Soybean and Cotton Fertility

Brian Arnall

OkState Precision Nutrient Management

Importance of Proper Fertility

In-Season Apps

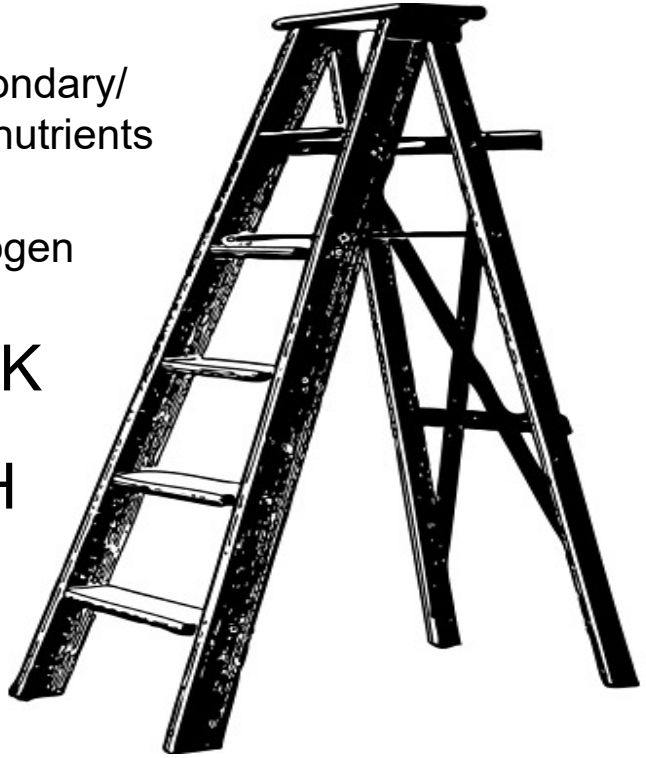
Secondary/
Micronutrients

Nitrogen

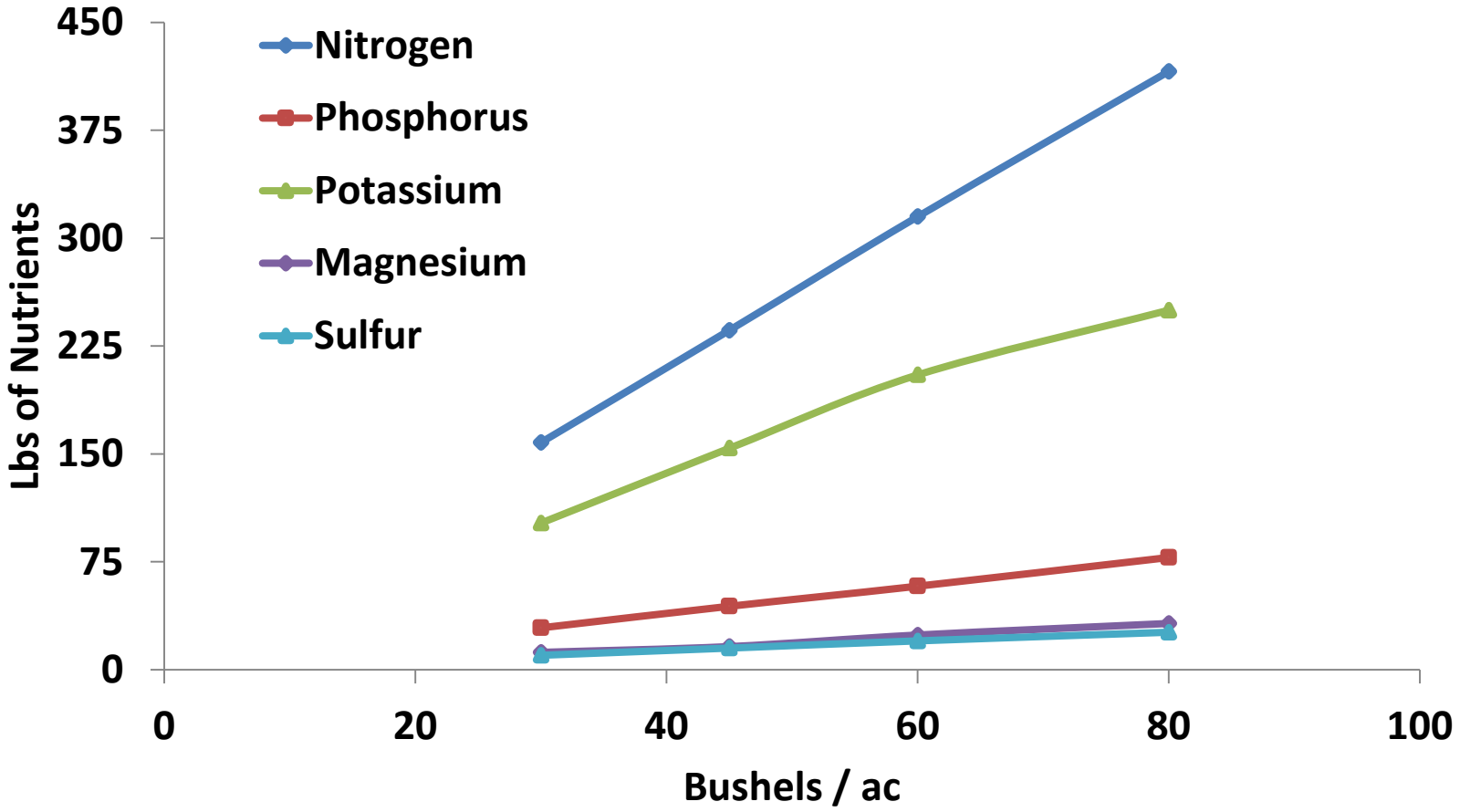
P & K

Soil pH

Soil Test



Soybean Nutrient Uptake



Nutrients removed in harvested crop

Crop	Unit	N	P2O5	K2O
Soybean	lb/bu	4.00	.80	1.4
Corn	lb/bu	.75	.44	.29
Wheat	lb/bu	1.29	.50	.30
Canola	lb/bu	1.88	.91	.46

Nutrient uptake by plant

Crop	Unit	N	P2O5	K2O
Soybean	lb/bu	5.26	.96	3.4
Corn	lb/bu	1.33	.56	1.33
Wheat	lb/bu	2.076	.675	2.3
Canola	lb/bu	3.00	1.33	2.4

Phosphorus and Potassium

Soil P Index	Percent Sufficiency	P2O5 lb/ac
0	40	70
10	60	50
20	80	30
40	95	20
>65	100	0

Soil K Index	Percent Sufficiency	K2O lb/ac
0	40	100
75	60	70
125	75	60
200	90	40
275	100	0
>350	100	0


About 2” of below ground biomass

Nitrogen

- The soybean a legume
  - In most cases N is not needed
    - If the field is well inoculated.
    - pH
- <60 bushels no N response in yield
- Can Increase Plant Size
- > 60 could benefit from N is residual is low
  - It should be noted that soybeans are extremely sensitive to salt injury and any addition of with seed starter should be done with caution.
- Most N deficiencies in Oklahoma
  - not from exceptional yields
  - improper inoculation procedures or lack of inoculation.

Sulfur

- Sulfur is similar to N in non legumes.

Yield Goal	Sulfur lbs/ac
10	3
20	6
30	9
40	12
50	15
60	18

Other Nutrients

- **Magnesium.**
- is sometimes deficient in highly acid soils.
- Considered deficient at <100 lbs/ac
- Liming with dolomite lime will correct Mg deficiency.

- **Boron**
- Is considered deficient when soil test <.5 ppm
- B deficiencies may occur on deep sandy, irrigated soils.
- Correct with banding 1 lb or less B at planting.

Other Nutrients

- **Molybdenum.**
- Molybdenum (Mo) is sometimes deficient in highly acid soils. A seed treatment of 0.2-.04 ounce of Mo per acre may be applied.
- Liming will correct Mo deficiency.
- In Oklahoma test, liming has proven to be the best solution for Mo deficiency problems.

- **Iron and Zinc**
- Iron (Fe) and Zinc (Zn) deficiencies may occur on soybeans grown in calcareous (calcium and magnesium rich) and/or high pH (>7.5) soils.
- Foliar spraying of Fe is most effective but expensive.
  - Often fields that are only slightly deficient will grow out of the deficiency without a loss of yield.
- Zinc deficiencies can be corrected by the application of 2 to 4 pounds per acre of zinc in the form of a zinc sulfate or zinc chelate.
  - Normally Zn is applied with a starter fertilizer and may not need to be applied every year.

Fertility Issues

- **Banding with seed (Irrigated)**
  - Soybeans are very sensitive to N and K. Reduced stand.
  - Urea (46-0-0) and DAP (18-46-0) should be avoided as they can release large amounts of free ammonia (NH_3) that will damage seed and seedlings.
- **Broadcast application pre-plant or a 2x2 band**
  - Band application is recommended for soybeans, but broadcast application ahead of planting works well.
- **Historically**
  - Build the fertility levels on the crop previous to soybeans in the rotation, in double crop soybeans. **?????? NOW??????**
  - Sufficient fertility must be carried over for the soybeans or additional fertilizer will have to be added for the soybean crop.
  - P and K
    - total amount applied is less if the fertilizer is applied prior to the soybean crop as apposed to applying enough for the previous and soybean crop.

Last note on Beans

- Watch for Stink Bugs

Cotton

OSU Recs

Table 1. Primary Nutrient Soil Test Interpretations for Selected Small Grains and Row Crops.

Nitrogen Requirements

SMALL GRAIN				GRAIN SORGHUM		CORN		COTTON		CANOLA	
Yield Goal (bu/A)			**N**	Yield Goal	**N**	Yield Goal	**N**	Yield Goal	**N**	Yield Goal	**N**
Wheat	*Barley*	*Oats*	***(lbs/A)***	*(lbs/A)*	***(lbs/A)***	*(bu/A)*	***(lbs/A)***	*(bales/A)*	***(lbs/A)***		***(lbs/A)***
15	20	25	**30**	2000	**30**	40	**40**	0.50	**25**	1000	**50**
20	25	35	**40**	2500	**40**	50	**50**	0.75	**37**	1500	**75**
30	35	55	**60**	3000	**50**	60	**60**	1.00	**50**	2000	**100**
40	50	70	**80**	4000	**70**	85	**85**	1.25	**67**	2500	**125**
50	60	90	**100**	4500	**85**	100	**110**	1.50	**75**	3000	**150**
60	75	105	**125**	5000	**100**	120	**130**	1.75	**87**	3500	**175**
70	90	125	**155**	7000	**160**	160	**190**	2.00	**100**		
80	100	140	**185**	8000	**195**	180	**215**	2.25	**112**		
100	125	175	**240**	9000	**230**	200	**240**	2.50	**125**		

Per 10 ppm of NO3 you get 2.25 lbs N per acre inch
10 ppm and 12 inches = 27 lbs N.

OSU Recs

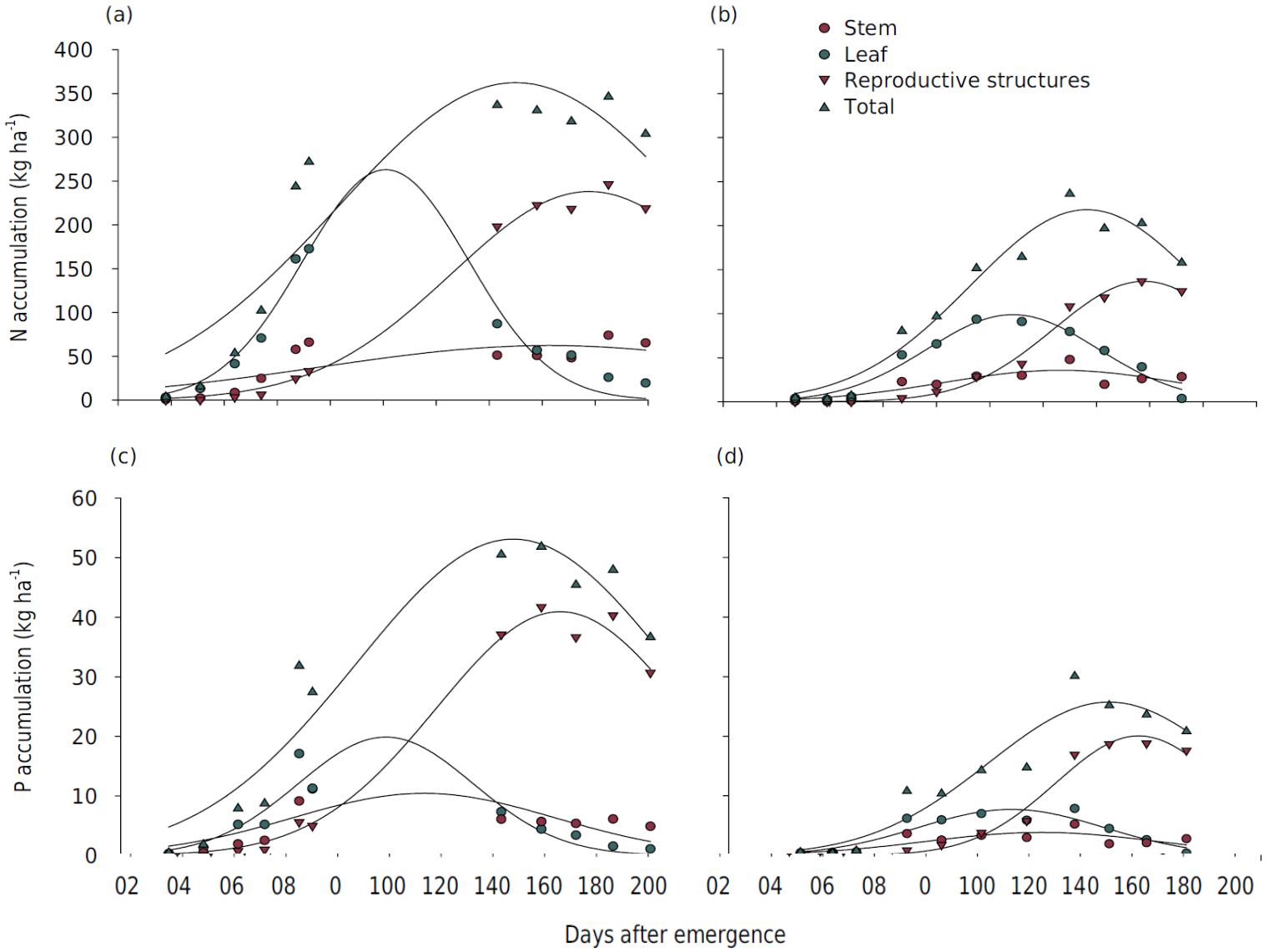
Phosphorus Requirements

P SOIL TEST INDEX	SMALL GRAINS		GRAIN SORGHUM		CORN		COTTON		CANOLA	
	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)
0	25	80	40	60	30	80	55	75	25	80
10	45	60	60	50	60	60	70	60	45	60
20	80	40	80	40	80	40	85	45	80	40
40	90	20	95	20	95	20	95	30	90	20
65+	100	0	100	0	100	0	100	0	100	0

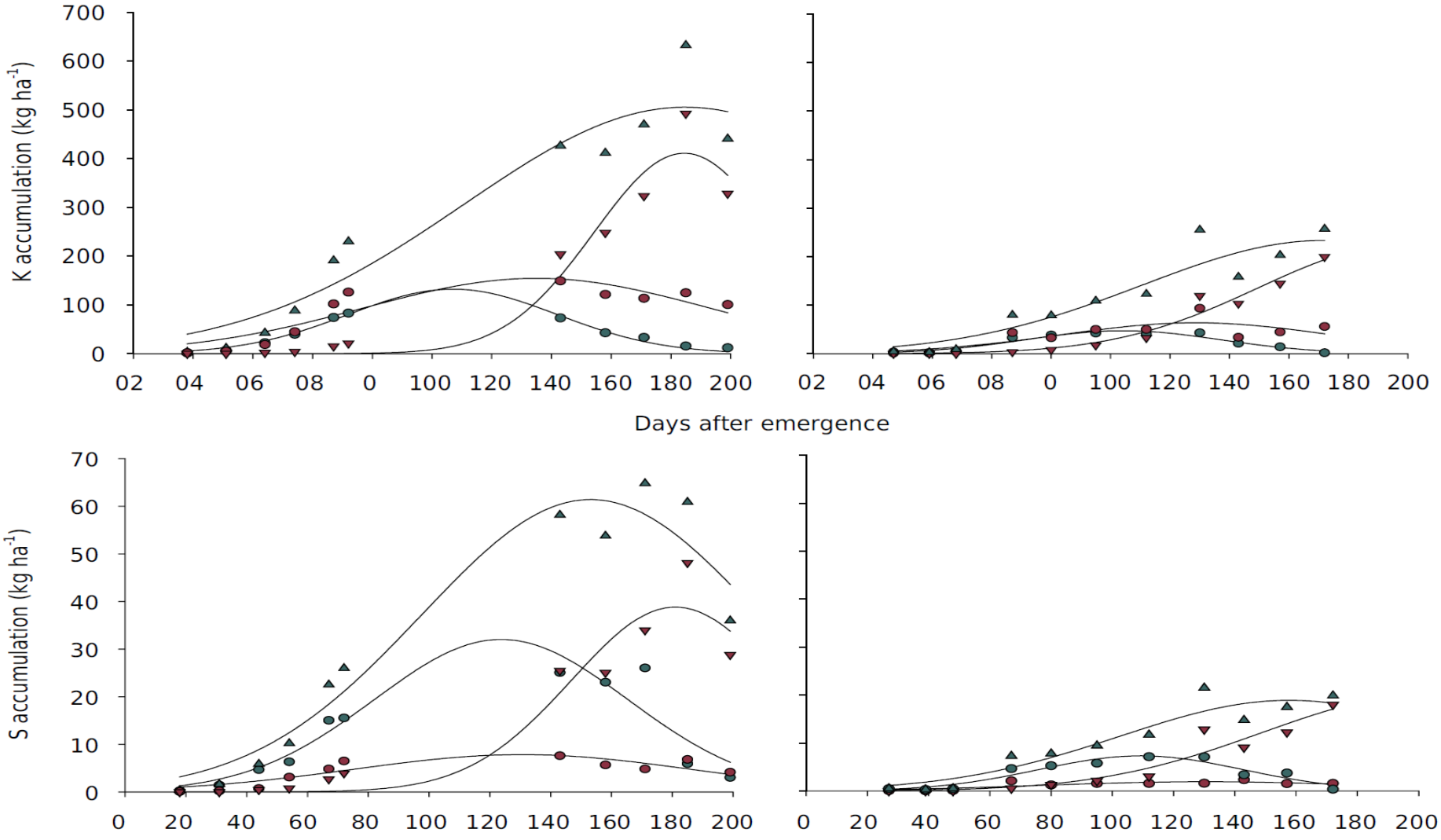
Potassium Requirements

K SOIL TEST INDEX	SMALL GRAINS		GRAIN SORGHUM		CORN		COTTON		CANOLA	
	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)
0	50	60	40	100	40	120	40	110	50	60
75	70	50	65	75	60	80	60	80	70	50
125	80	40	80	50	75	60	75	60	80	40
200	95	20	95	30	90	40	90	40	95	20
250+	100	0	100	0	100	0	100	0	100	0

5 bale vs 2.5 bale



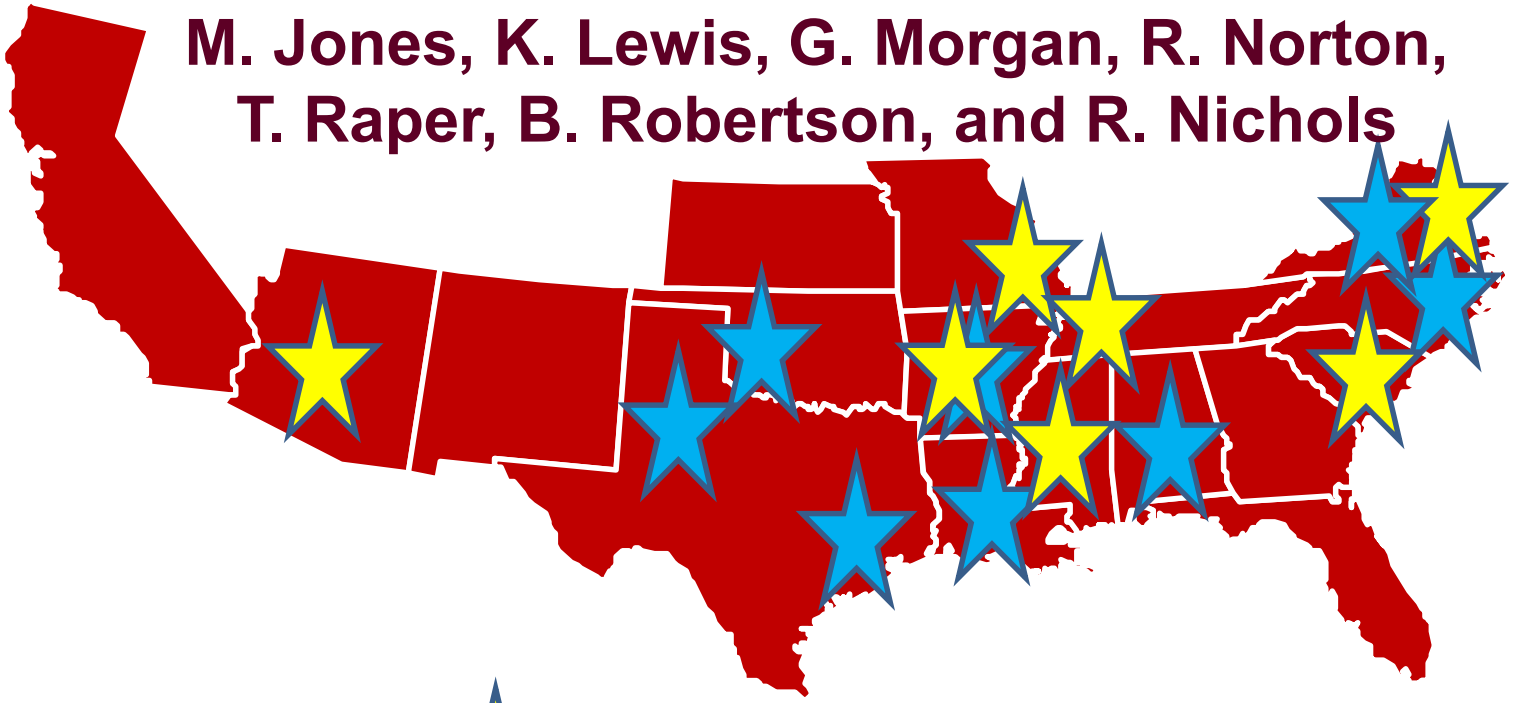
K and S


K accumulation (kg ha-1)
700
600
500
400
300
200
100
0
02
04
06
08
0
100
120
140
160
180
200
Days after emergence
S accumulation (kg ha-1)
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200

MATERIALS AND METHODS

- **2015-2017 Locations**

R. Boman, T. Cutts, D. Delaney, D. Dodds, K. Edmisten, H. Frame D. Fromme, A. Jones, M. Jones, K. Lewis, G. Morgan, R. Norton, T. Raper, B. Robertson, and R. Nichols



Single year sites

Multi-year sites

Katie L. Lewis
Assistant Professor, Soil Chemistry and Fertility
Texas A&M AgriLife Research – Lubbock
Plant and Soil Science, Texas Tech University

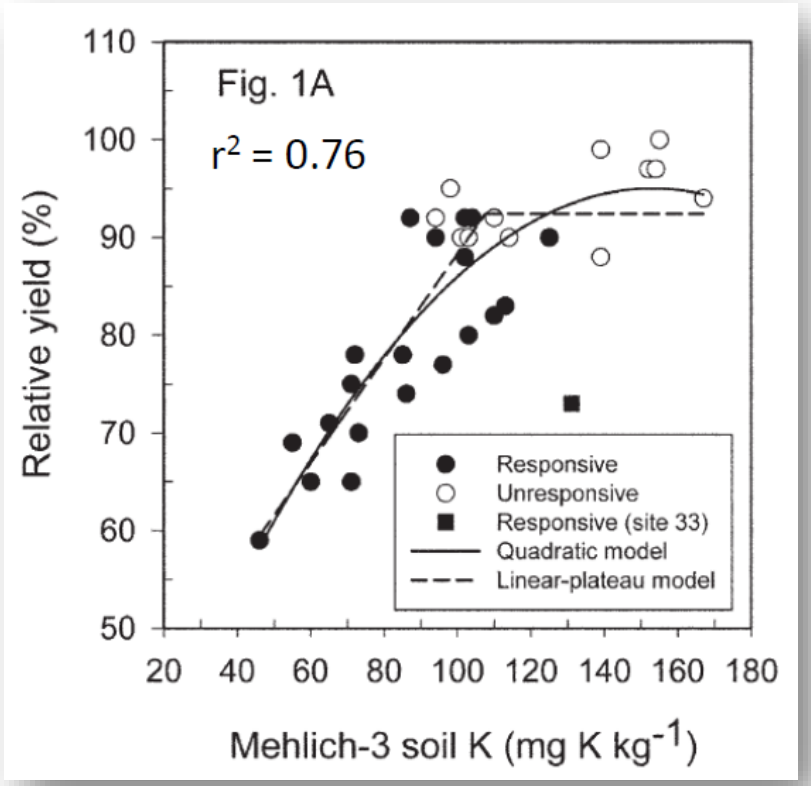
Year	Location	Mehlich-3 K concentrations at different soil depths								
		0-6"		6-12"		12-24"		*P > F*	0-12"	0-24"
		mg K kg^{-1} soil							mg K kg^{-1} soil	
2016	VA	30	a	40	a	37	a	0.748	35	36
2016	**★AL**	**39**	**b**	**56**	**a**	**44**	**b**	**0.002**	**48**	**46**
2017	AL	56	a	54	a	67	a	0.153	55	59
2015	AL	61		64		82			63	69
2017	VA	61	a	47	a	61	a	0.184	54	56
2017	NC	73	a	69	a	63	a	0.344	71	68
2016	WM	83	a	77	a	86	a	0.133	80	82
2016	**NC**	**86**	**a**	**66**	**b**	**57**	**b**	**0.007**	**76**	**70**
2015	VA	92	a	99	a	93	a	0.393	95	94
2015	WM	96	a	96	a	98	a	0.694	96	97
2017	**MS**	**100**	**a**	**90**	**b**	**89**	**b**	**0.071**	**95**	**93**
2017	**LA**	**152**	**a**	**129**	**b**	**92**	**c**	**0.003**	**140**	**124**
2017	**★AR**	**158**	**b**	**167**	**b**	**212**	**a**	**0.005**	**163**	**179**
2015	**LA**	**159**	**a**	**144**	**b**	**129**	**c**	**0.0004**	**151**	**144**
2016	**★AR**	**168**	**ab**	**153**	**b**	**174**	**a**	**0.099**	**160**	**165**
2015	**AR**	**174**	**a**	**112**	**b**	**99**	**c**	**<.0001**	**143**	**128**
2016	**LA**	**177**	**a**	**139**	**b**	**92**	**c**	**0.0004**	**158**	**136**
2016	**OK**	**204**	**a**	**178**	**b**	**171**	**c**	**0.0002**	**191**	**185**
2017	**WM**	**207**	**a**	**216**	**a**	**180**	**b**	**0.001**	**211**	**201**
2017	**LU**	**261**	**a**	**236**	**b**	**246**	**b**	**0.019**	**249**	**248**
2017	OK	267	a	267	a	259	a	0.366	267	264
2016	**LU**	**277**	**a**	**265**	**a**	**244**	**b**	**0.015**	**271**	**262**
2015	**LU**	**391**	**a**	**281**	**b**	**253**	**c**	**<.0001**	**336**	**309**

Lint Yield

Year	Loc.	Soil	Broadcast K, lb K_2O acre^{-1}					*P > F*	LSD	Injected K, lb K_2O acre^{-1}					*P > F*	LSD
		K	0	40	80	120	160			0	40	80	120	160		
		mg kg^{-1}	lb acre^{-1}							lb acre^{-1}						
2016	VA	30	78	236	427	406	321	**0.002**	**268**	114	319	456	296	469	**0.004**	**302**
2016	AL	39	1123	1120	1093	1166	1147	0.888	ns	1130	1176	1129	1159	1112	0.652	ns
2017	AL	56	1777	1569	1609	1526	1552	**0.034**	**347**	1657	1386	1489	1583	1499	0.428	ns
2015	AL	61	1382	1500	1407	1530	1334	0.630	ns	1393	1429	1453	1536	1619	0.174	ns
2017	VA	61	1342	1633	1970	1868	1597	**0.005**	**486**	1806	1932	1588	1638	1691	0.541	ns
2017	NC	73	1411	1497	1426	1475	1478	0.515	ns	1344	1425	1518	1430	1533	**0.067**	**257**
2016	WM	83	219	246	218	306	317	**0.094**	**112**	185	209	257	244	309	**0.031**	**111**
2016	NC	86	661	590	648	743	636	0.924	ns	627	654	655	609	625	0.956	ns
2015	VA	92	1237	1216	1228	1220	1235	0.850	ns	1260	1210	1173	1224	1283	0.599	ns
2015	WM	96	318	343	416	385	392	**0.032**	**107**	298	377	434	363	421	**0.001**	**98**
2017	MS	100	600	506	507	528	537	0.228	ns	543	545	530	561	512	0.926	ns
2017	LA	152	904	902	842	944	891	0.899	ns	953	886	951	871	820	0.357	ns
2017	AR	158	1177	1099	1231	1103	1072	0.691	ns	1204	1303	1226	1257	1131	0.838	ns
2015	LA	159	1549	1454	1464	1309	1355	0.281	ns	1322	1368	1297	1551	1553	0.374	ns
2016	AR	168	1132	1105	1088	1116	1163	0.909	ns	1096	1140	1145	1295	1267	0.375	ns
2015	AR	174	1382	1401	1343	1343	1312	0.772	ns	1342	1362	1272	1336	1433	0.928	ns
2016	LA	177	1374	1497	1473	1479	1497	0.152	ns	1522	1508	1487	1466	1525	0.752	ns
2016	OK	204	1629	1788	1779	1788	1893	**0.002**	**183**	1767	1851	1857	1768	1862	0.279	ns
2017	WM	207	800	875	734	754	788	0.881	ns	811	771	701	790	814	0.500	ns
2017	LU	261	1695	1602	1600	1847	1773	0.922	ns	1758	1871	1868	1539	1865	0.856	ns
2017	OK	267	1652	1678	1607	1685	1630	0.975	ns	1713	1723	1733	1701	1573	0.516	ns
2016	LU	277	1724	1753	1902	1649	1629	0.945	ns	1474	1695	1813	1778	1788	**0.032**	**474**
2015	LU	391	1790	1640	1739	1687	1660	0.119	ns	1670	1743	1767	1770	1868	**0.033**	**190**

SOIL TEST CORRELATION

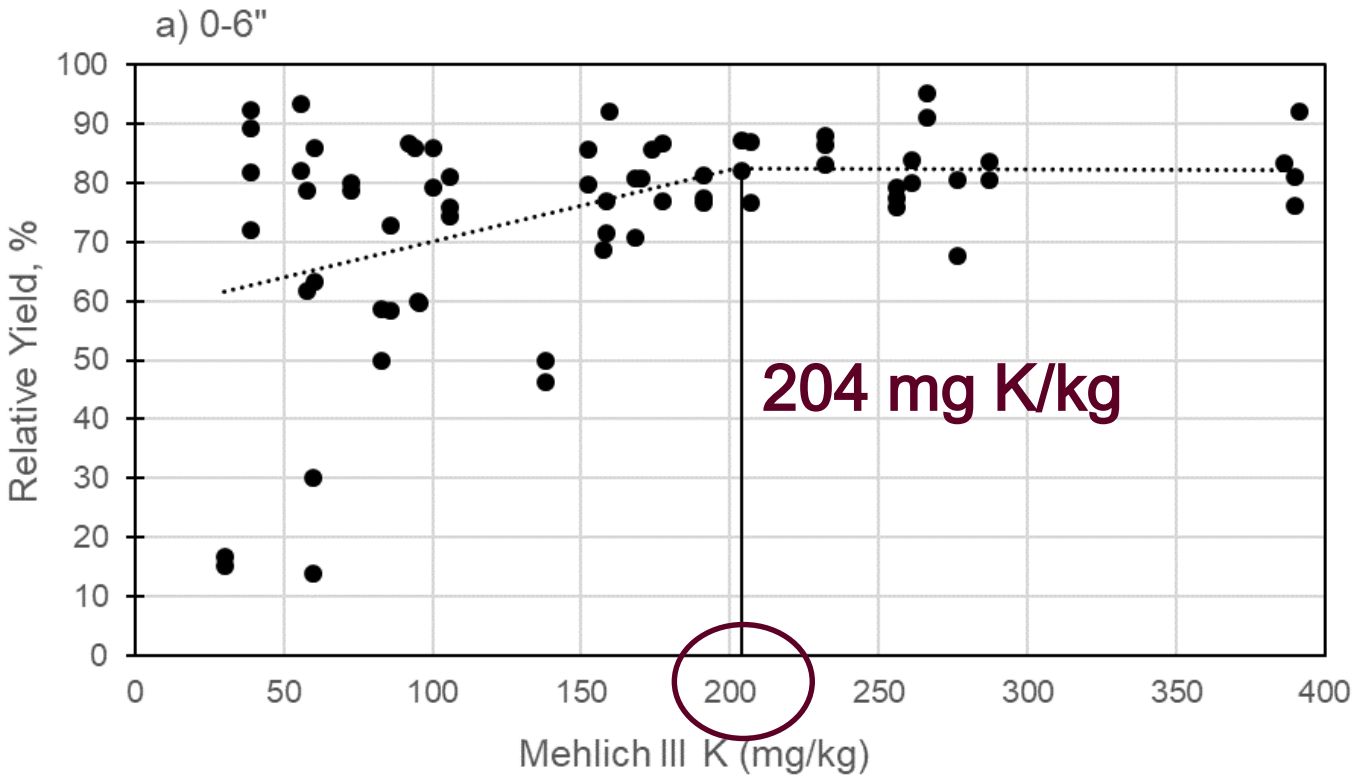
- **Relative Yield (RY)**
  - RY, % = $(K_0/K_T)*100$
  - RY < 100 means $K_T > K_0$ (responsive site)
  - RY ≥ 100 means $K_T < K_0$ (nonresponsive site)
- **Linear plateau model in SAS 9.4 used to define the critical level**
- **Additional Texas site years added (2012 – 2014) including locations in Wharton and**



Slaton et al. (2010)

POTASSIUM SOIL TEST CORRELATION

Mehlich III K critical level is currently 125 mg/kg



Observations	Plateau	Joint	*P*-value
68	83%	204 mg/kg	0.001

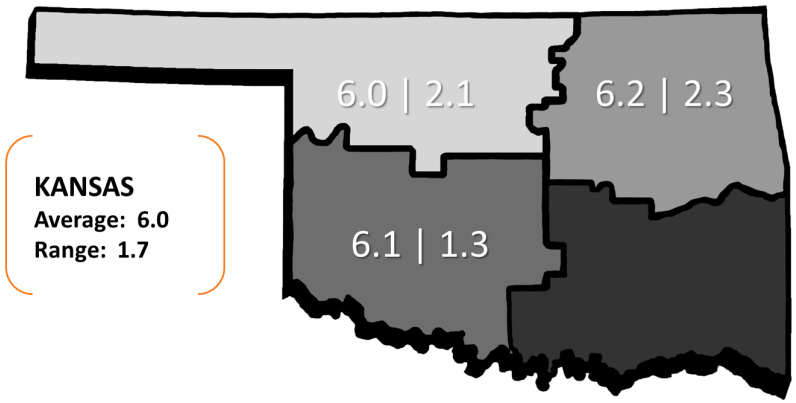
Relative Yield = mean of check lint yield divided by highest numerical treatment lint yield; multiplied by 100.

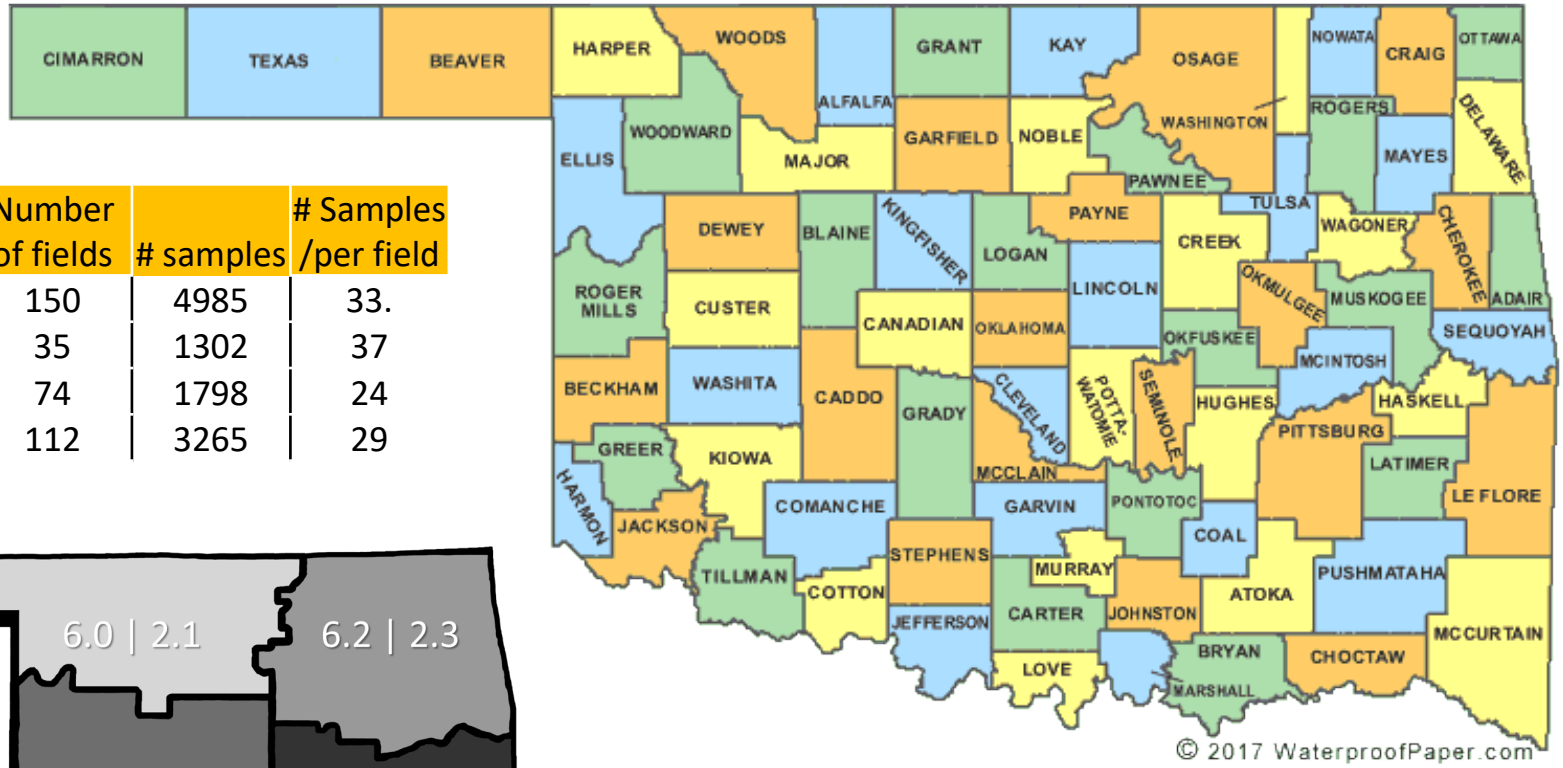
Fertility “ Mis-Managemant” Impact on Quality

- Altus Long term, 25 years of Data.
- Increasing K rate Increased Fiber Length
  - Over application of N and under application of K Sig Decreased Length
- When All over nutrients sufficient Increasing N above optimum Sig Decreased Fiber Strength

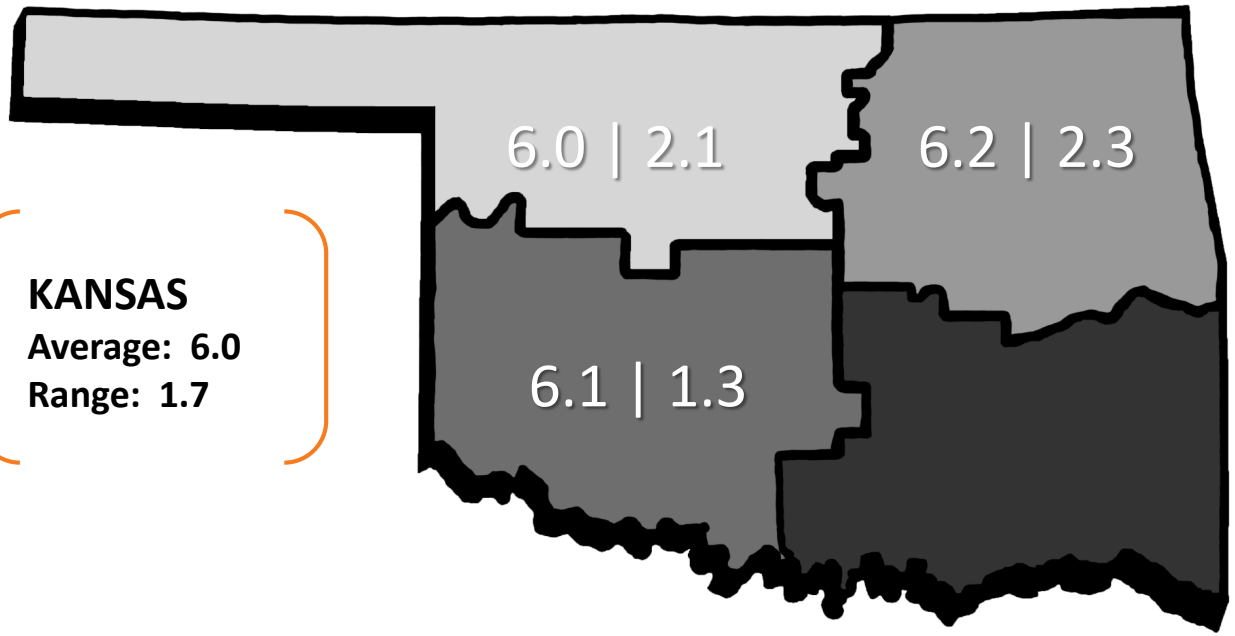
Data by County

Region	Number of fields	# samples	# Samples /per field
NW	150	4985	33.
NE	35	1302	37
SW	74	1798	24
KS	112	3265	29





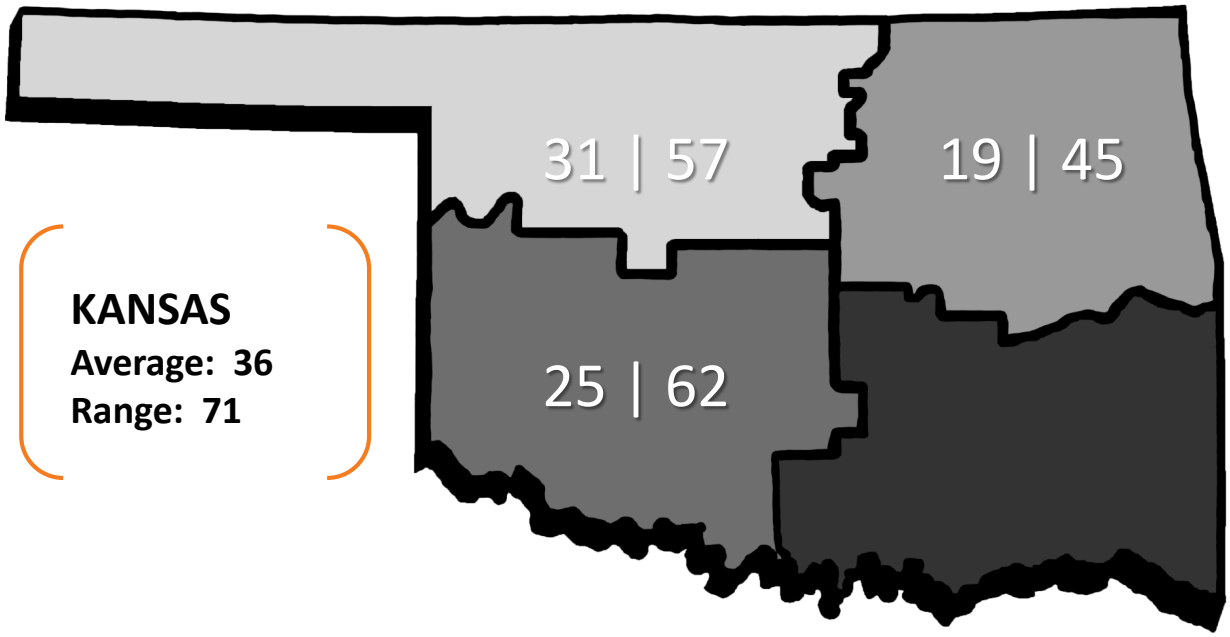
Grid Data Results Soil pH



KANSAS
Average: 6.0
Range: 1.7

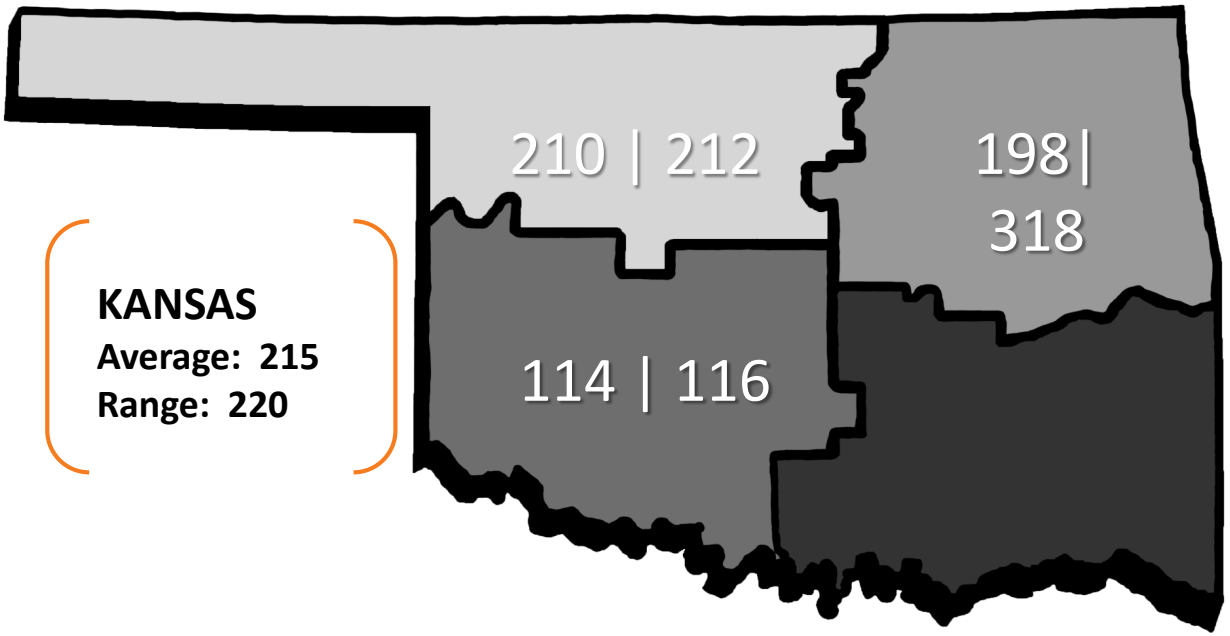
Region	# of fields
NW	150
NE	35
SW	74
KS	112

Grid Data Results M3P and Bray P1 ppm



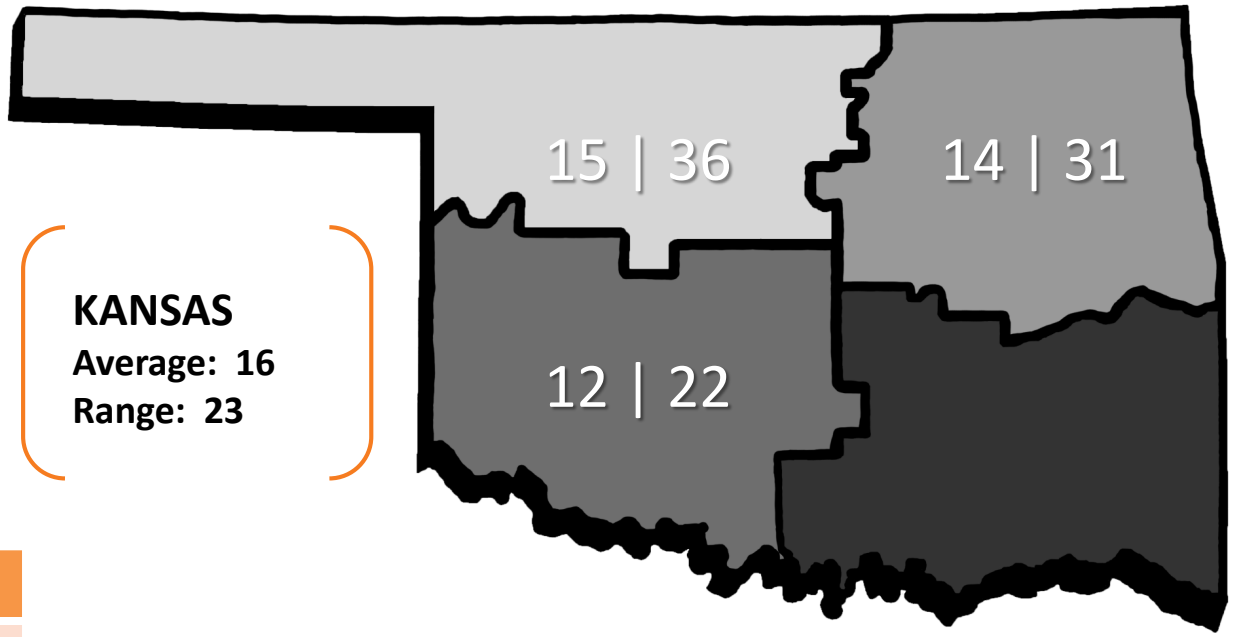
Region	# of fields
NW	150
NE	35
SW	72
KS	103

Grid Data Results Potassium



Region	# of fields
NW	140
NE	32
SW	45
KS	96

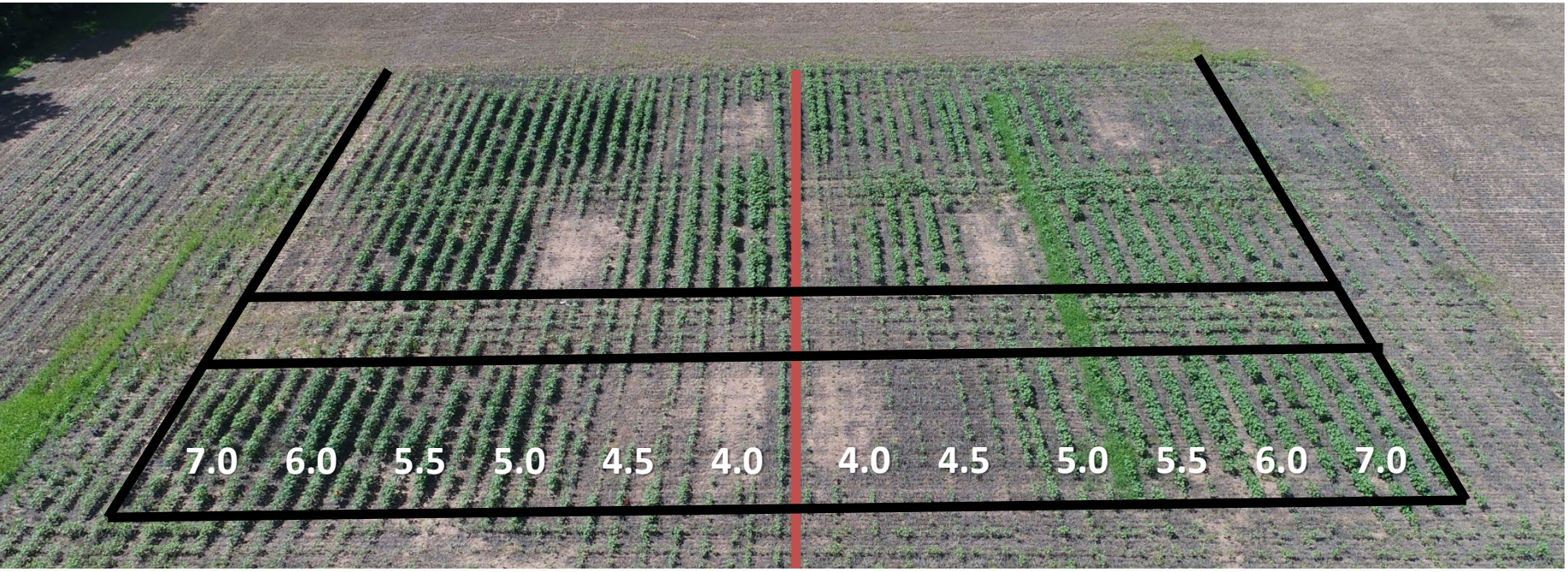
Grid Data Results Sulfur



KANSAS
Average: 16
Range: 23

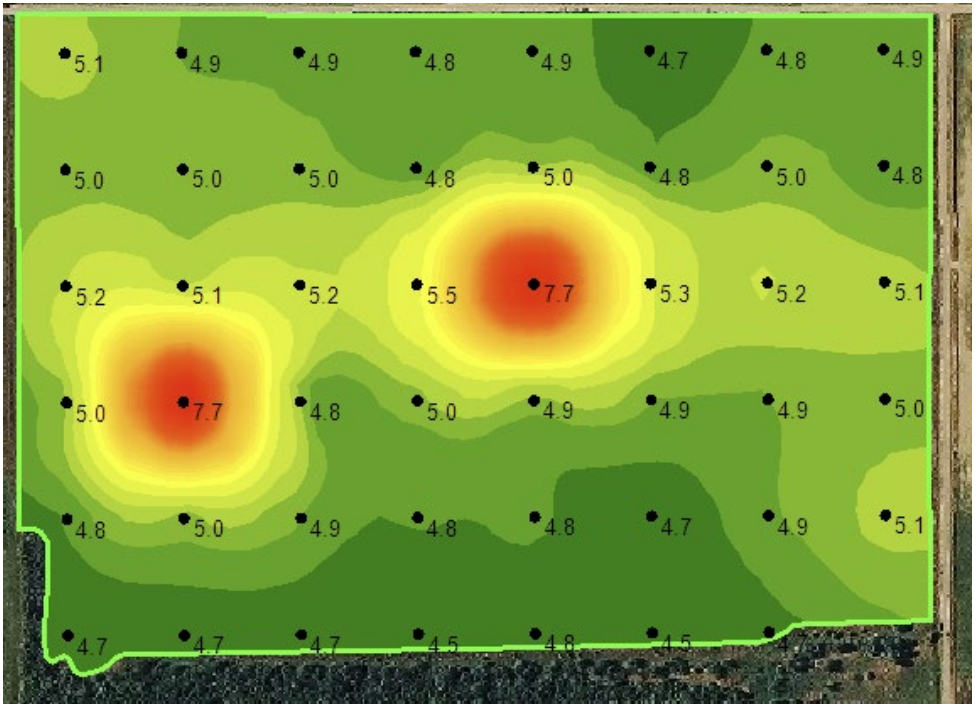
Region	# of fields
NW	40
NE	10
SW	36
KS	95

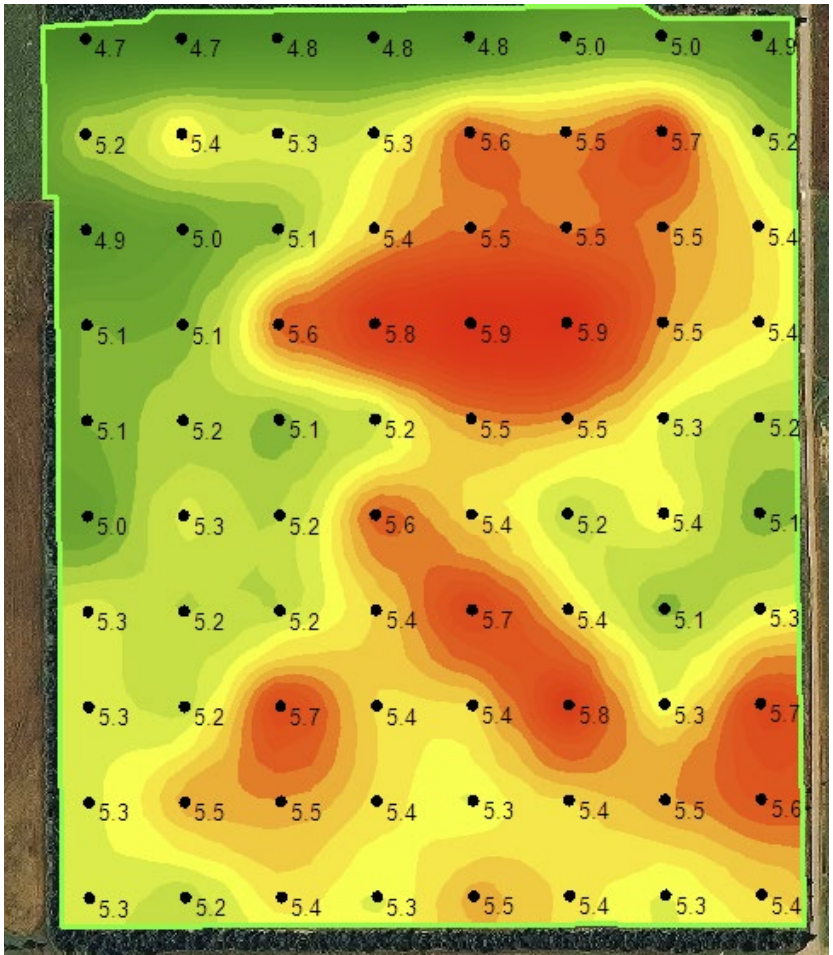
Soil pH

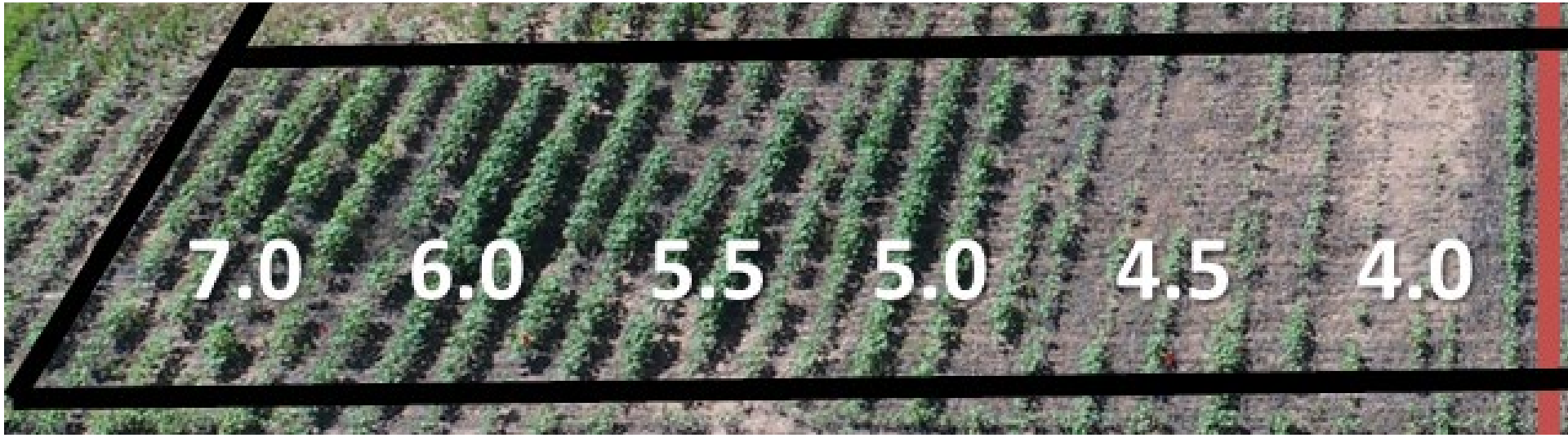


Soil pH

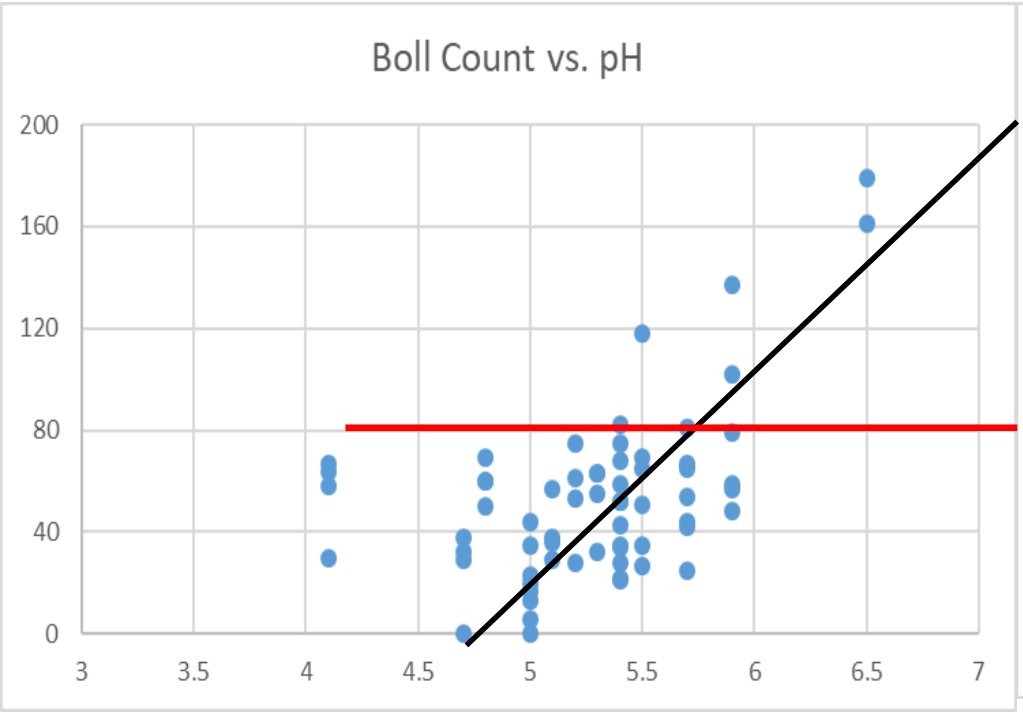
- Soybean 2017 -> Cotton 2018 -> Cotton 2019
  - P 51 ppm
  - K 195 ppm

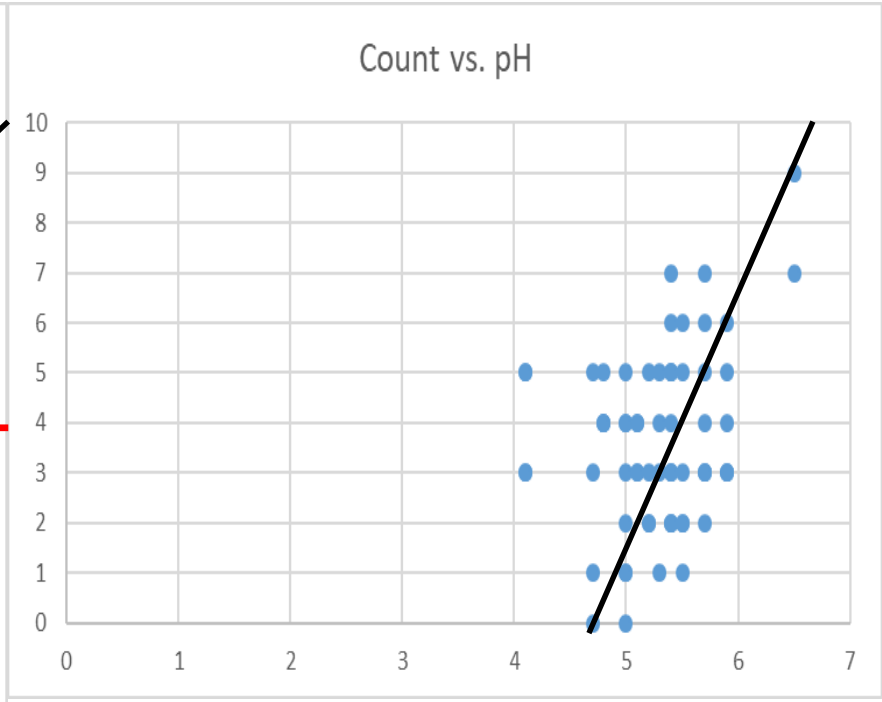


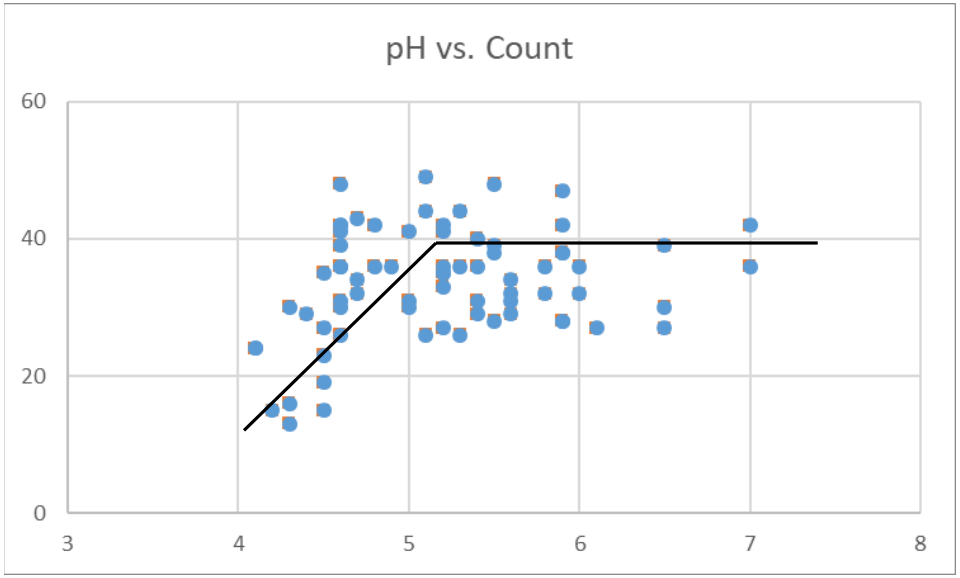


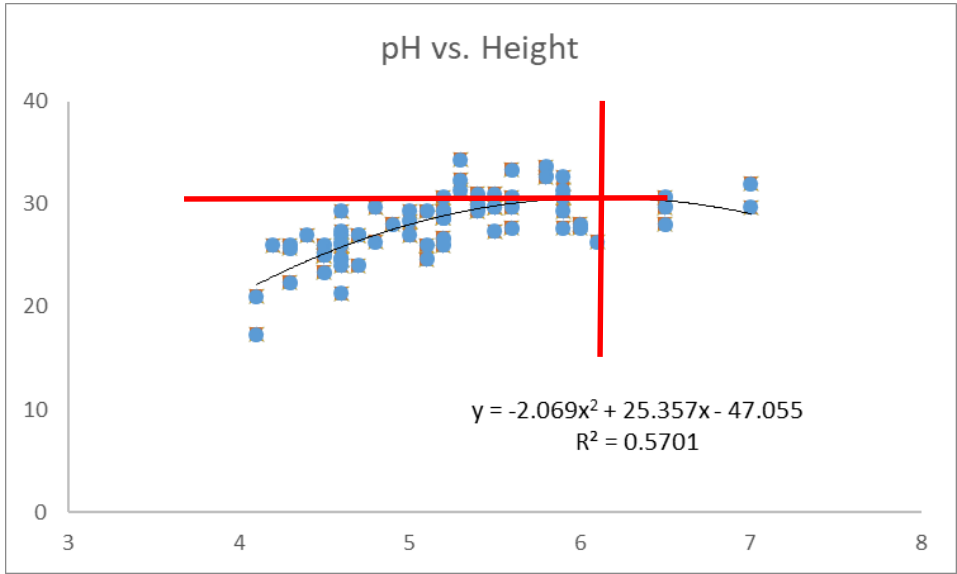

7.0
6.0
5.5
5.0
4.5
4.0


4.0
4.5
5.0
5.5
6.0
7.0


Boll Count vs. pH
200
160
120
80
40
0
3
3.5
4
4.5
5
5.5
6
6.5
7


Count vs. pH
10
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7


pH vs. Count
60
40
20
0
3
4
5
6
7
8


pH vs. Height
40
30
20
10
0
3
4
5
6
7
8
y = -2.069x² + 25.357x - 47.055
R² = 0.5701

Thank you!

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A website to bridge the gap between Landlords and Leesses

Brian Arnall

373 Ag Hall

405-744-1722

b.arnall@okstate.edu

Twitter: **@OSU_NPK**

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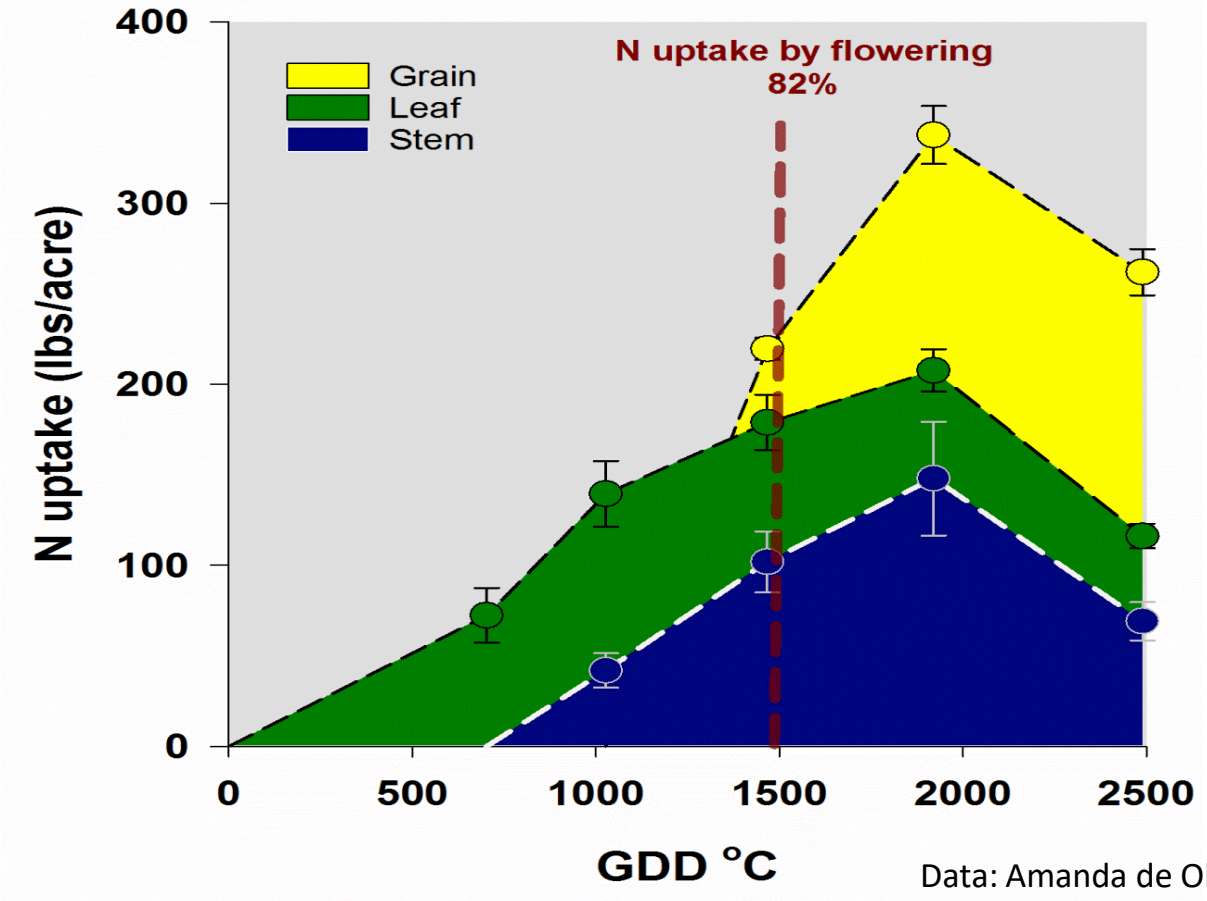
N-Rich Strips

Nitrogen timing

KANSAS STATE UNIVERSITY



Data: Amanda de Oliveira