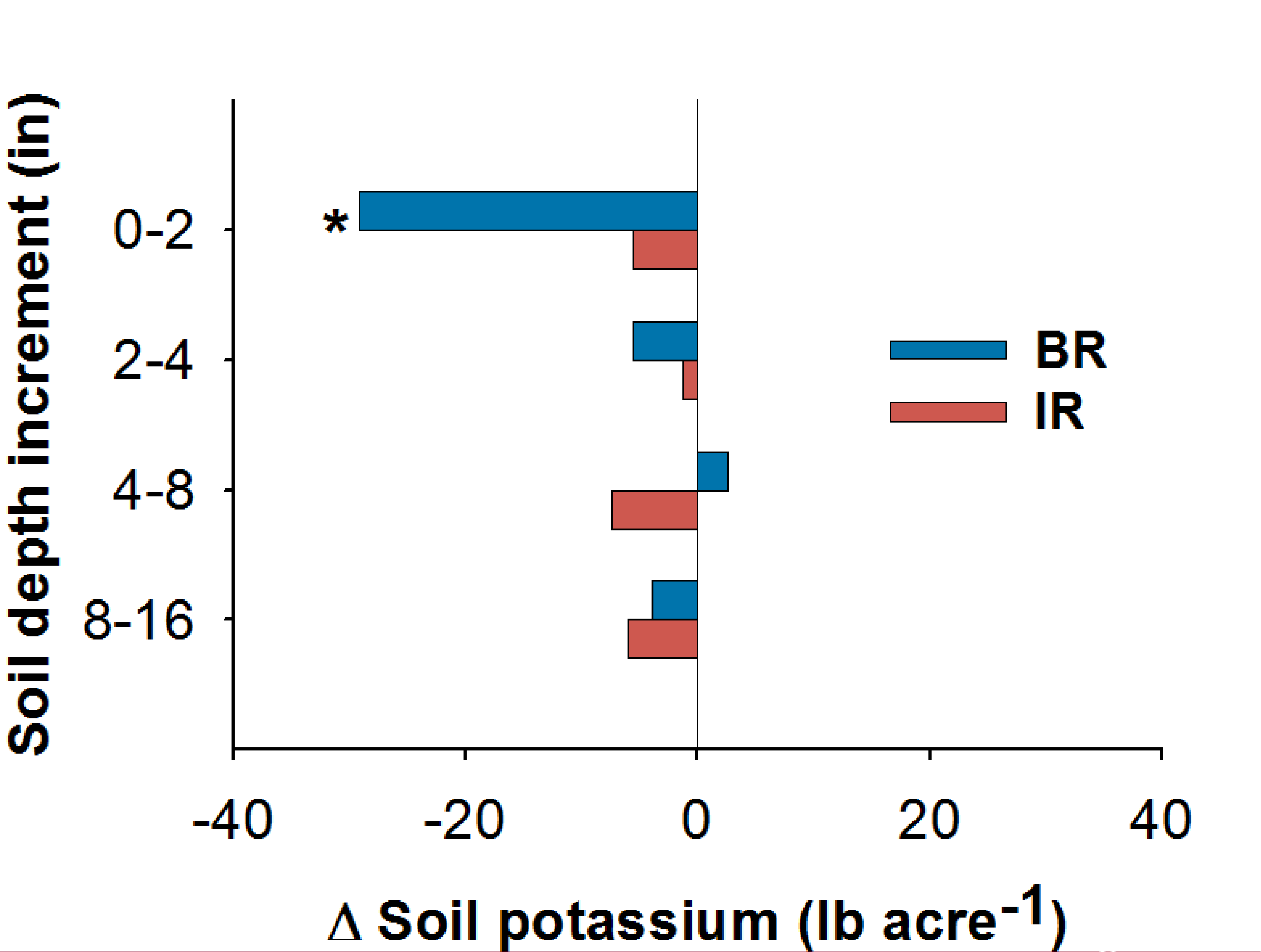



IR
BR
Soil depth increment (in)
0-2
2-4
4-8
8-16
A
B
C
D
A
B
C
C
b
a
17,694 miles/ac
NTBC
STDB
0
2
4
6
8
10
12
14
16
Root length density (cm cm-3)
BR
IR
B
B
A
A
b
b
b
a
a
a
A
A
A
B
NTBC
STDB
0.22
0.24
0.26
0.28
0.30
0.32
0.34
0.36
Mean root diameter (mm)

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

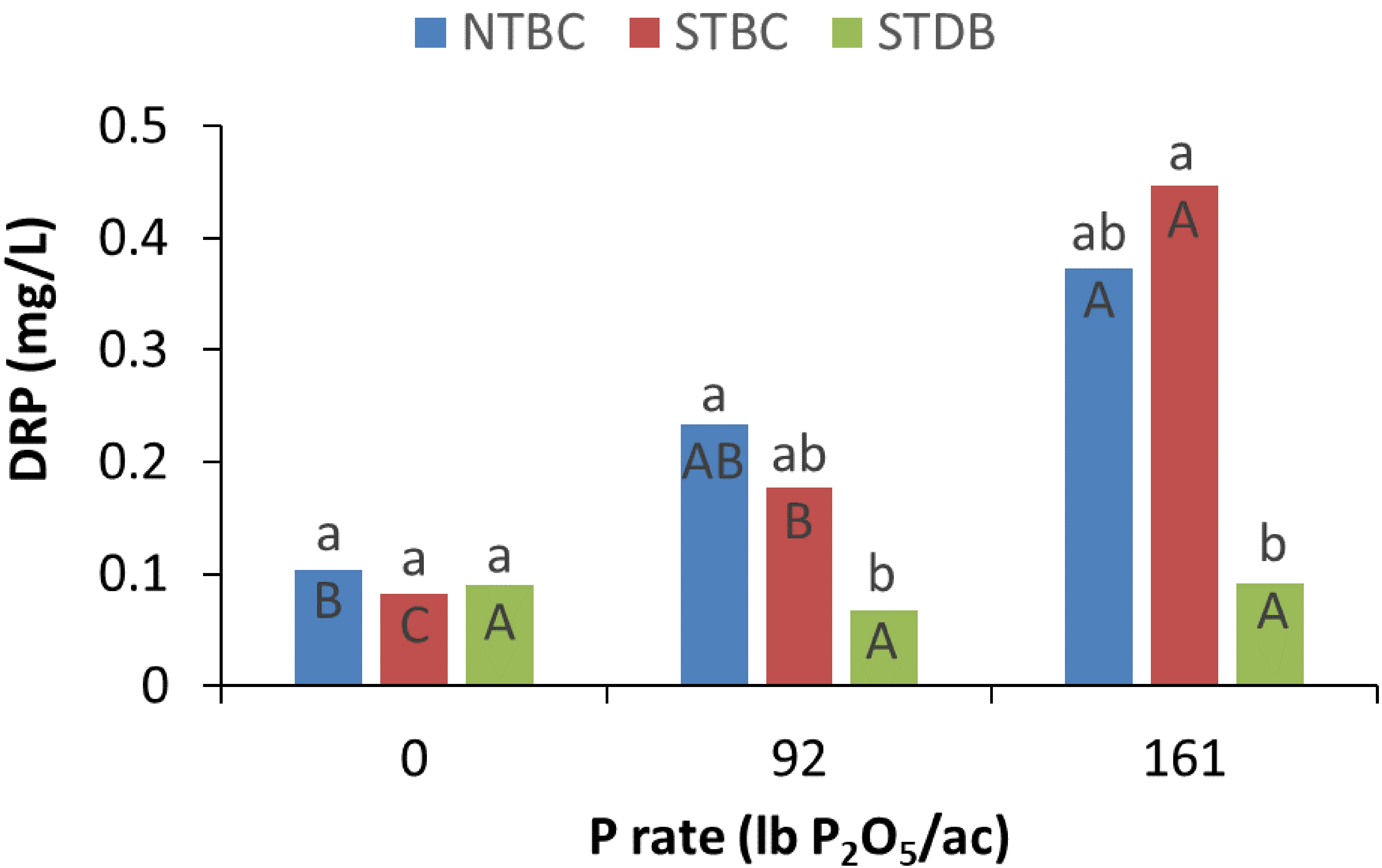


In-Season Soil K Change, V12-R2 (±70% of K uptake)



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



Nutrient Management

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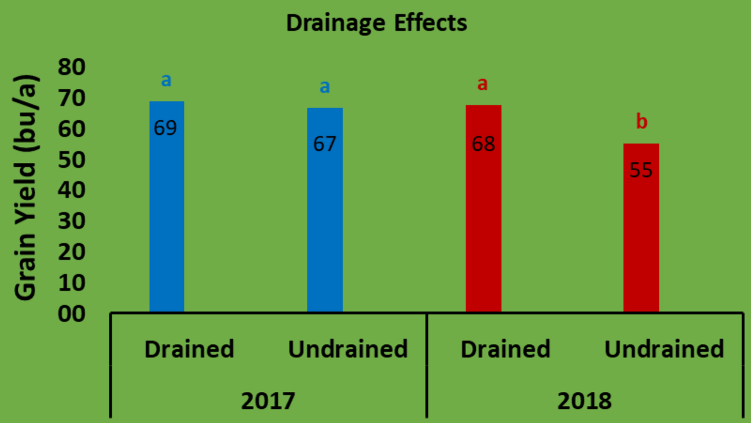
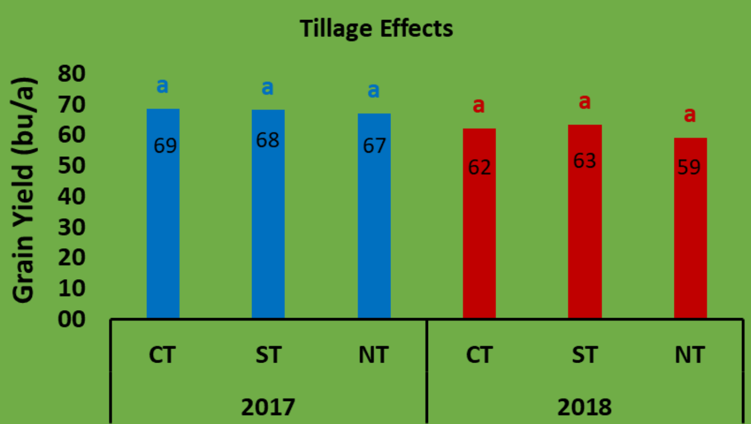
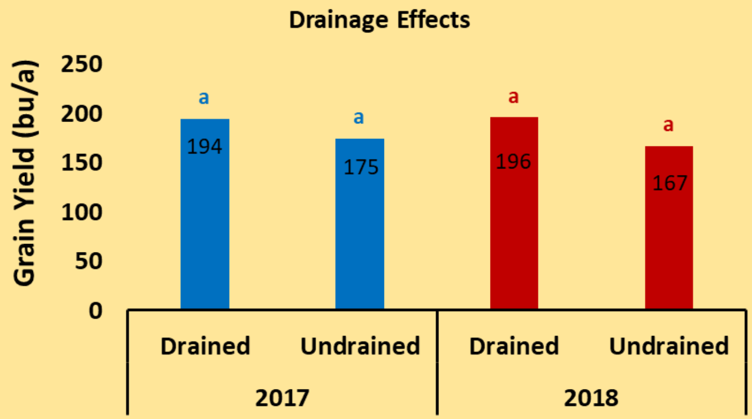
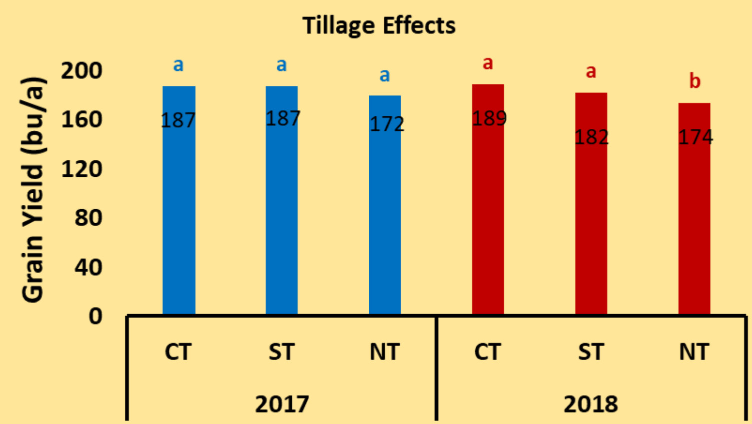
Soybeans





Corn





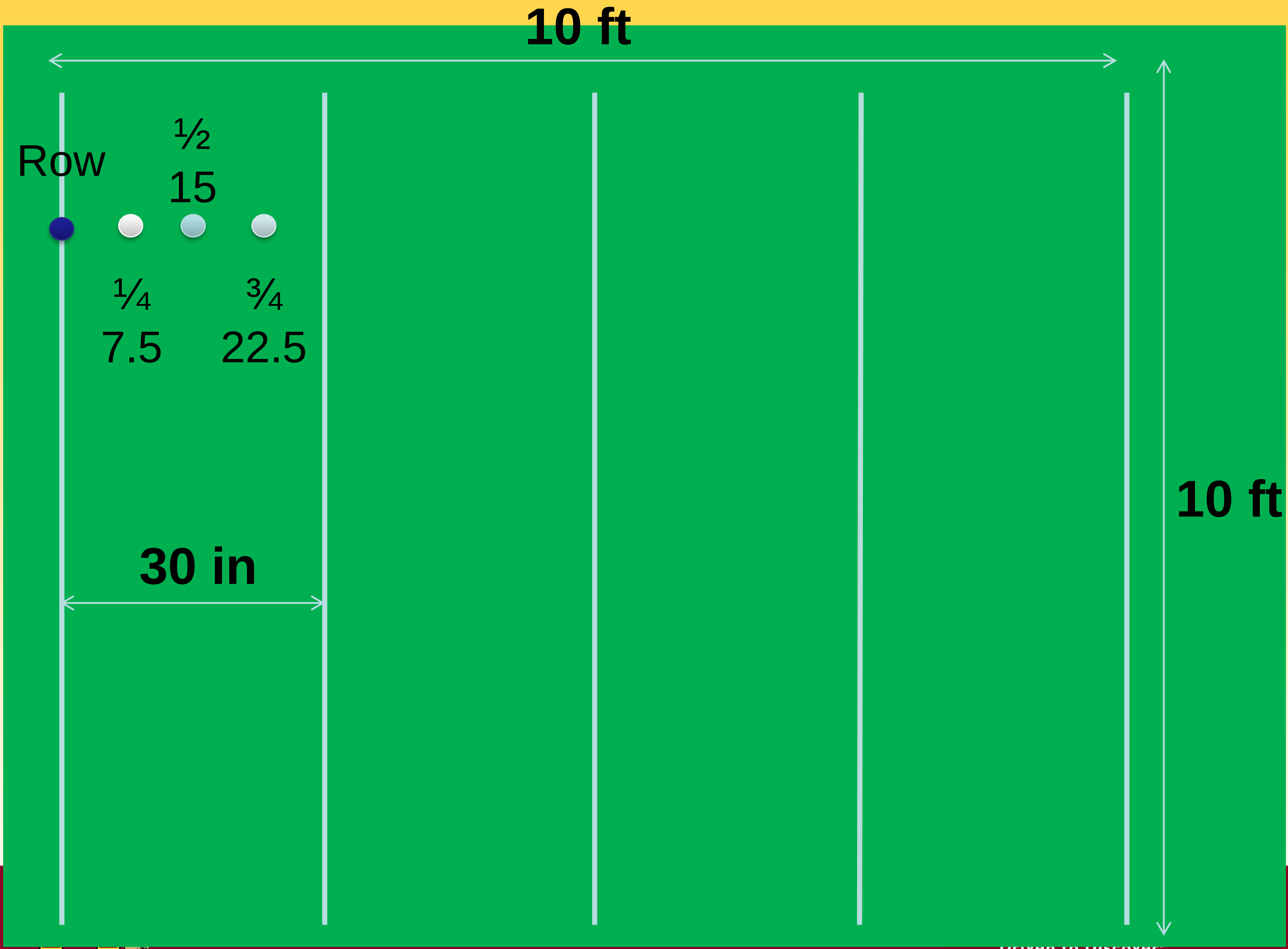
Is There a Role for Splitting N

Treatment	EONR			
	2017		2018	
	PPT	PPT/V6	PPT	PPT/V8
Drained-CT	154	197	200	174
Drained-NT	171	200	200	156
Drained-ST	147	158	200	184
Undrained-CT	200	200	200	167
Undrained-NT	187	171	200	200
Undrained-ST	173	200	200	189

Soil Sampling When P and K are Banded

Depth	Fertilizer rate treatment (lb P_2O_5 acre^{-1})		
	0	115	161
inch	—Soil P test level (lb acre^{-1}) —		
2	31	69	81
3	26	62	68
4	24	58	61
5	22	52	54
6	20	48	49
7 (CL 40)	**19**	**43**	**44**
8	18	40	41
9	17	37	38
10	16	34	35
11	15	32	33
12	14	30	32

Depth	Fertilizer rate treatment (lb K_2O acre^{-1})		
	0	115	161
inch	—Soil K test level (lb acre^{-1})—		
2	316	473	442
3	276	418	391
4	256	390	366
5	238	353	331
6	225	328	308
7 (CL 300)	**215**	**305**	**287**
8	207	287	272
9	202	273	261
10	198	262	252
11	196	256	245
12	195	251	239


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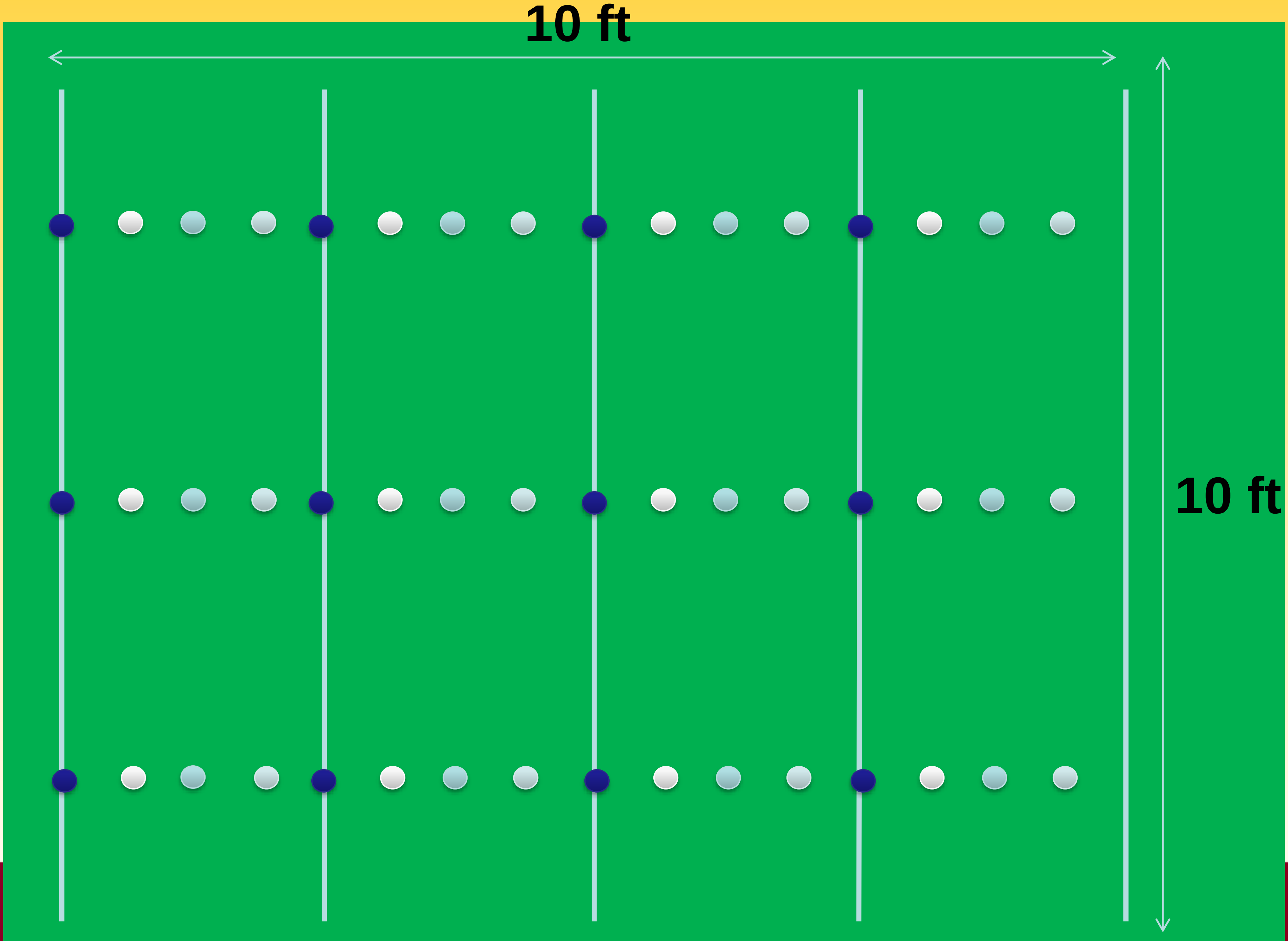
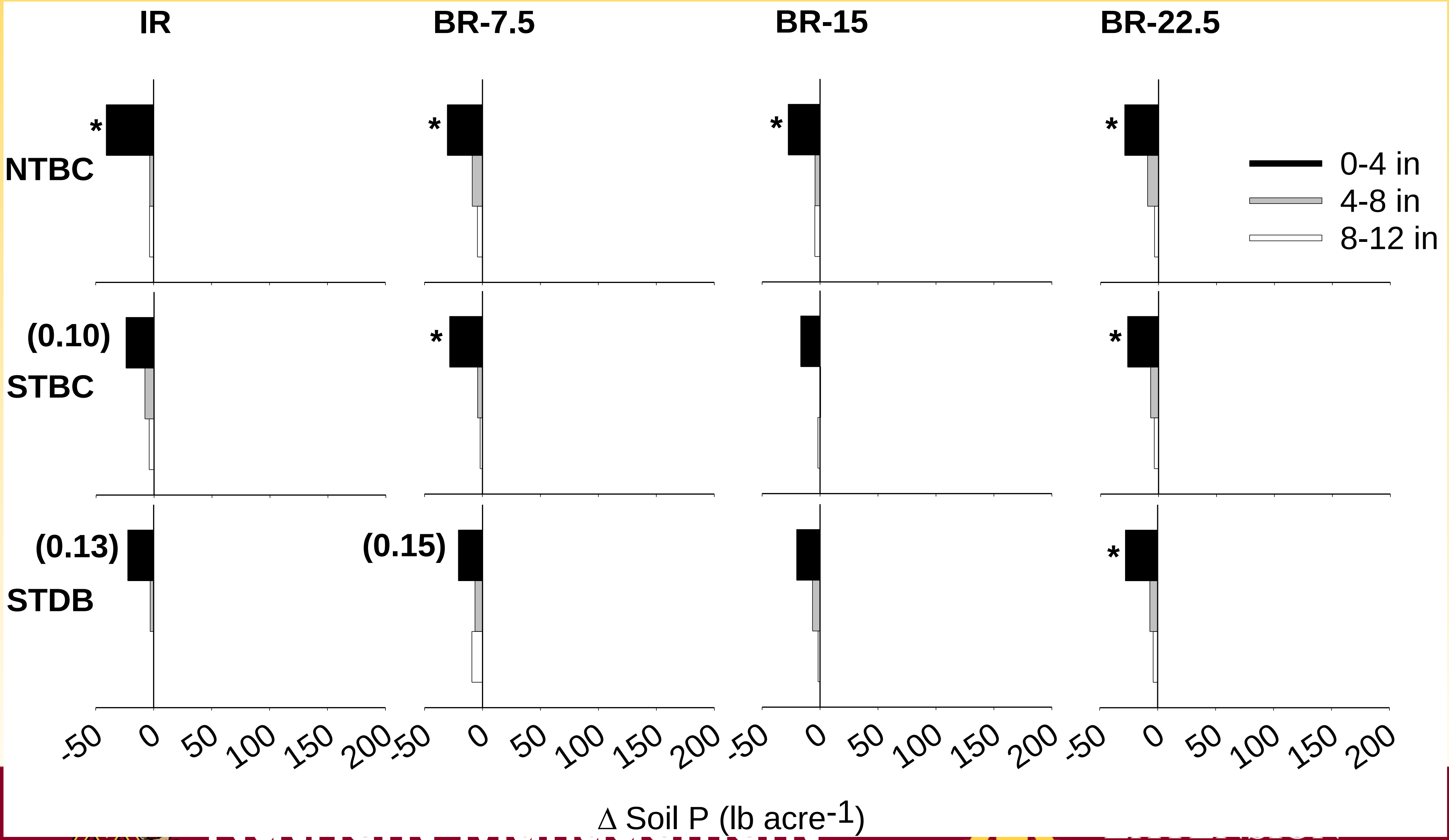
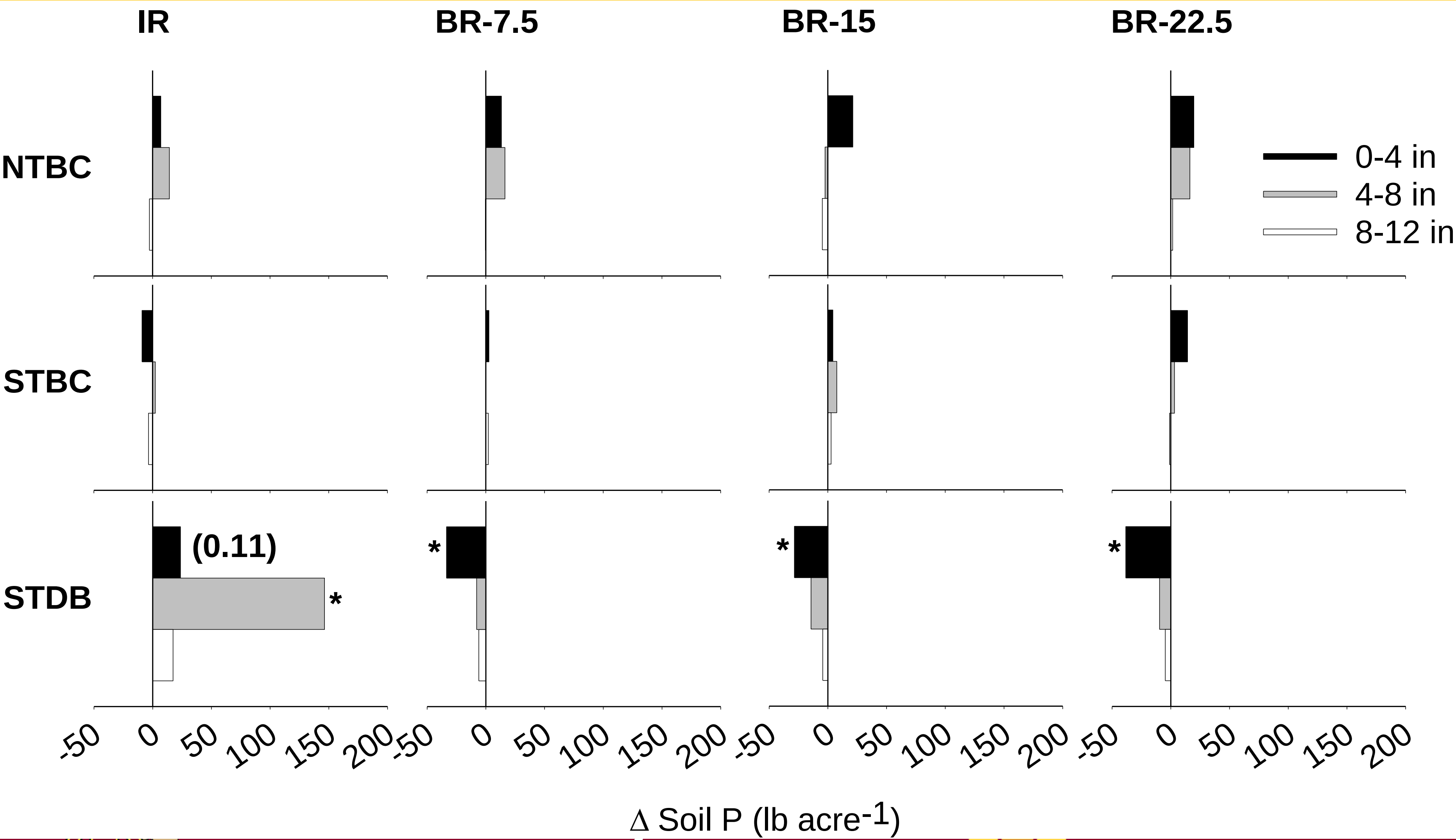

10 ft
10 ft

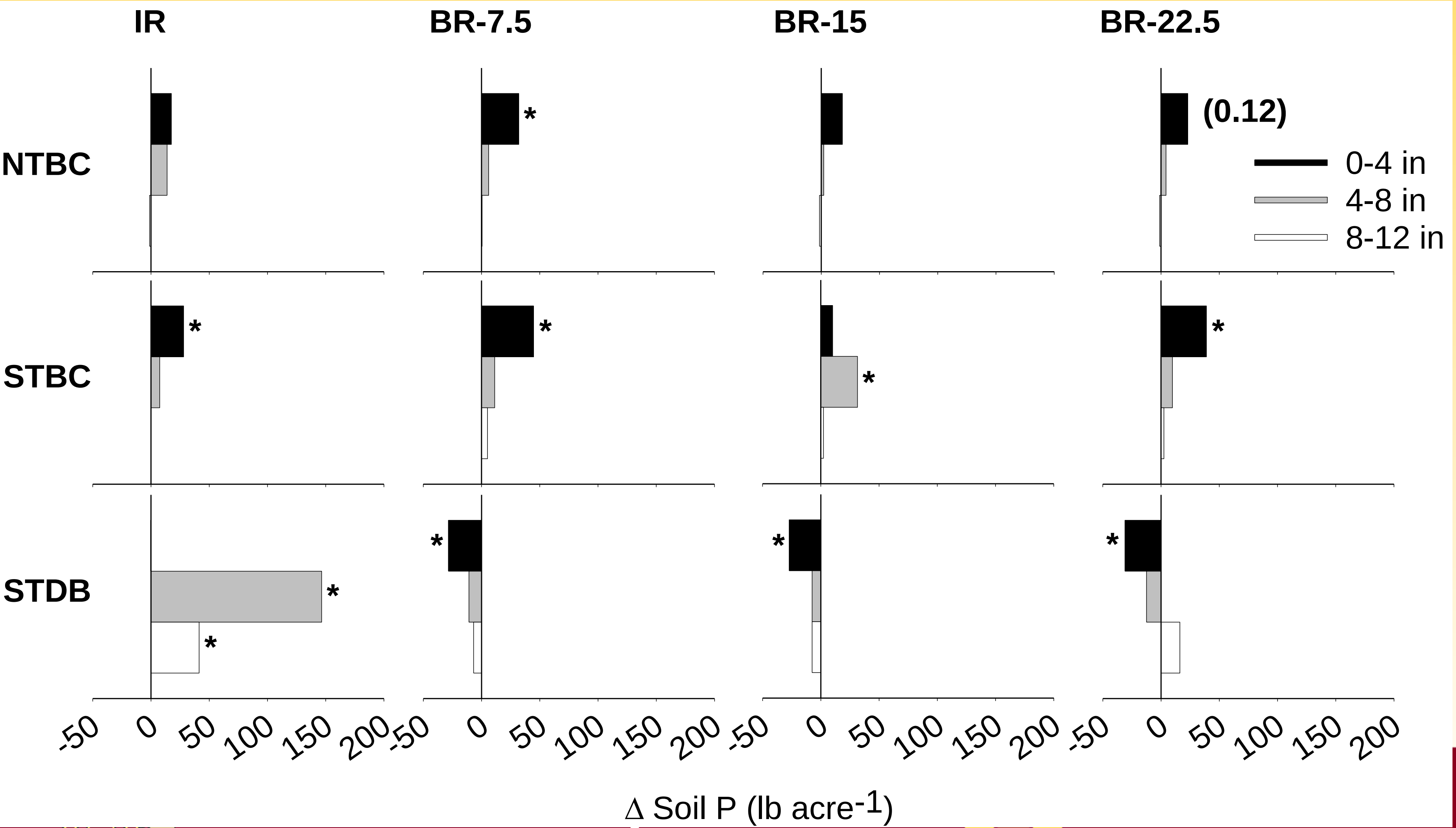
Check (0 lb P_2O_5)



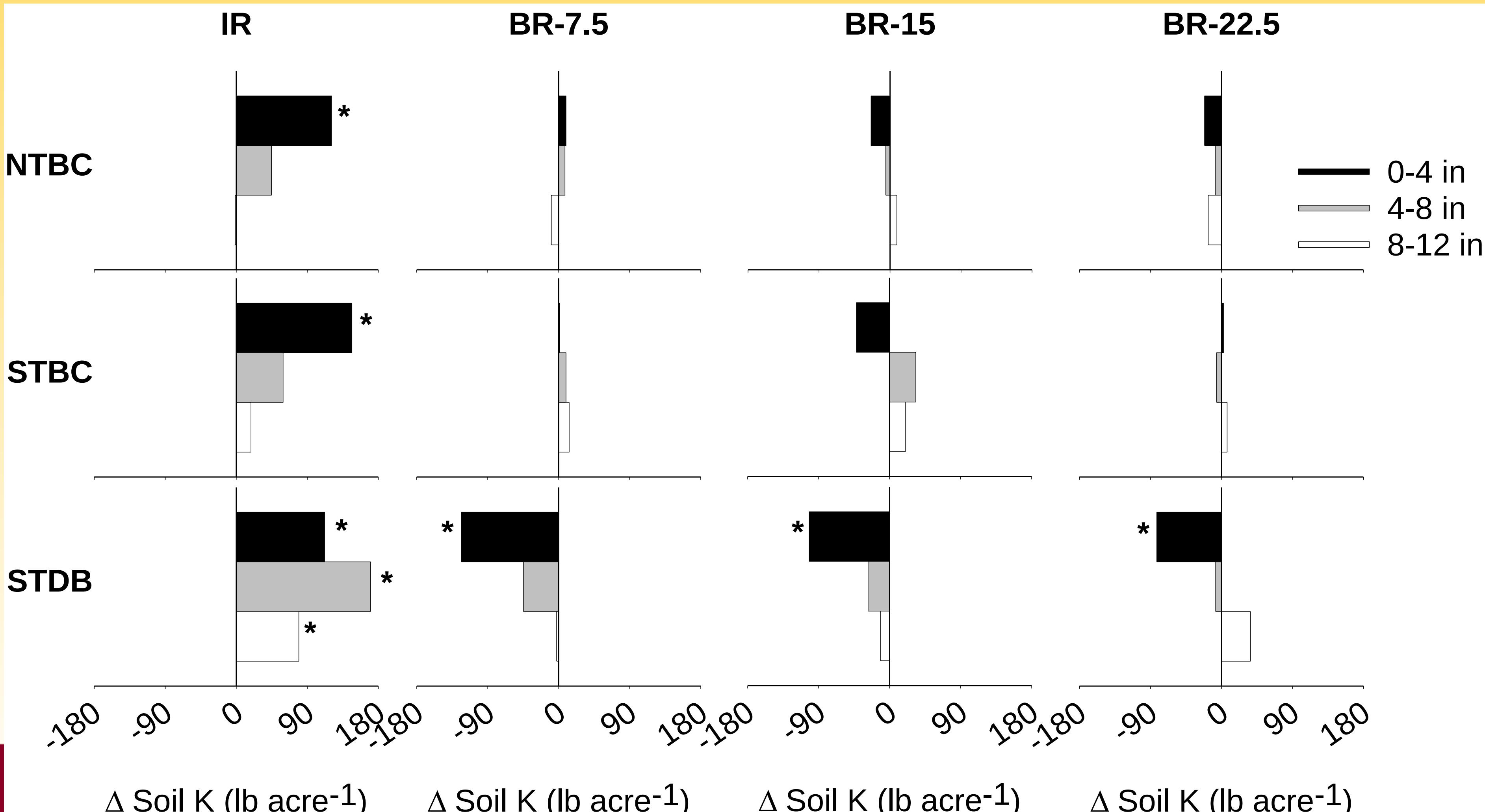
Maintenance (115 lb P_2O_5)

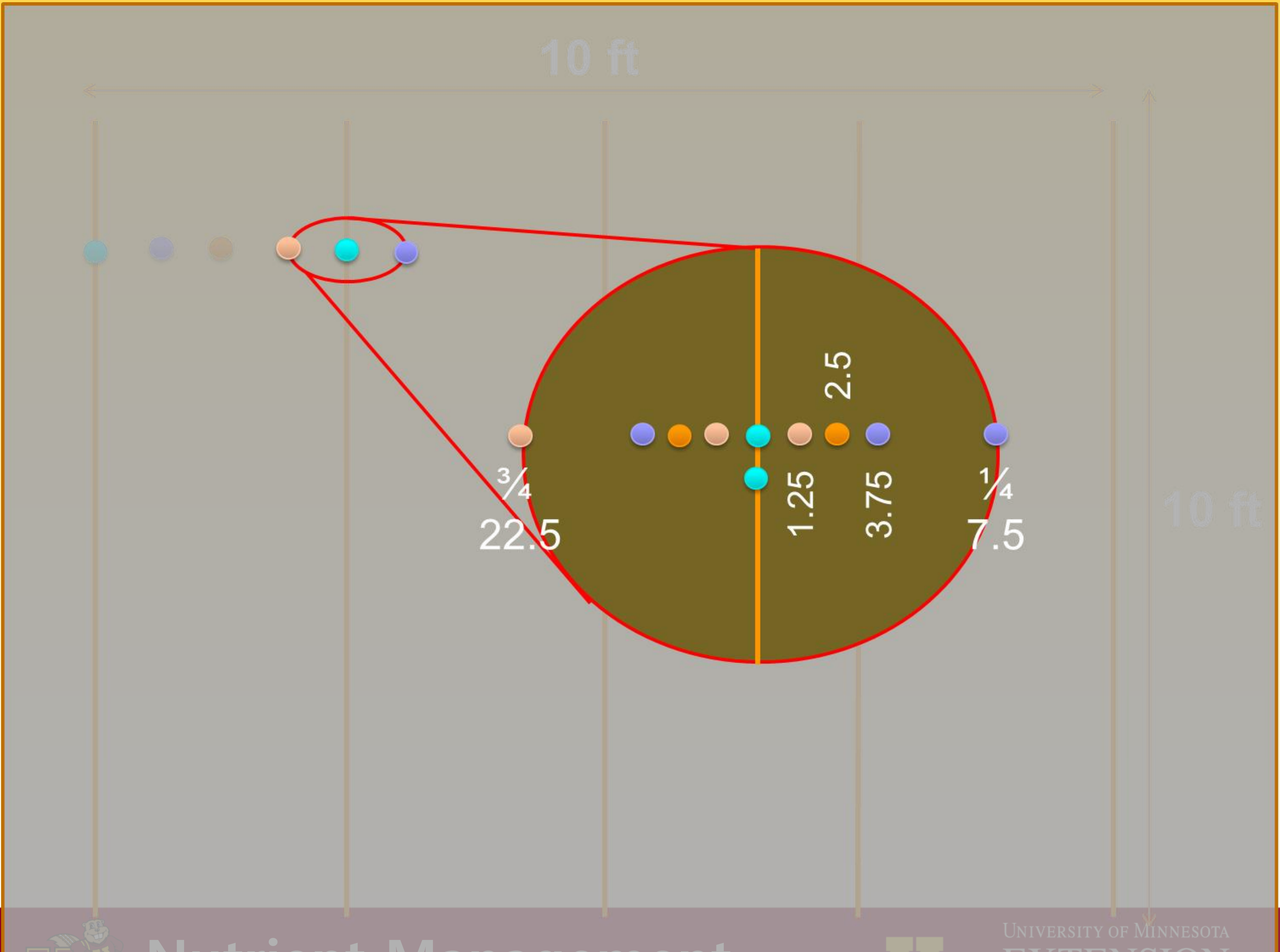


Highest Rate (161 lb P_2O_5)



Highest Rate (161 lb K_2O)

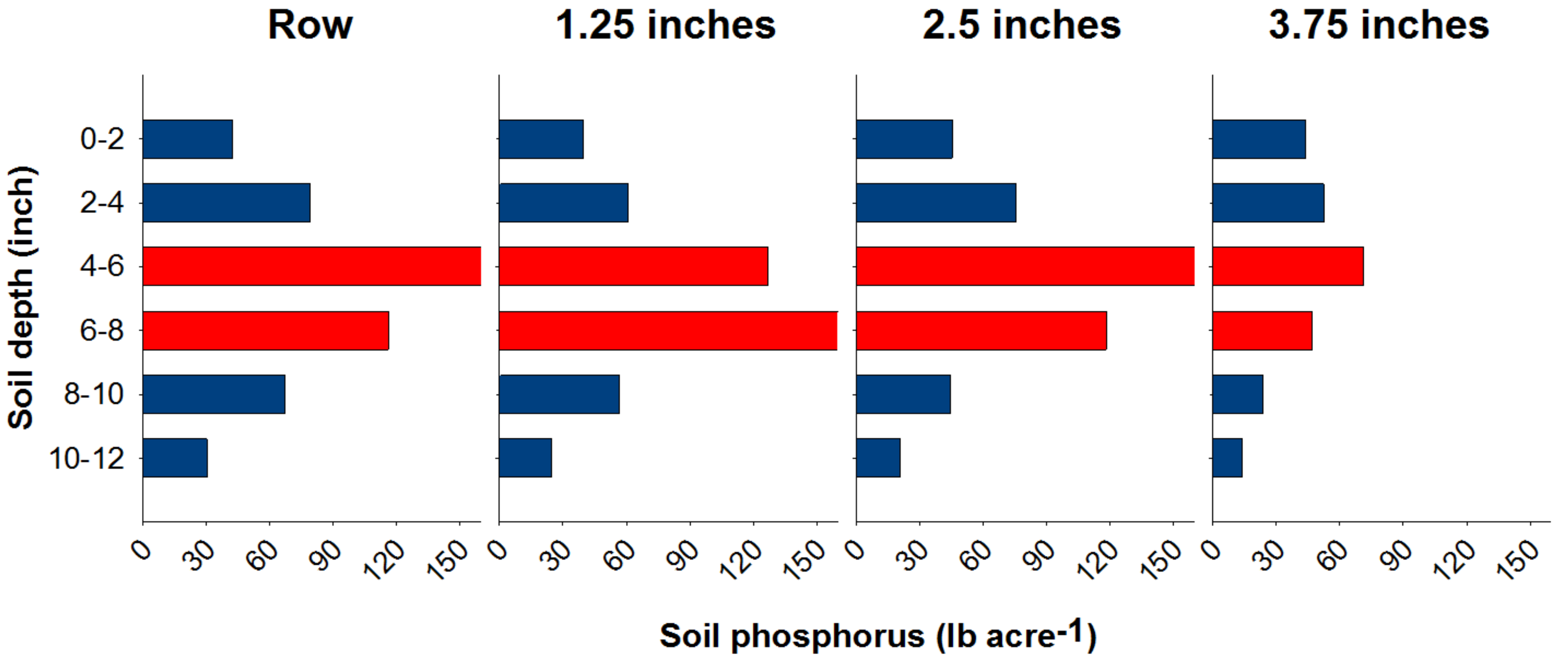




10 ft
2.5
¾
22.5
1.25
3.75
¼
7.5
10 ft

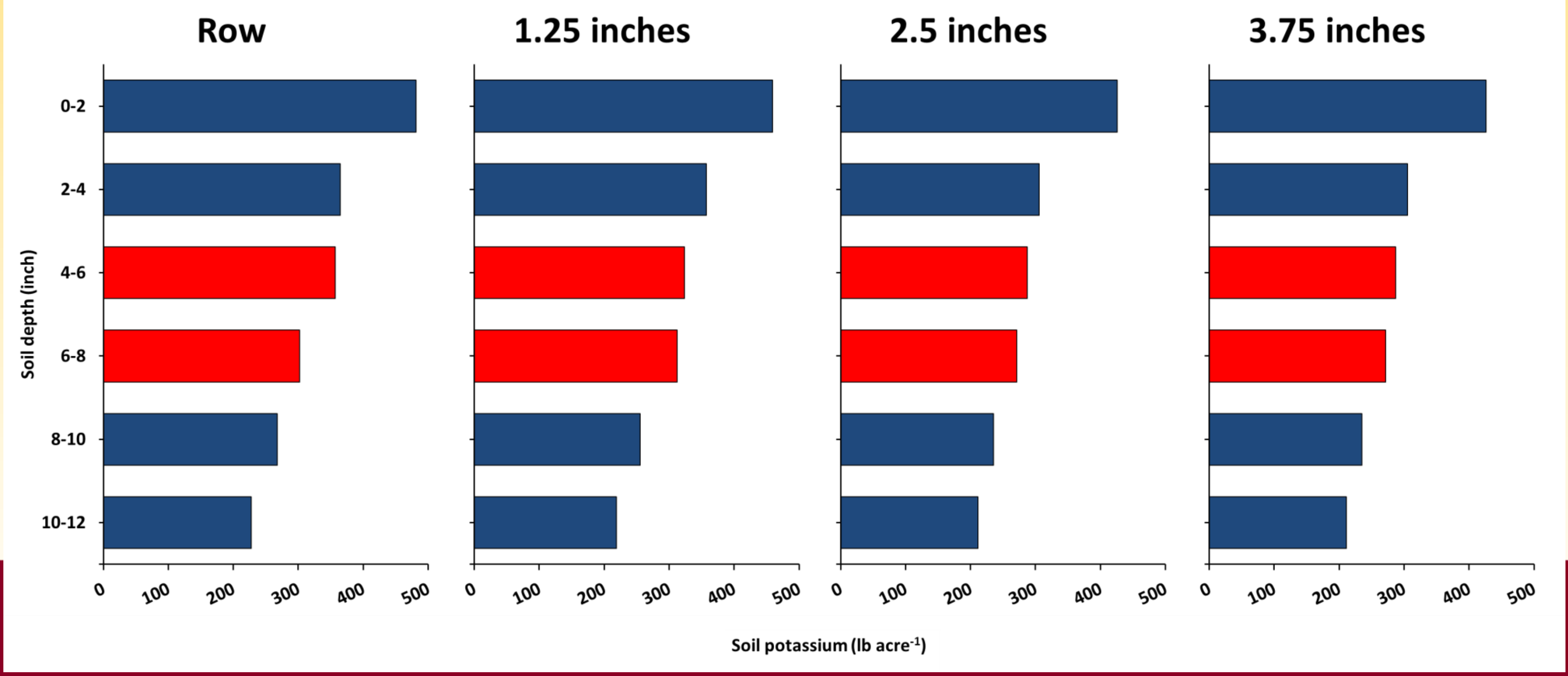
Small-Scale Fertilizer Movement/Application Variability (STDB, 161 lb P_2O_5)

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



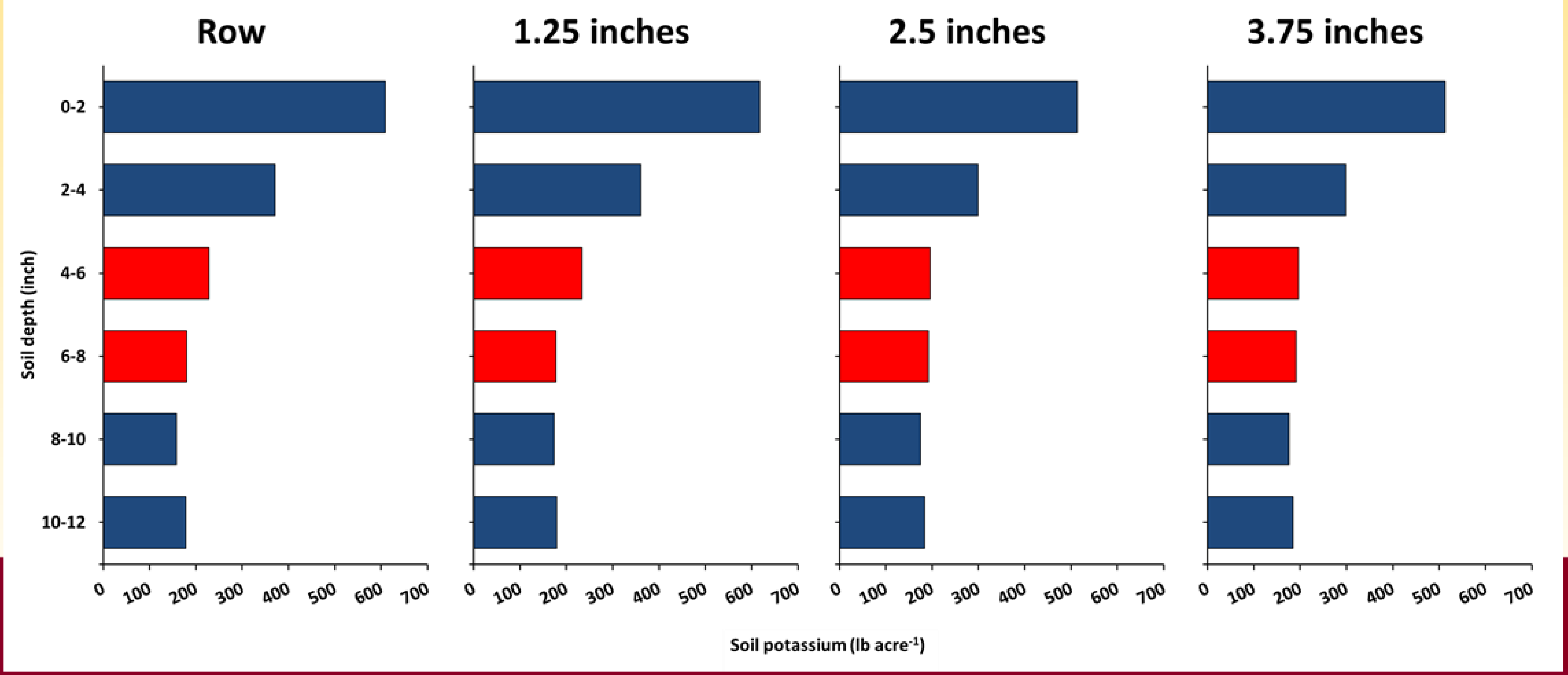
Small-Scale Fertilizer Movement/Application Variability (STDB, 161 lb K_2O)

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



Small-Scale Fertilizer Movement/Application Variability (STBC, 161 lb K_2O)

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



P&K	"True"	STBC				
	1:3	1:3	1:2	1:1	1:0	0:3
lb acre^{-1}	lb P acre^{-1}					
0	23	35	34	33	29	37
46	41	39	38	38	36	39
69	39	42	41	39	32	45
92	32	44	43	41	35	46
115	51	48	48	46	41	51
138	47	60	59	56	47	65
161	52	66	65	64	61	67
	lb K acre^{-1}					
0	256	250	254	262	287	237
46	279	264	271	285	327*	243
69	285	295	304	322*	374*	269
92	270	271	276	285	314*	257
115	302	293	300	313	353*	273
138	315	301	309	325	375*	276
161	310	322	329	344	385*	298

P&K	"True"	STDB				
	1:3	1:3	1:2	1:1	1:0	0:3
lb acre^{-1}	lb P acre^{-1}					
0	23	24	24	23	21	25
46	41	30	33	38	52	23*
69	39	39	42	49	70*	28*
92	32	49*	58*	74*	125*	24
115	51	50	59	76*	128*	24*
138	47	51	60	77*	133*	25*
161	52	45	53	67	111*	23*
	lb K acre^{-1}					
0	256	239	243	249	269	230*
46	279	262	271	288	340*	236*
69	285	276	286	306	366*	246*
92	270	297*	309*	335*	411*	259
115	302	292	306	335*	422*	249*
138	315	323	343*	382*	498*	265*
161	310	306	323	357*	460*	254*

Take Home Message

- Adequate P and K levels are more important than fertilizer placement
- Tillage and not P and K placement had an important effect in corn and soybean yields in our studies. Also strip-till had a positive benefit in soil properties
- No evidence that P and K rates can be reduced when banding the fertilizer
- When P and K are banded, for each core taken in the fertilizer band, 2-3 cores need to be taken away from the band
- 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

1. Yuan, M., F.G. Fernández, C.M. Pittelkow, K.D. Greer, and D. Schaefer. n.d. Phosphorus runoff from various application methods under conservation tillage with minimal slope. J. Environ. Qual. 47: 462-470
2. Sorensen, B., F.G. Fernández, and M.B. Villamil,. n.d. A comparison of soil properties in long-term no-till and strip-till sytems. Agron. J. 107: 1339-1346.
3. Fernández, F.G., B.S. Farmaha, and E.D. Nafziger. 2012. Soil fertility status of soils in Illinois. Commun. Soil Sci. and Plant Anal. 43: 2897-2914.
4. Farmaha, B.S., F.G. Fernández, and E.D. Nafziger. 2012b. Soybean seed composition, aboveground growth, and nutrient accumulation with phosphorus and potassium fertilization in no-till and strip-till. Agron. J. 104:1006-1015.
5. Fernández, F.G., and C.E. White. 2012. No-till and strip-till corn production with broadcast and subsurface-band phosphorus and potassium. Agron. J. 104: 996-1005.

6. Fernández, F.G., and D. Schaefer. 2012. Assessment of soil phosphorus and potassium following real time kinematic-guided broadcast and deep-band placement in strip-till and no-till. Soil Sci. Soc. Am. J. 76:1090-1099.
7. Farmaha, B.S., F.G. Fernández, and E.D. Nafziger. 2012a. Distribution of soybean roots, soil water, phosphorus and potassium concentrations with broadcast and subsurface-band fertilization. Soil Sci. Soc. Am. J. 76:1079-1089.
8. Farmaha, B.S., F.G. Fernández, and E.D. Nafziger. 2011. No-till and strip-till soybean production with surface and subsurface phosphorus and potassium fertilization. Agron. J. 103:1862-1869.


Thank You