Improving Cotton Production Efficiency With Phosphorus and Potassium Placement At Multiple Depths in Strip Tillage Systems

Hunter Frame

Assistant Professor/Field Crops Agronomist, Virginia Tech

Tidewater Agricultural Research and Extension Center

Suffolk, VA

Austin Brown

MS Student, Virginia Tech

Blacksburg, VA

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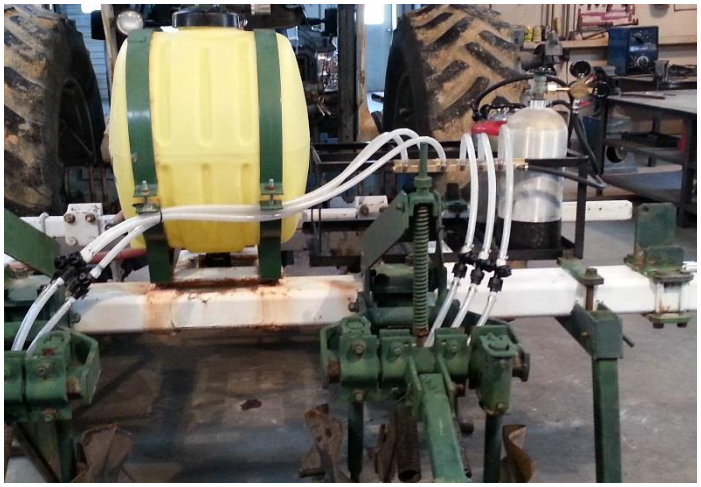
Research Objectives

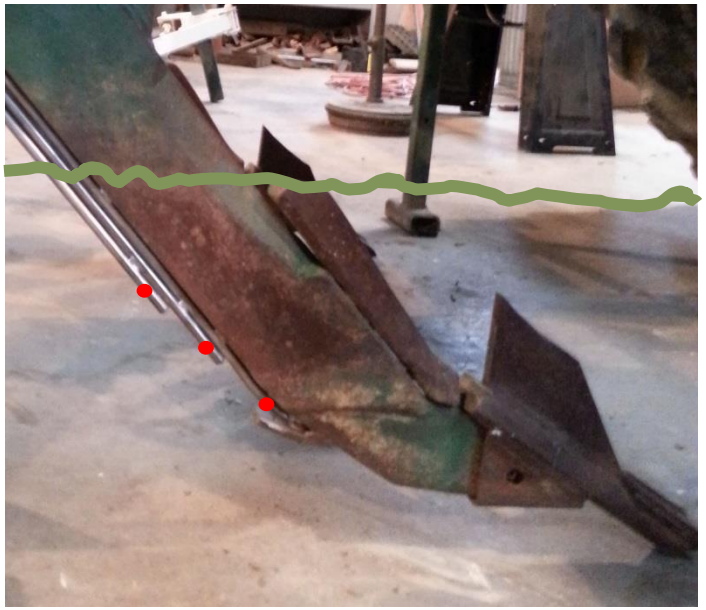
1. Determine the impact on early season development of upland cotton (*Gossypium hirsutum)* through first square, nutrient status throughout the bloom period, and lint yield and quality of placing a fluid P & K fertilizer at multiple depths below the seed during strip-till cultivation.

2. Evaluate selected combinations of P and K placed at multiple depths in the strip-till process in combination with 2x2 banding of P and K solutions at planting on early season development through first square, nutrient status throughout the bloom period, and lint yield and quality.

Materials and Methods

- Two Locations:
  - Suffolk, VA (TAREC)
  - Lewiston, NC
- Fertilizer Placement
  - Deep Placement with Strip-tillage
    - 6, 9, and 12 in. below the row
    - 1-2 weeks prior to planting
  - 2 X 2 Band at Planting





Materials and Methods

- Fluid Fertilizer Sources
  - Ammonium Polyphosphate (10-34-0)
  - Potassium thiosulfate (0-0-25-17S)
  - Soil Test Recommendations (100%):
    - 40 lbs. P_2O_5 ac^{-1}
    - 40 lbs. K_2O ac^{-1}
- Granular Fertilizer Sources
  - Diammonium phosphate (18-46-0)
  - Potassium Chloride (0-0-60)
- All preplant nitrogen and sulfur were balanced among treatments
  - Urea Ammonium nitrate (30-0-0)
  - Ammonium thiosulfate (12-0-0-26S)
  - 35 lbs N ac^{-1} and 41 lbs. S ac^{-1}

Treatment List

Trt	Placement	Description
1	Unfertilized Control	No P or K Fertilization
2	Broadcast Agronomic Control	P + K Broadcast – Soil test recommendation
3	Liquid Starter Agronomic Control	112 kg /ha of 10-34-0 in 2X2 band + K broadcast
4	2 X 2 Band	50%P + 50%K
5	2 X 2 Band	100%P + 100%K¶
6	2 X 2 Band	150%P + 150%K
7	Deep Placement	50%P + 50%K
8	Deep Placement	100%P + 100%K
9	Deep Placement	150%P + 150%K
10	2 X 2 + Deep Placement	(80%P + 80% K) + (20%P + 20%K)
11	2 X 2 + Deep Placement	(60%P + 60% K) + (40%P + 40%K)
12	2 X 2 + Deep Placement	(40%P + 40% K) + (60%P + 60%K)
13	2 X 2 + Deep Placement	(20%P + 20% K) + (80%P + 80%K)

¶ 100% rate equals 40 lbs. P_2O_5 and 40 lbs. K_2O per hectare based on soil test recommendations for producing cotton in Virginia

Materials and Methods

- Treatment were applied to 4 row plots
  - Row spacing = 3 ft.
  - Plot length = 40 ft

- In-season Plant Measurements
  - Plant Population
  - Plant Height (until 1st flower)
  - Total Nodes (from 1st square)
  - Nodes Above White Flower (NAWF)

Materials and Methods

- Petiole and Tissue Sampling
  - 1st through 9th week of bloom petiole sampling
  - 4th leaf down the main stem
  - 24 petioles per plot from the 1st and 4th rows
  - Petioles immediately detached from leaf
  - Petioles analyzed for nitrate-N, phosphorus, potassium, and sulfur
  - Leaf samples taken during 1st and 5th week of bloom
    - Complete nutrient analysis for leaf samples

Materials and Methods

- Lint Yield and Quality
  - Cotton harvested with two row cotton picker from center two rows
  - Lint will be ginned on 10 saw micro-gin for % lint
  - Lint will be sent to USDA for HVI analyses on lint quality

Unfertilized Check

40 lbs. P_2O_5 ac^{-1}

40 lbs. K_2O ac^{-1}

Statistical Design and Analysis

- Randomized Complete Block Design
  - 4 replications of each treatment
  - Analysis of variance was conducted at the $\alpha = 0.05$
    - Nutrient management systems tested at 40 lbs P_2O_5 and 40 lbs K_2O per acre as single factors
    - Placement and rate analyzed as 2 X 3 factorial
    - Combination placement treatments tested as single factors (Data not shown)
    - Tukey-Kramer HSD used for mean separation at $\alpha = 0.05$

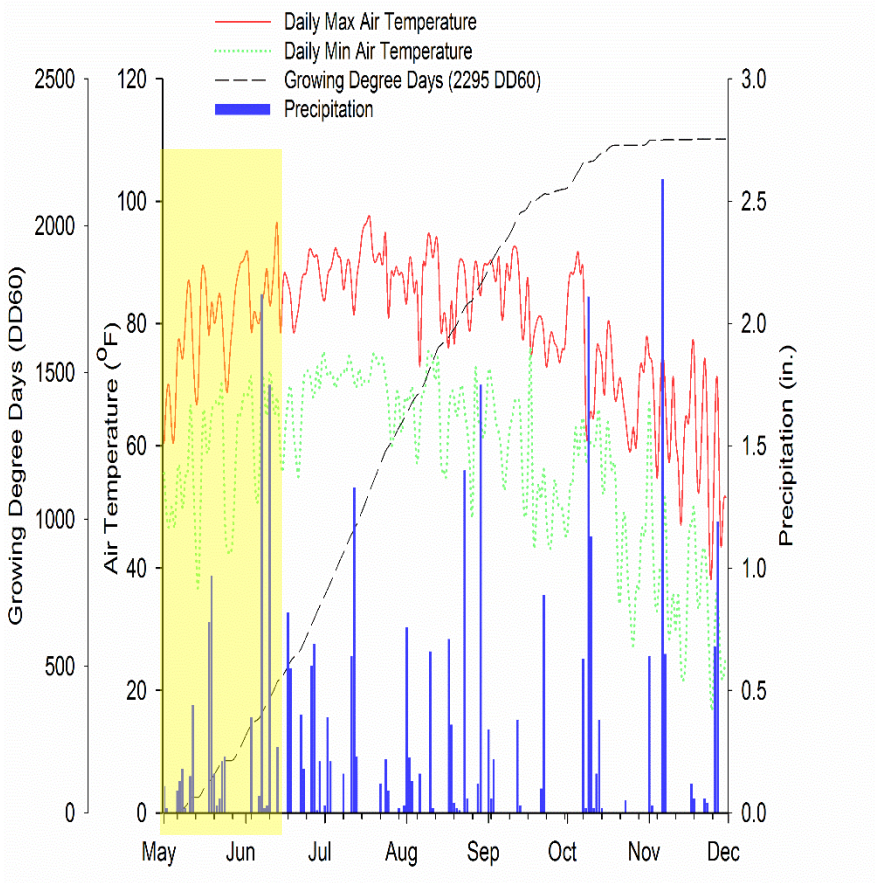
Mehlich I Soil Test Results for 2014 Locations

Depth	TAREC		Lewiston	
inches	P	K	P	K
	ppm			
0-3	39 (H)¶	106 (H)	15 (M+)	81 (M+)
3-6	26 (H-)	98 (H-)	12 (M)	60 (M)
6-9	17 (M+)	76 (M+)	9 (M-)	48 (M-)
9-12	7 (M-)	101 (H-)	3 (L)	42 (M-)

¶ Indicates the soil test level based on Virginia's soil test calibration

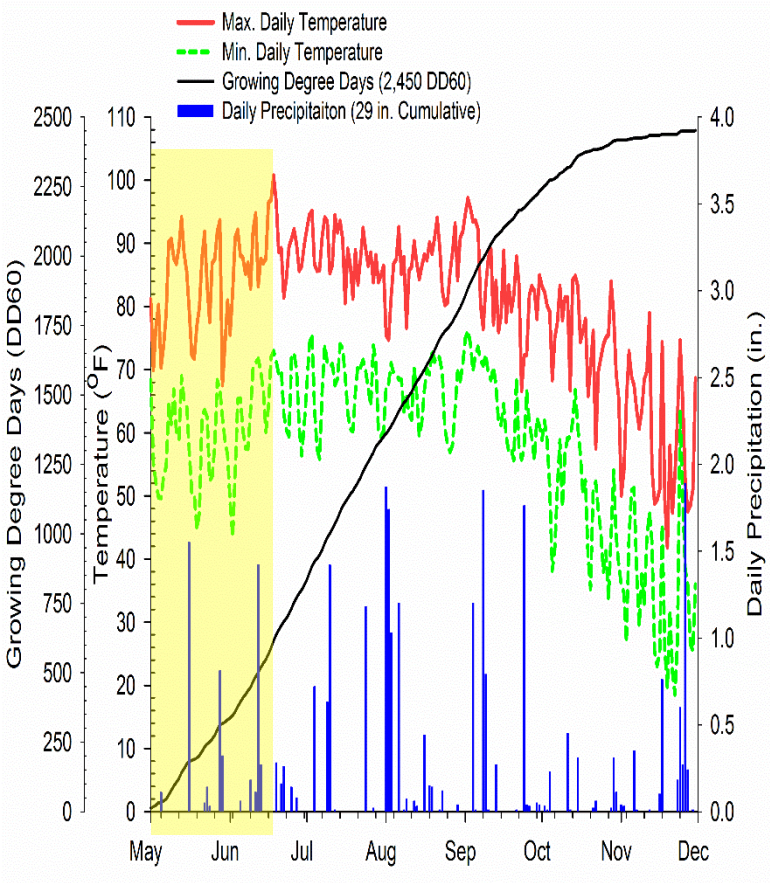
Weather Data for TAREC

2013



8 in. rainfall from May 1 – June 15

2014



5 in. rainfall from May 1 – June 15

Nutrient Management Systems and Early Season Growth (TAREC) in 2013

Nutrient Systems	Plant Height (in.)					
	4-Jun	**13-Jun**	**20-Jun**	**26-Jun**	**3-Jul**	**10-Jul**
Unfertilized Check	4.8	7.4 c*	9.4 c	13.2 d	18.0 c	22.0 b
Broadcast Control	4.8	8.5 ab	10.5 bc	15.4 c	22.4 b	29.6 a
Starter Control	5.0	9.6 a	11.1 ab	17.8 ab	24.1 ab	31.4 a
2 x 2 Band (100%)	5.2	9.4 ab	12.1 a	18.6 a	25.9 a	32.0 a
Deep Placement (100%)	4.9	8.7 ab	11.3 ab	16.9 bc	23.9 b	30.9 a

* Values with the same letter are not significantly different at $\alpha = 0.05$

Nutrient Management Systems and Early Season Growth in 2014

TAREC

Nutrient Systems	Plant Height					
	3-Jun	12-Jun	19-Jun	26-Jun	2-Jul	11-Jul
	in.					
Unfertilized Check	3.3 b*	5.8 b	10.0 c	14.6 b	19.3 c	23.7 c
Broadcast Control	3.6 ab	7.0 ab	10.3 bc	17.7 a	23.2 b	29.2 b
Starter Control	3.6 ab	7.6 a	12.0 ab	19.3 a	24.4 ab	30.0 ab
2 x 2 Band (100%)	3.8 a	7.6 a	12.5 a	19.5 a	24.6 ab	30.6 a
Deep Placement (100%)	3.6 ab	7.4 a	12.3 a	19.5 a	24.8 a	30.8 a

*Values with the same letter are not significantly different at α = 0.05

Lewiston

Nutrient Systems	Plant Height					
	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul
	in.					
Unfertilized Check	3.5 b	6.6 b	10.4 b	15.2 b	20.0 b	28.1 b
Broadcast Control	4.1 a	7.5 a	12.1 a	17.8 a	23.2 a	31.9 a
Starter Control	4.2 a	7.7 a	12.0 a	18.4 a	23.6 a	32.1 a
2 x 2 Band (100%)	4.1 ab	7.4 ab	11.1 ab	17.4 a	23.6 a	31.9 a
Deep Placement (100%)	4.0 ab	7.8 a	12.1 a	18.5 a	24.1 a	33.3 a

*Values with the same letter are not significantly different at α = 0.05

Total Nodes and NAWF at TAREC for Nutrient Management Systems in 2013

Nutrient Systems	Total Nodes		Nodes Above White Flower (NAWF)			
	3-Jul	11-Jul	17-Jul	23-Jul	30-Jul	7-Aug
Unfertilized Check	9.8 b*	10.1 b	6.6 b	4.8 b	3.2 b	1.8 b
Broadcast Control	10.5 ab	11.7 a	7.7 a	6.3 a	4.5 a	2.6 ab
Starter Control	11.1 a	11.9 a	7.3 a	5.8 a	4.0 ab	2.3 ab
2 x 2 Band (100%)	11.5 a	11.6 a	7.4 a	5.8 a	4.2 ab	2.8 a
Deep Placement (100%)	11.2 a	11.4 a	7.9 a	6.0 a	4.1 ab	3.0 a

* Values with the same letter are not significantly different at $\alpha = 0.05$

Total Nodes, Vigor, NDVI, and NAWF at TAREC for Nutrient Management Systems in 2014

TAREC

Nutrient Systems	Vigor	NDVI	Nodes	NAWF		
	18 Jun		16-Jul	16-Jul	22-Jul	31-Jul
Unfertilized Check	2.75 b*	0.36 c	10.4 b	5.5	4.1 b	2.5 c
Broadcast Control	4.25 a	0.44 bc	11.5 ab	6.1	5.3 a	4.0 a
Starter Control	4.50 a	0.48 ab	11.9 a	6.1	5.0 ab	3.3 b
2 x 2 Band (100%)	5.25 a	0.55 a	11.6 a	6.3	5.3 a	3.7 ab
Deep Placement (100%)	4.50 a	0.45 abc	11.9 a	6.3	5.4 a	3.4 ab

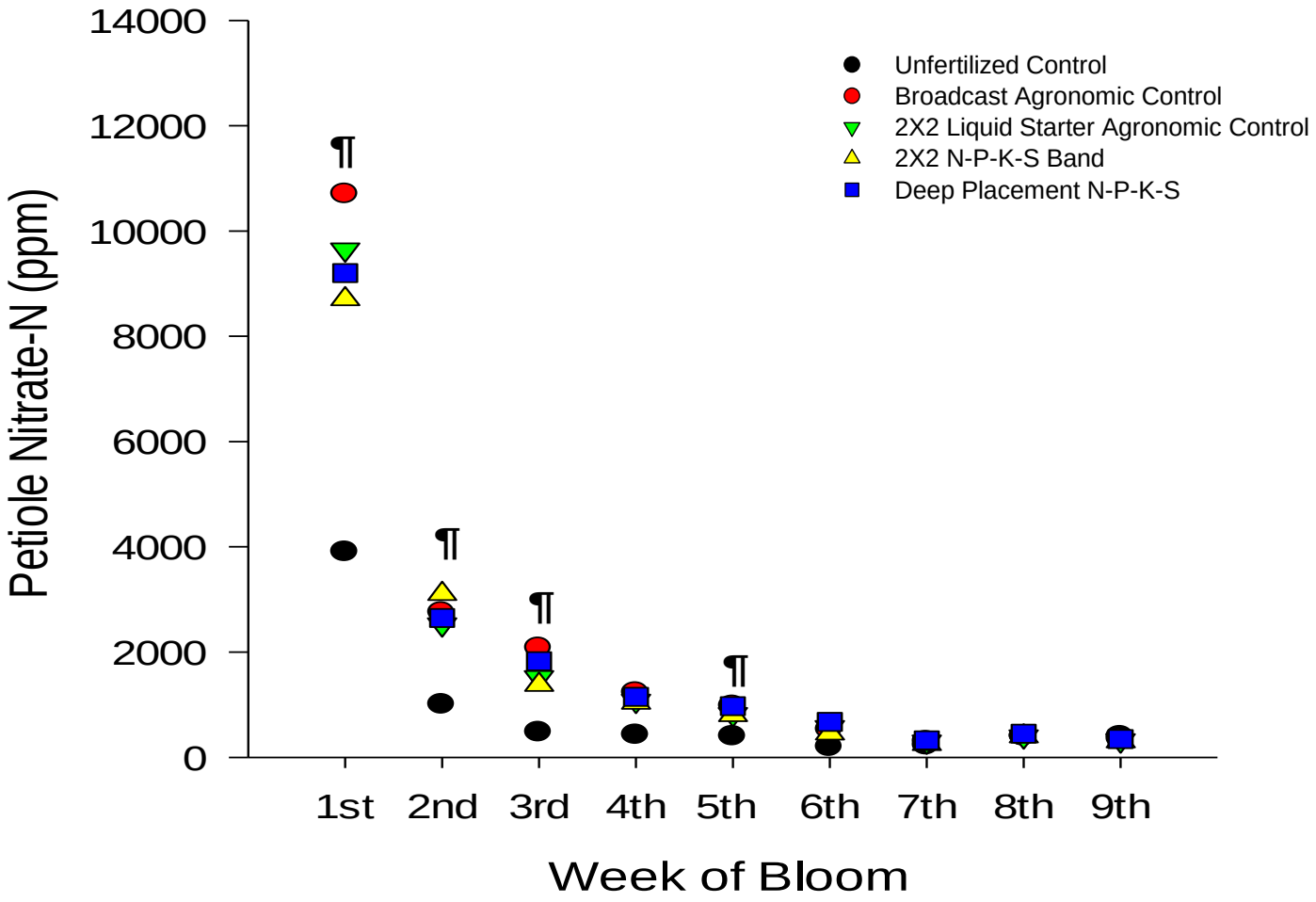
*Values with the same letter are not significantly different at α=0.05

Lewiston

Nutrient Systems	Nodes	NAWF			
	22-Jul	22-Jul	29-Jul	5-Aug	12-Aug
Unfertilized Check	12.4	7.5	7.0 a	5.7	4.5
Broadcast Control	12.3	7.5	6.6 ab	5.3	4.3
Starter Control	13.1	7.3	6.4 b	5.1	3.8
2 x 2 Band (100%)	12.2	7.3	6.7 ab	5.1	4.5
Deep Placement (100%)	12.8	7.3	6.8 ab	5.2	4.4

*Values with the same letter are not significantly different at α=0.05

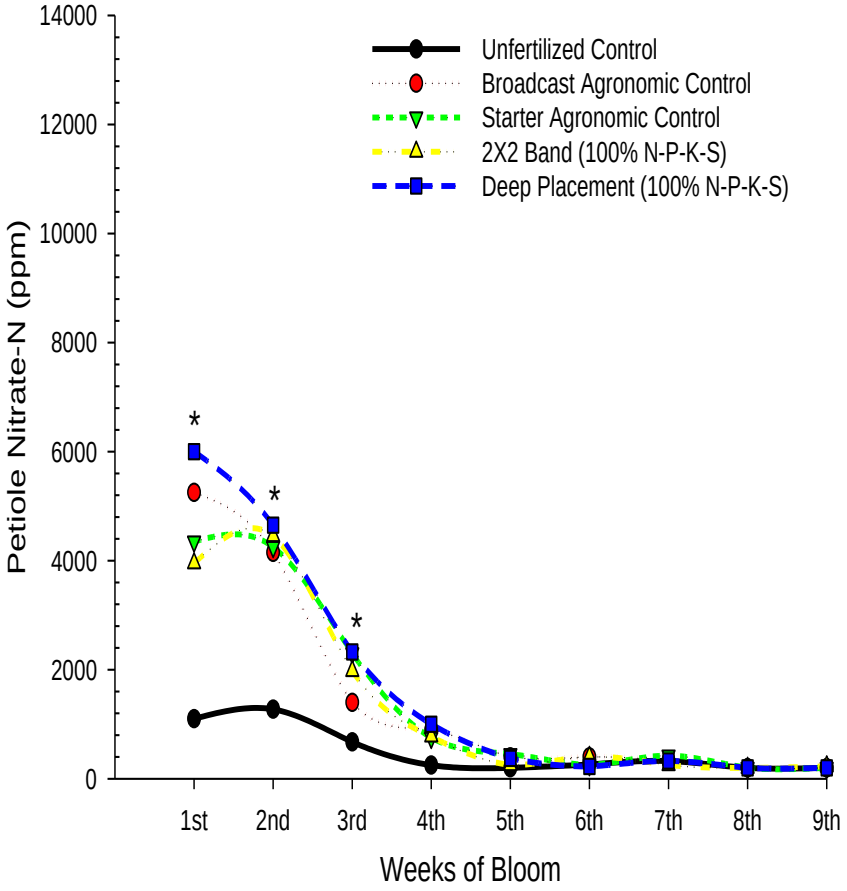
Petiole Nitrate-N Concentrations During Bloom Period (TAREC) in 2013



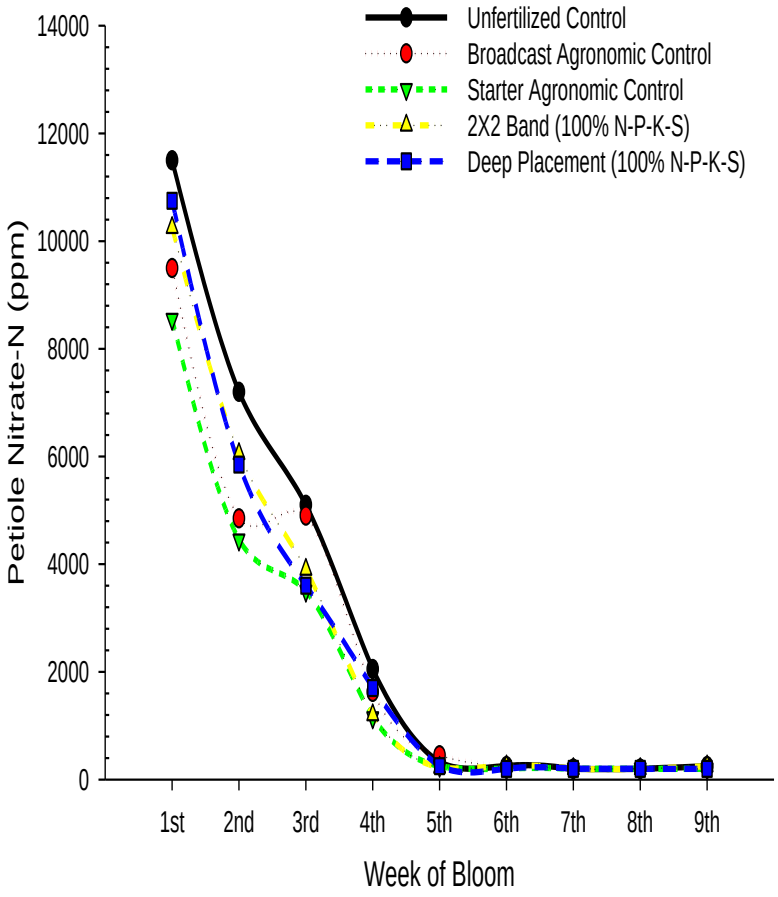
¶ Atleast two treatments are significantly different at α = 0.1

Petiole Nitrate-N Concentrations During Bloom Period in 2014

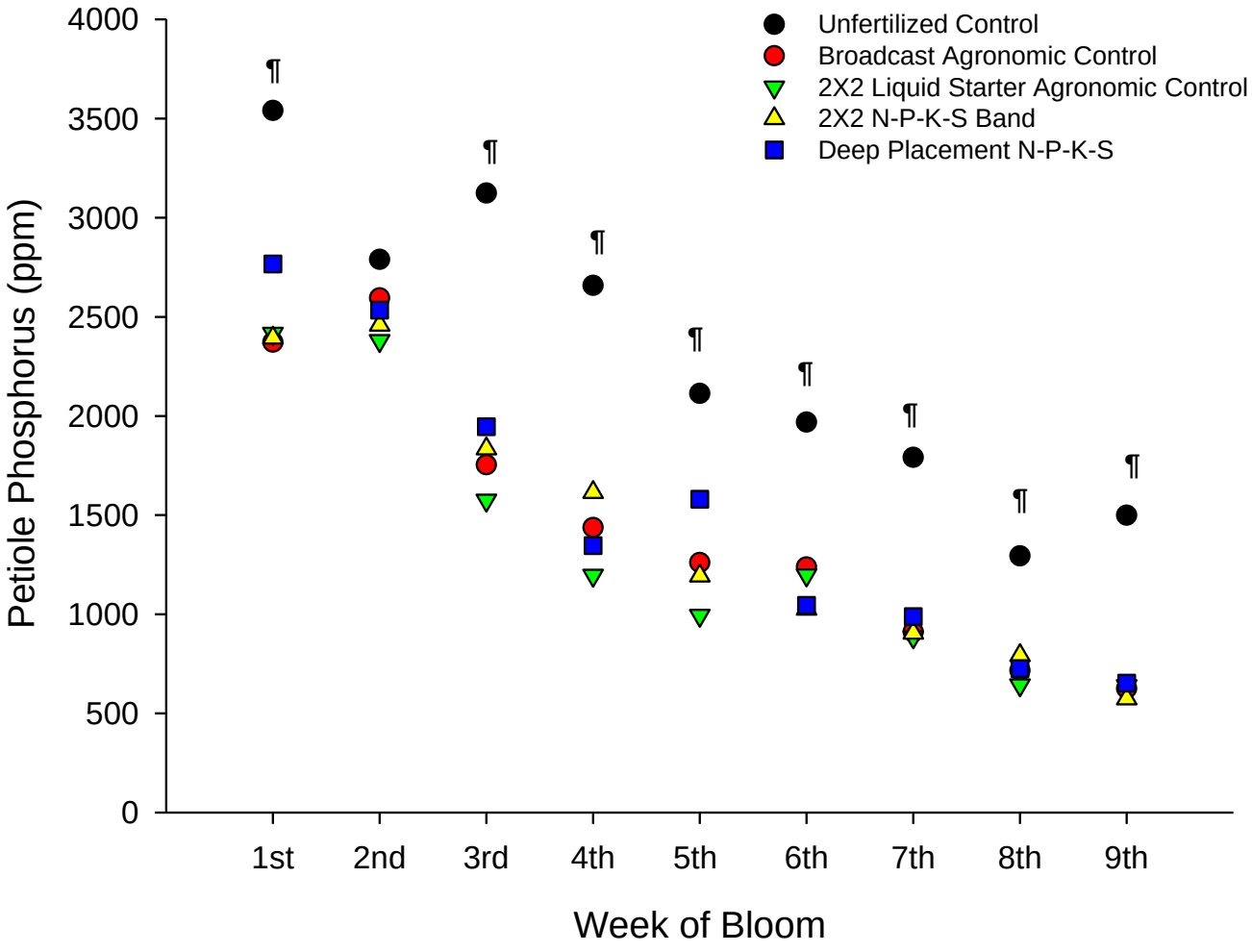
TAREC



Lewiston



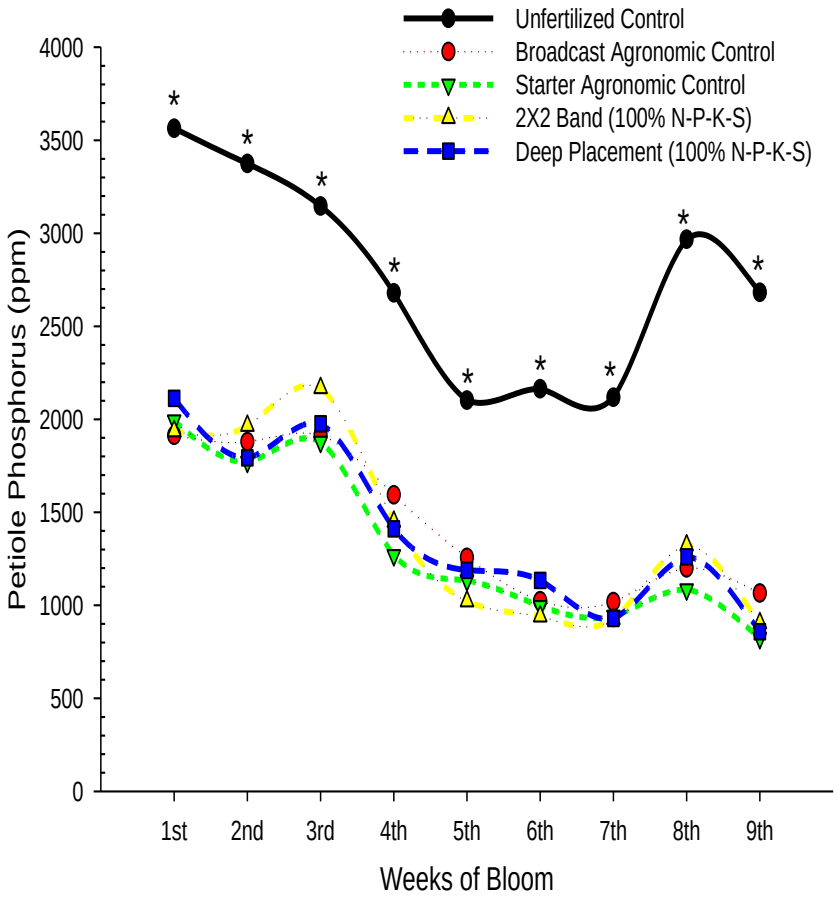
Petiole Phosphorus Concentrations During Bloom Period (TAREC) in 2013



¶ Atleast two treatments are significantly different at α = 0.1

Petiole Phosphorus Concentrations During Bloom Period in 2014

TAREC



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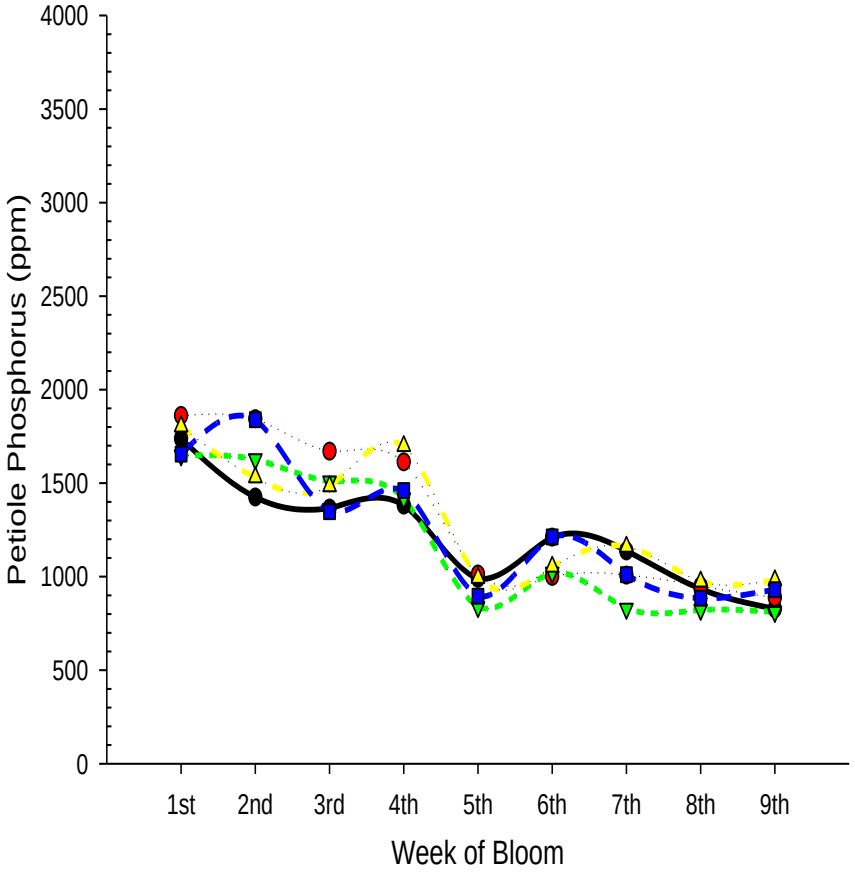
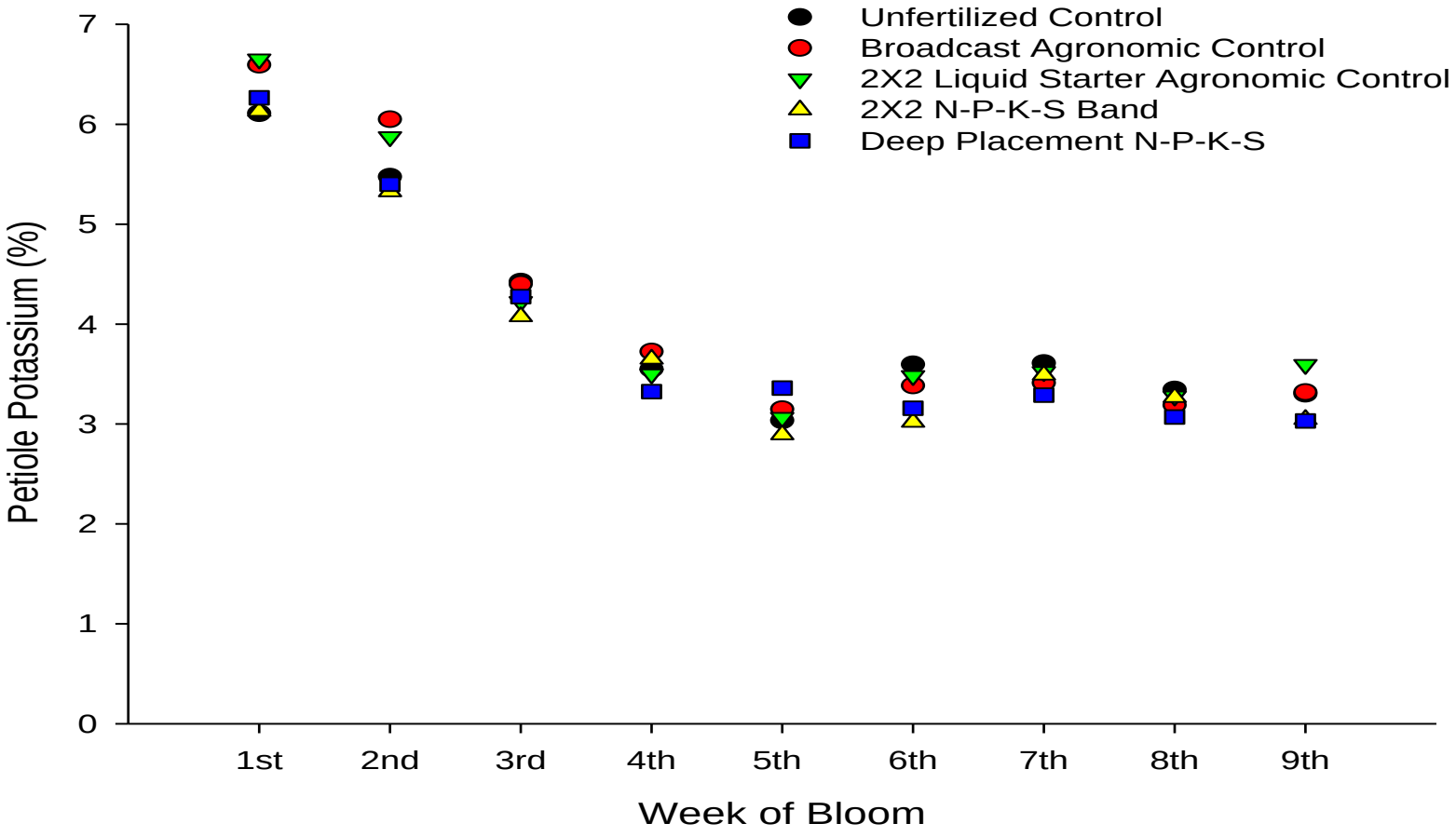
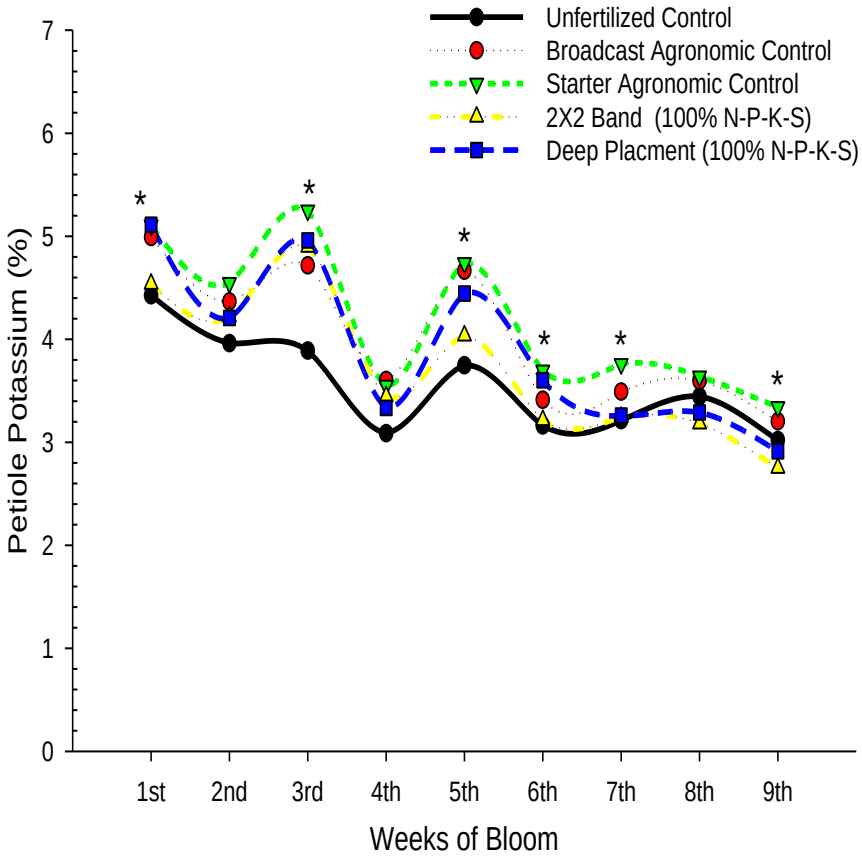


Petiole Potassium Concentrations During Bloom Period (TAREC) in 2013



Petiole Nitrate-N Concentrations During Bloom Period in 2014

TAREC



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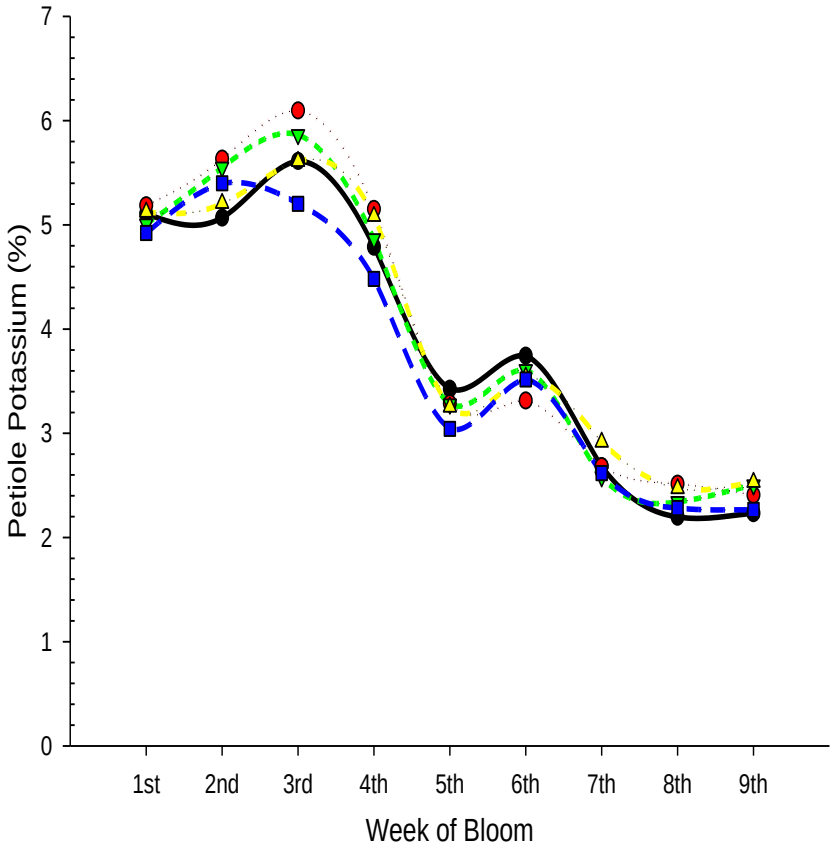
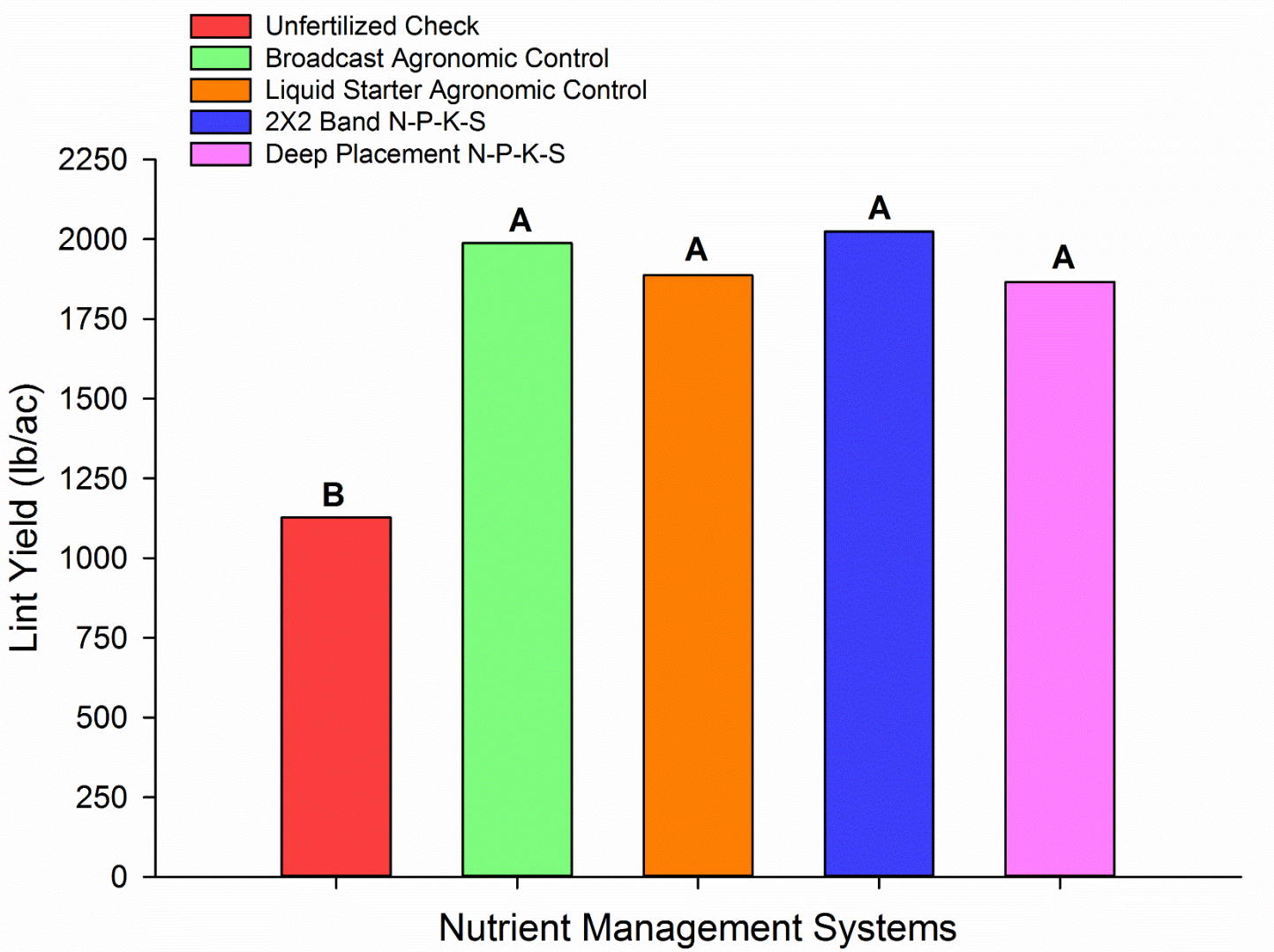
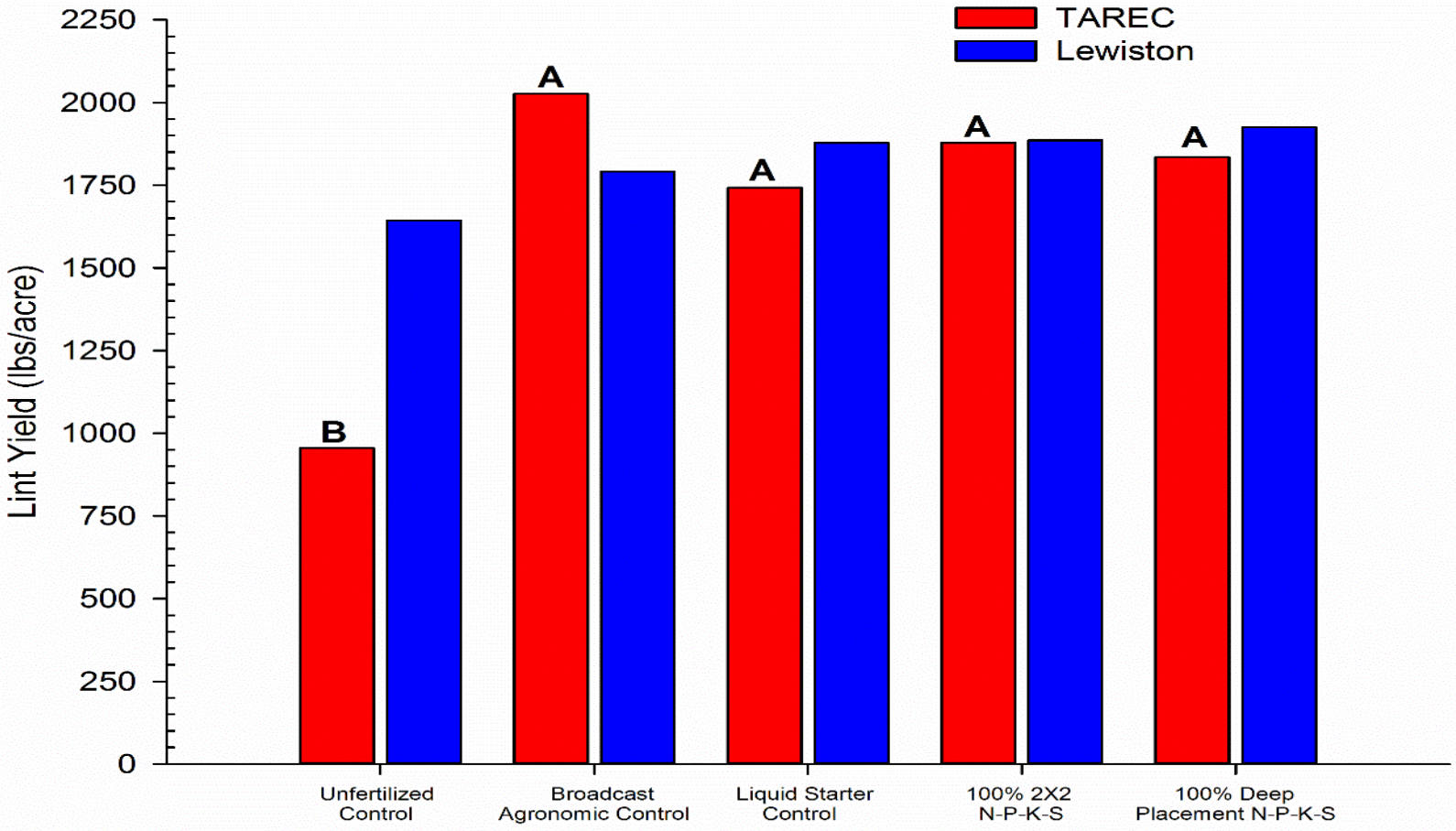


Lint Yield and Nutrient Management Systems (TAREC) in 2013



Nutrient Management Systems and Lint Yield in 2014



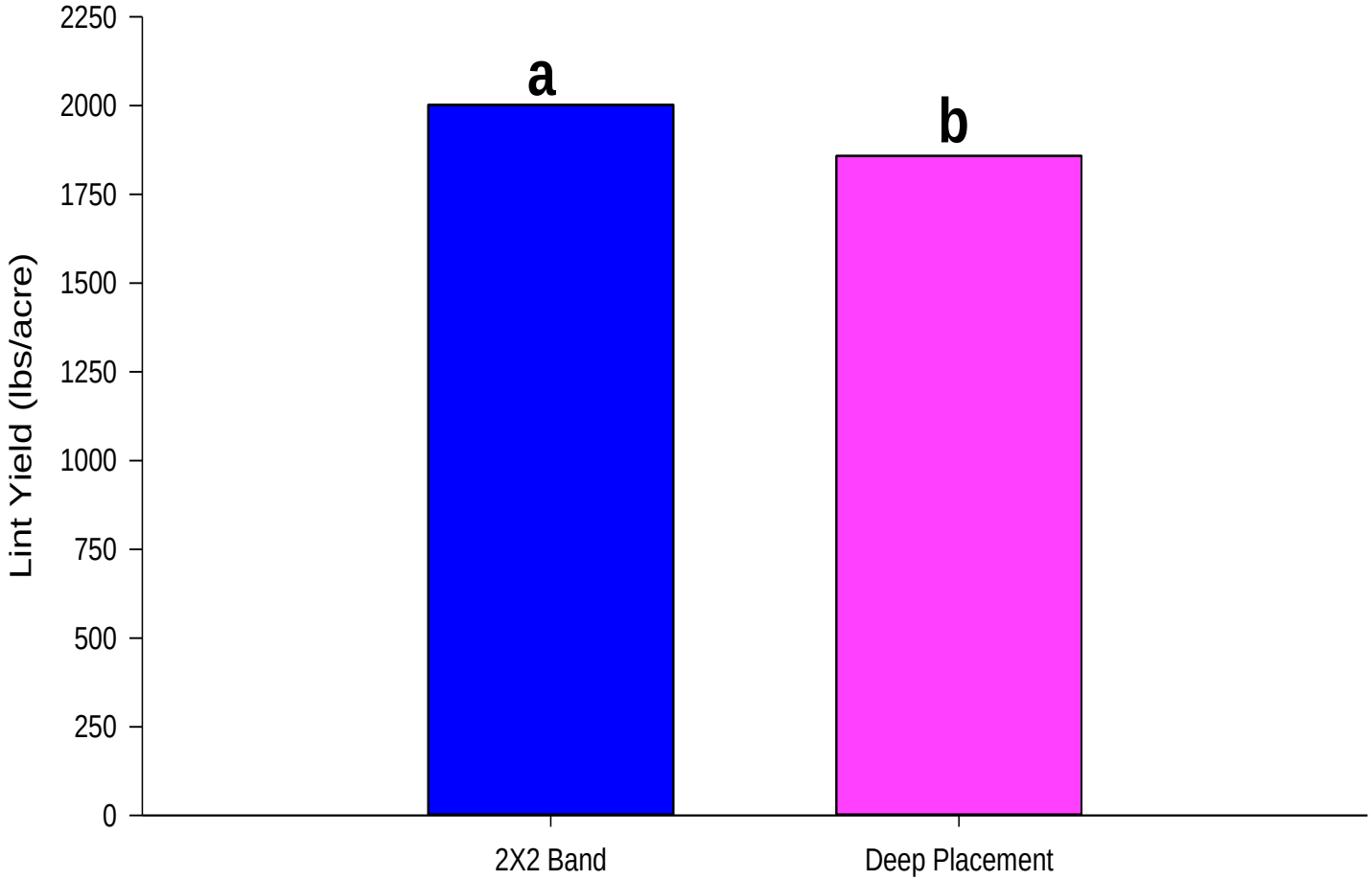
Early Season Plant Height and P and K Application Rates at TAREC in 2014

P and K Rate	Plant Height					
%¶	**3-Jun**	**12-Jun**	**19-Jun**	**26-Jun**	**2-Jul**	**11-Jul**
	---------- in. ----------					
50	3.5 b*	7.6 b	12.2 b	19.0 b	24.2 b	30.5
100	3.7 ab	7.5 b	12.4 b	19.4 ab	24.6 ab	30.7
150	3.8 a	8.3 a	13.1 a	20.4 a	25.4 a	31.2

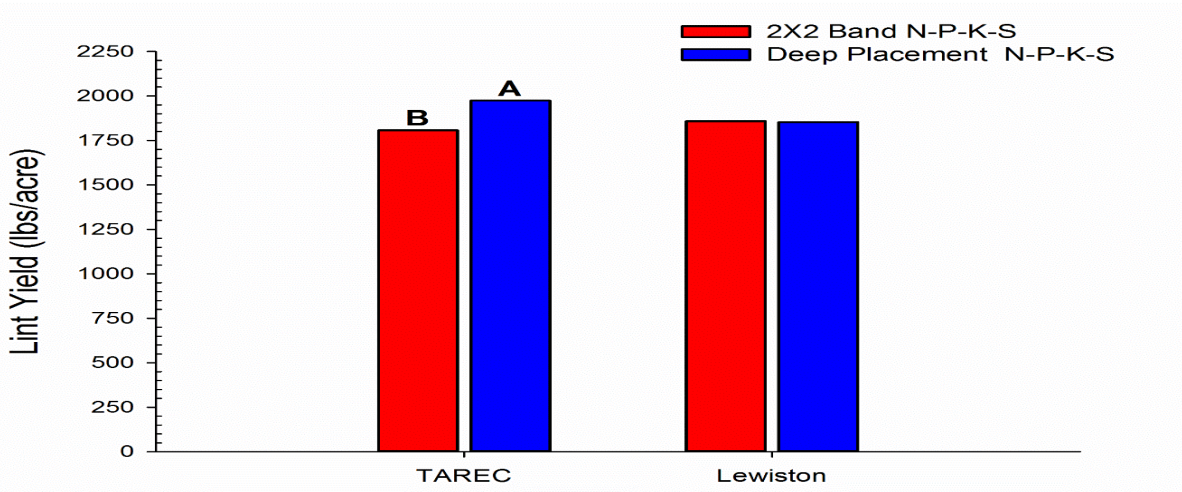
*Values with the same letter are not significantly different at $\alpha = 0.05$

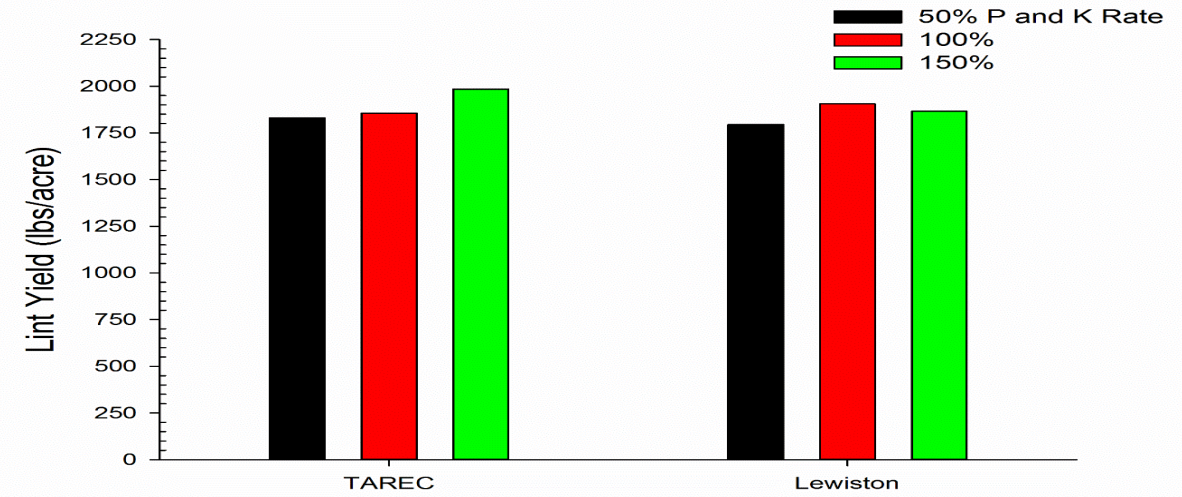
¶Percent of recommended P and K (40 lbs P_2O_5/acre and 40 lbs. K_2O per acre)

Lint Yield and Placement (TAREC) in 2013



P and K Rate and Placement Effect on Lint Yield in 2014



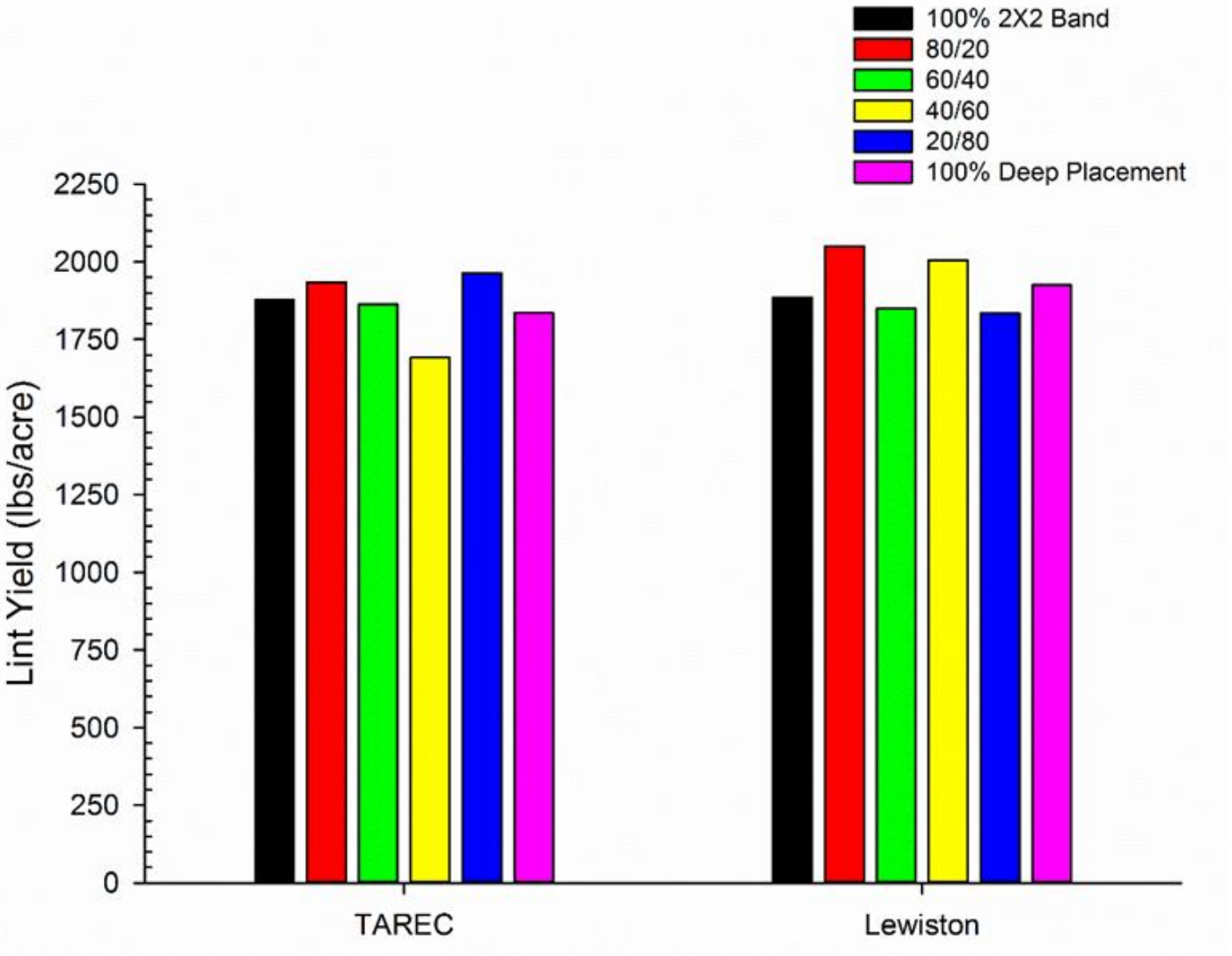


2x2 Band and Deep Placement Combinations on Early Plant Height (TAREC) in 2014

Placement Combinations	Plant Height					
% / %	3-Jun	12-Jun	19-Jun	26-Jun	2-Jul	11-Jul
	---------- in. ----------					
100 / 0	3.8	7.6	12.5	19.5	24.6	30.6
80 / 20	3.7	7.8	12.6	19.9	24.5	30.6
60 / 40	3.6	7.3	12.4	19.2	23.2	29.5
40 / 60	3.5	8.0	12.8	19.5	24.8	31.6
20 / 80	3.7	7.5	12.2	20.0	24.5	30.2
0 / 100	3.6	7.4	12.3	19.5	24.8	30.8

† Combinations of deep placement and 2X2 band of the P and K applied at the 100% (40lbs /acre) rate

2x2 Band and Deep Placement Combinations on Lint Yield (TAREC) in 2014



2014 Summary

- Early season growth is very important in Virginia cotton production as weather can be variable during May
  - Cool Temperatures
  - Heavy Rainfall Events
  - 2013 and 2014 seasons contrasting in early climatic conditions
- Major response in plant heights, nodes, NAWF an yield can be mainly attributed to nitrogen fertilization
- Nitrogen deficiency increased phosphorus concentrations in cotton petioles throughout the bloom period
  - When petiole sampling is used in cotton, N status will be important when making decisions about in-season phosphorus management
- Petiole phosphorus and potassium concentrations decrease linearly throughout the bloom period regardless of fertilizer nutrient management systems

Summary (cont.)

- All nutrient management systems produced similar lint yields when P and K were applied at the soil test recommended rates at all site years during the study
- Responses in early season plant growth, nodes, NAWF and petiole P and K levels were limited and inconsistent when evaluating P and K rates and placement
- 2X2 Band produced significantly higher lint yield than the deep placement at TAREC when analyzed over rates and placement in 2013
- Deep placement producer higher lint yields than the 2X2 banding at planting at the TAREC location in 2014
  - Most likely due to warmer/drier early season and promoted optimum root development
- Both locations during 2014 had increased yields above the 50% P and K rate indicating a moderate response to P and K fertilization

Acknowledgements

- Fluid Fertilizer Foundation
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Questions?