ROLE OF IRON IN BLUE GREEN ALGAE

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Blue Green Algae

- Blue Green Algae (BGA) create a variety of problems
  - *Harm humans*
  - *Hurt fisheries*
  - *Damage economies*

Jennifer Graham

Roger Denegar, Visuals Unlimited

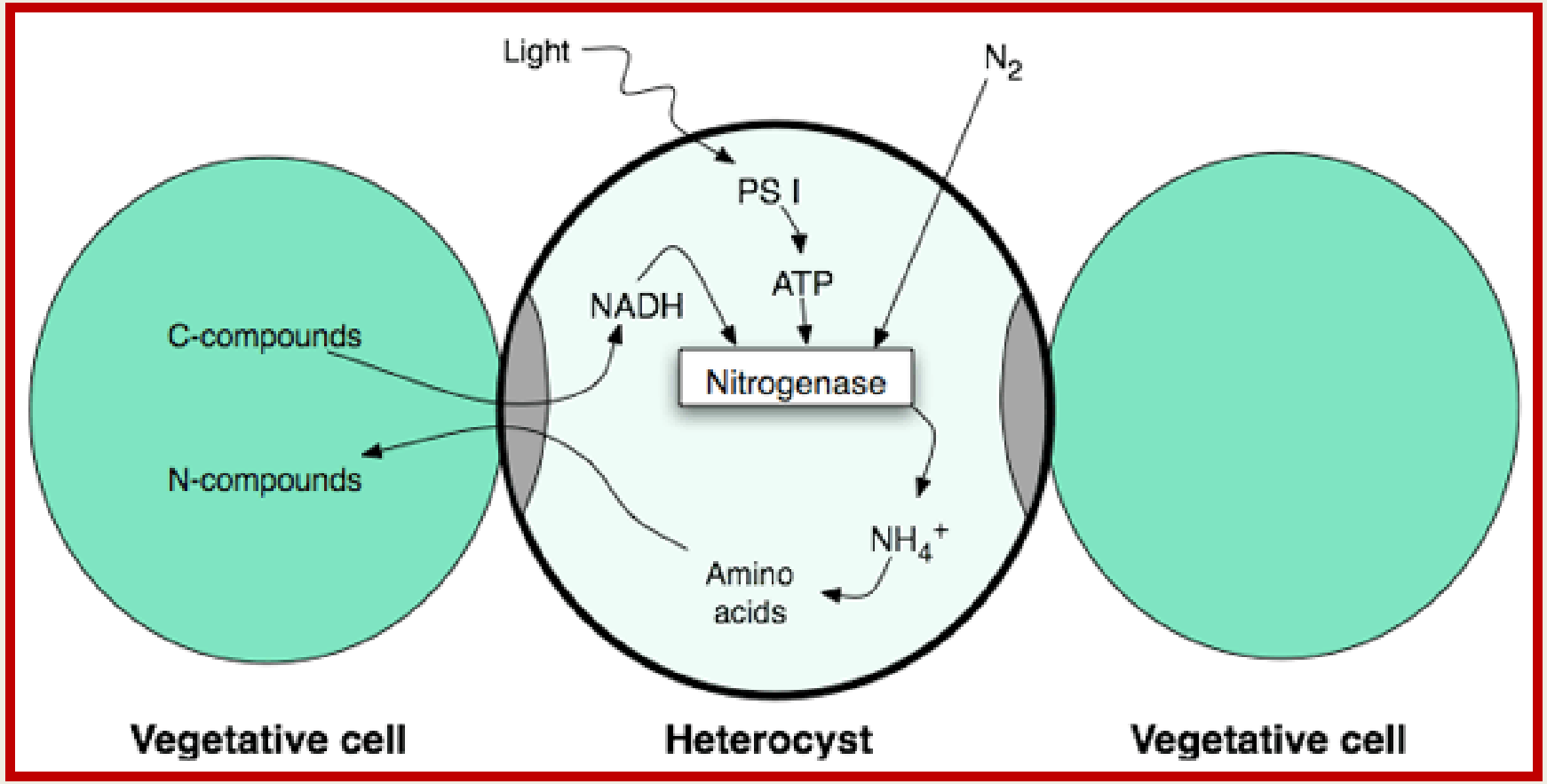
Murry Darlin Basin Authority

Nutrients that affect growth

- Most work on algae focused on P
- Considered most limiting nutrient in freshwater
- Ecosystem vs Organismal level

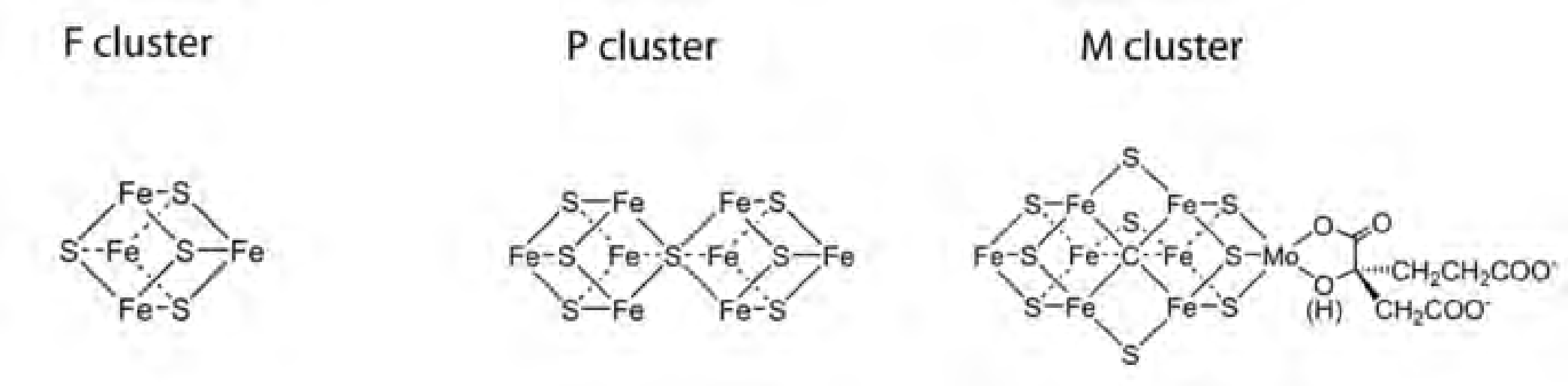
Lake 226. Schindler

Nitrogen Fixation



The Role of Iron (Fe)

- Nitrogenase is the enzyme of N fixation
- ~ 59% Fe by weight



Important for Freshwater?

- Many studies have linked Fe in oceans -> algal blooms
- Little work in freshwater
  - *Laboratory (Zhang et al 2017)*
  - *Field (Orihel et al 2016)*

Iron Variation Between Lakes

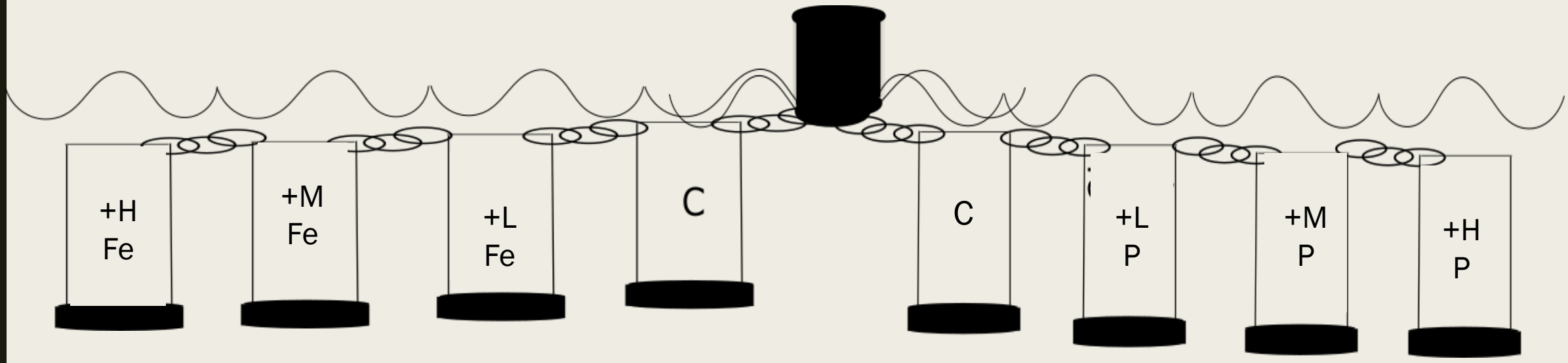
	Lake Nriagu	Lake Sherrell	Scandinavian Lakes	Lake Esthwaite
Fe (nmol L^{-1})	0.6-27	1.1-100	200-860	>5,000

House (1980), Sterner et al (2004), and Vrede and Tranvik (2006)

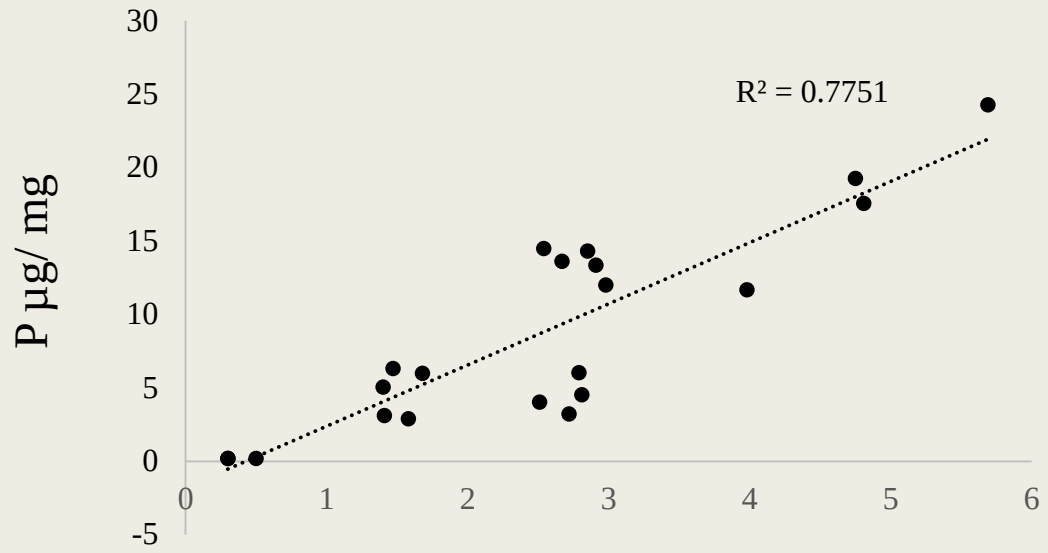
Question

- Does Fe influence algal growth?
- Is the effect more pronounced BGA than other species?
- How impactful is Fe on algae?

Methods

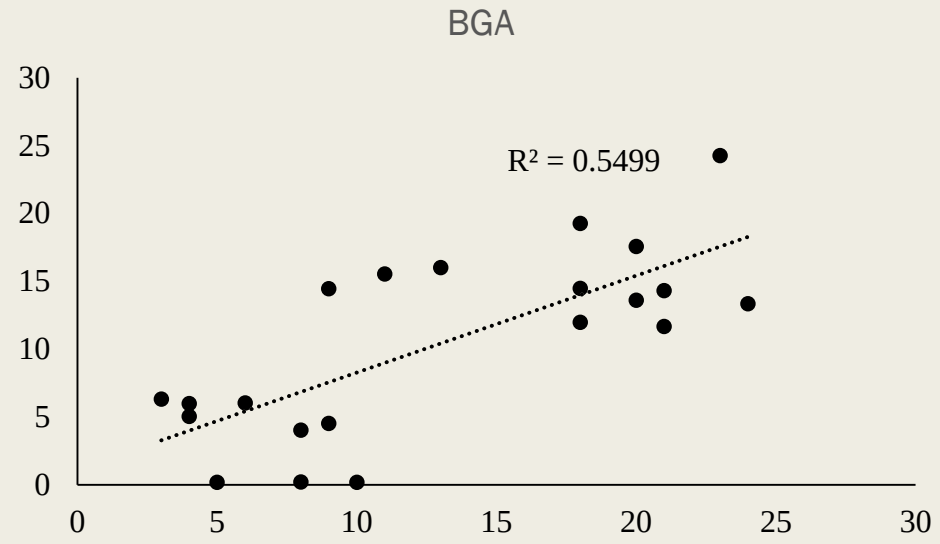


Results



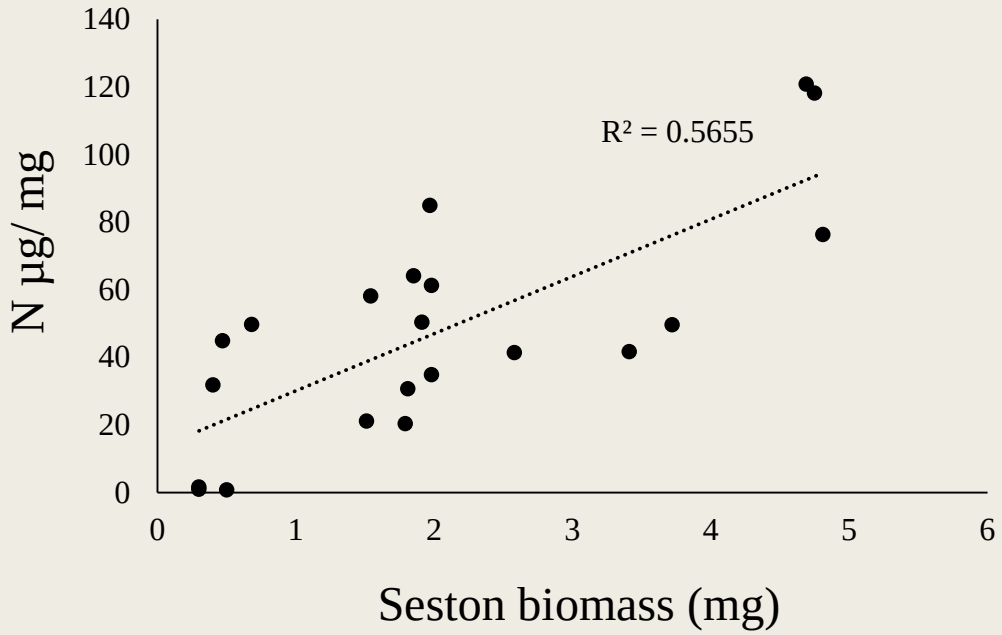
Seston biomass (mg)

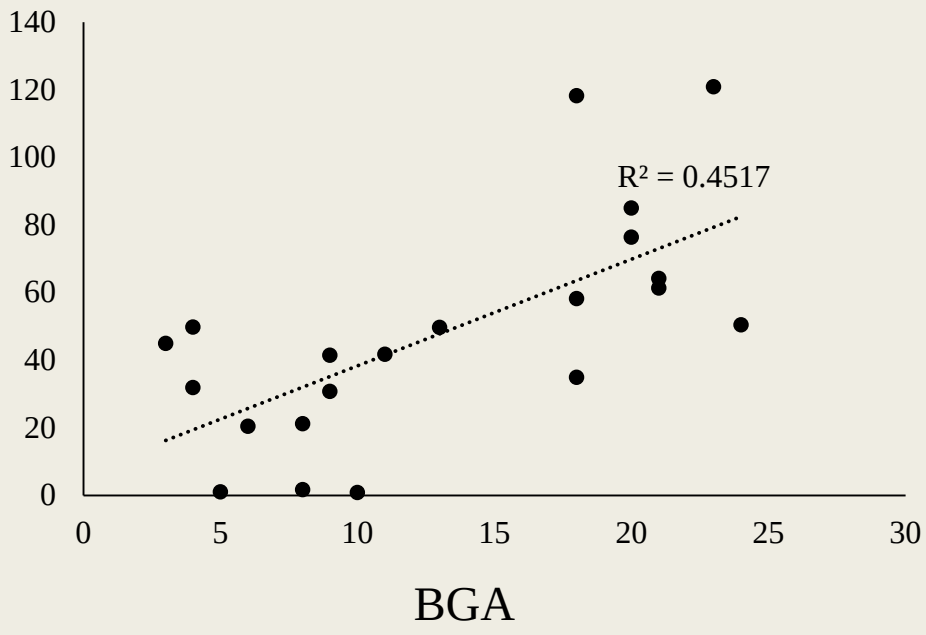
p=<0.001



BGA

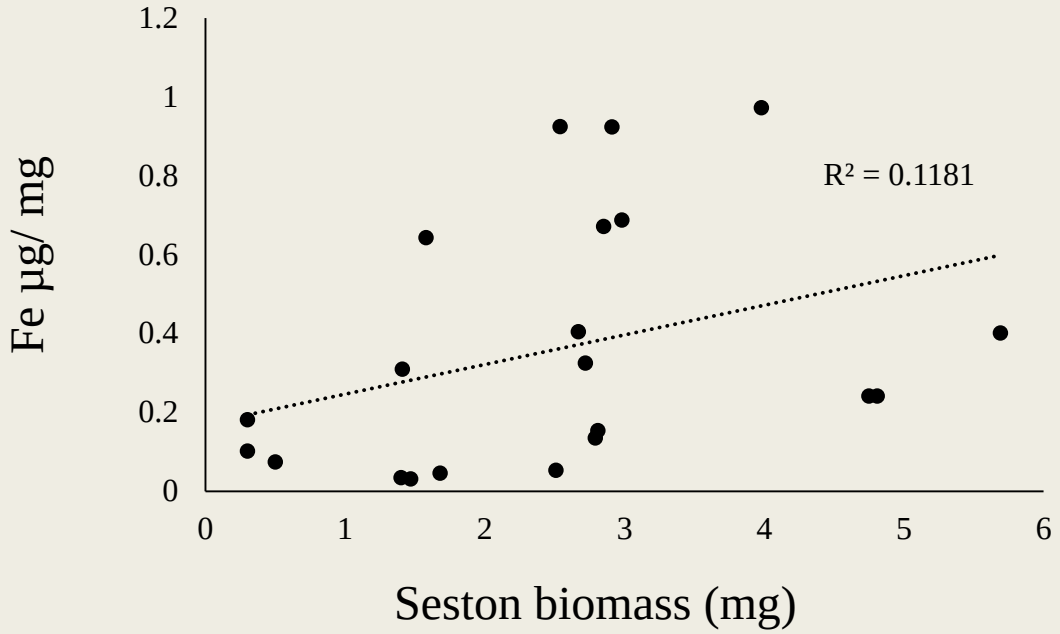
p=<0.001


N µg/ mg
R² = 0.5655
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
Seston biomass (mg)

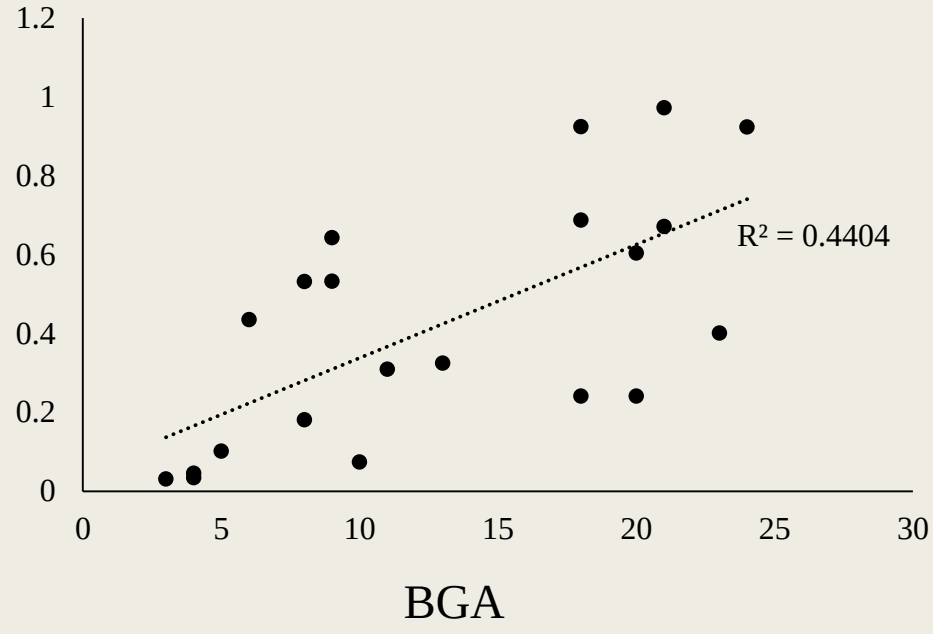

R² = 0.4517
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
BGA

p=<0.001

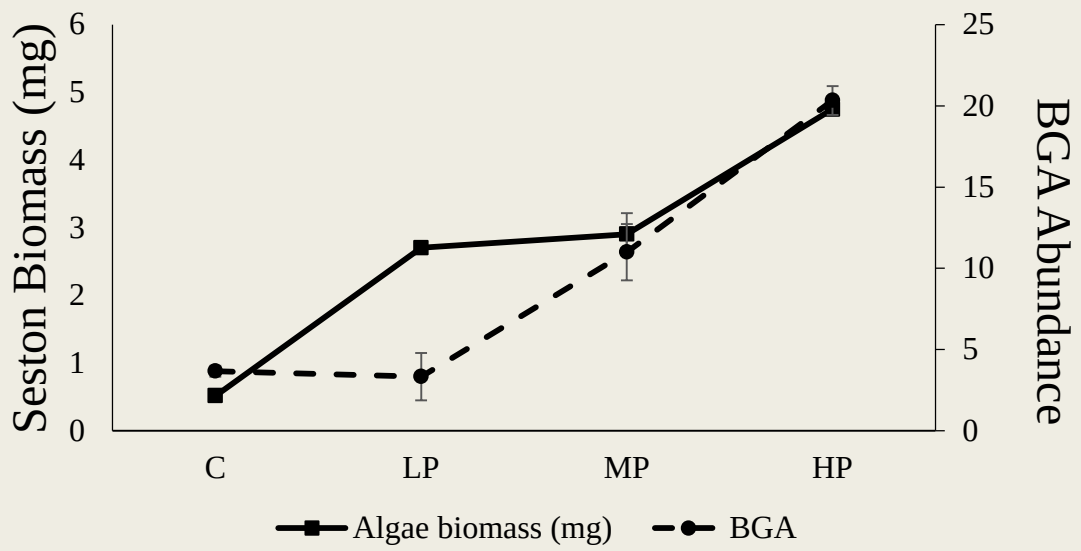
p=<0.001

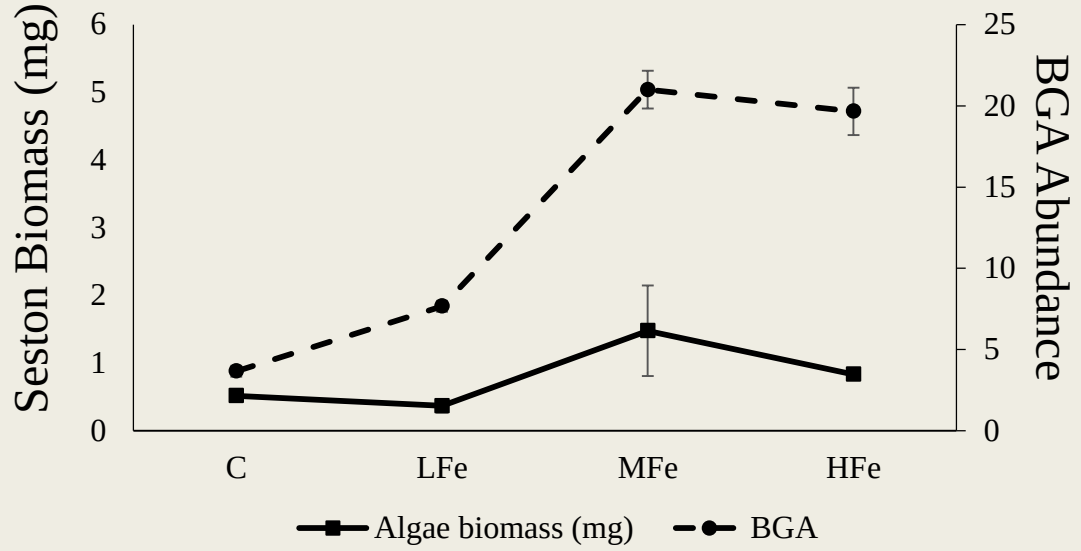

Fe µg/ mg
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
R² = 0.1181
Seston biomass (mg)

p=0.46


1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
R² = 0.4404
BGA

p=0.001


Seston Biomass (mg)
BGA Abundance
0
1
2
3
4
5
6
0
5
10
15
20
25
C
LP
MP
HP
Algae biomass (mg)
BGA


Seston Biomass (mg)
BGA Abundance
0
1
2
3
4
5
6
0
5
10
15
20
25
C
LFe
MFe
HFe
Algae biomass (mg)
BGA

Conclusions

- Fe has little effect on total algal biomass
- Increased BGA growth
- More than 1 or 2 elements (i.e. N &P) are important for growth
- More work needs to be done

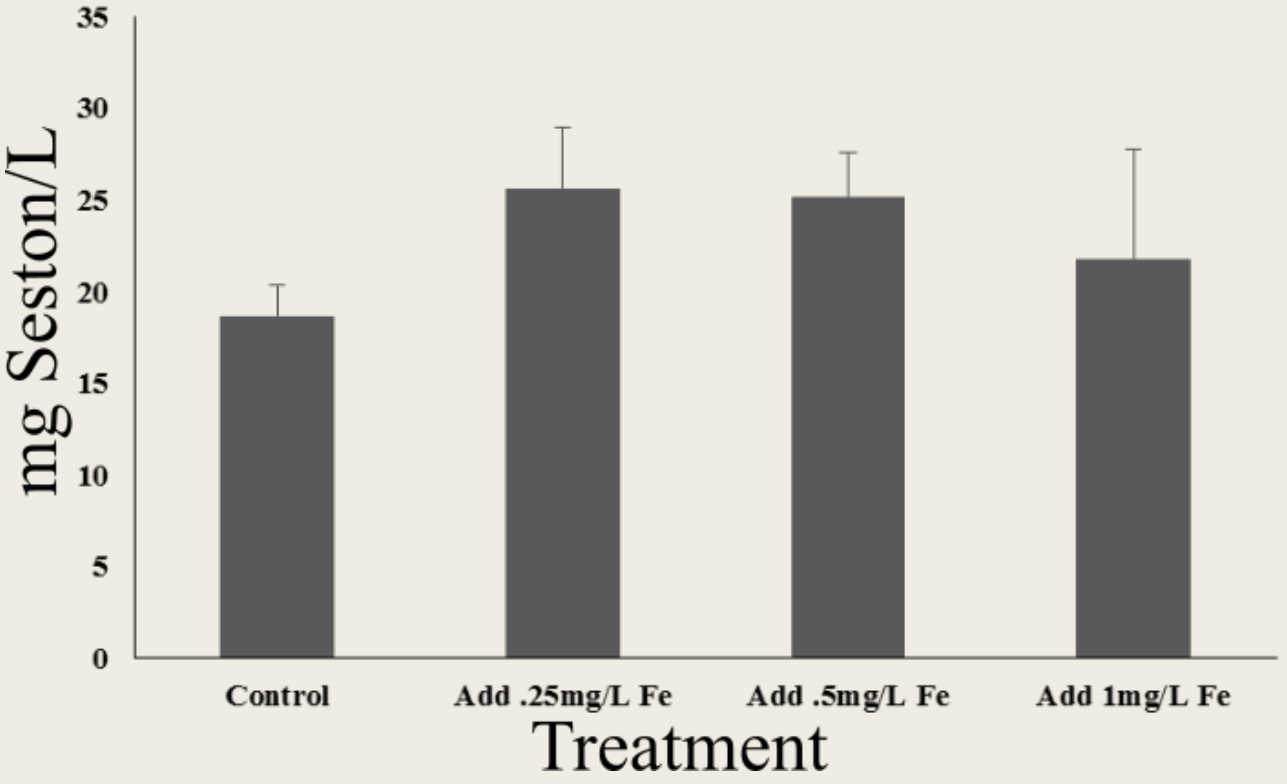
Future Directions

- Nitrogenase Activity
  - *Is the increase in growth in BGA truly because of higher rates of N fixing*
- Detailed Look at How Fe Affects Growth
  - *At what level of Fe do BGA experienced increased growth?*
  - *At what level does adding more Fe no longer have an affect?*
- Assessment of Fe Variation and Influx Among Local Lakes
  - *How much Fe is in an Oklahoma Lake?*
  - *How variable is that amount?*

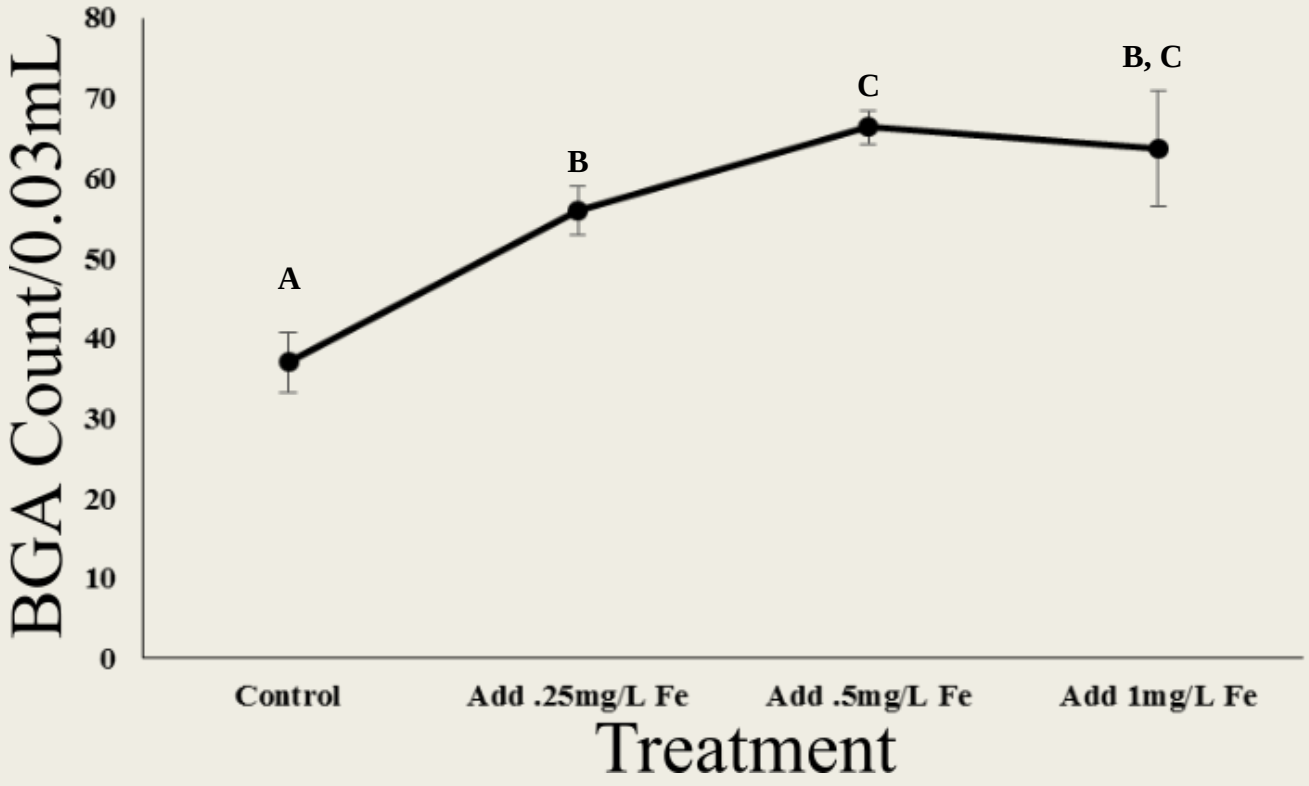
Acknowledgments

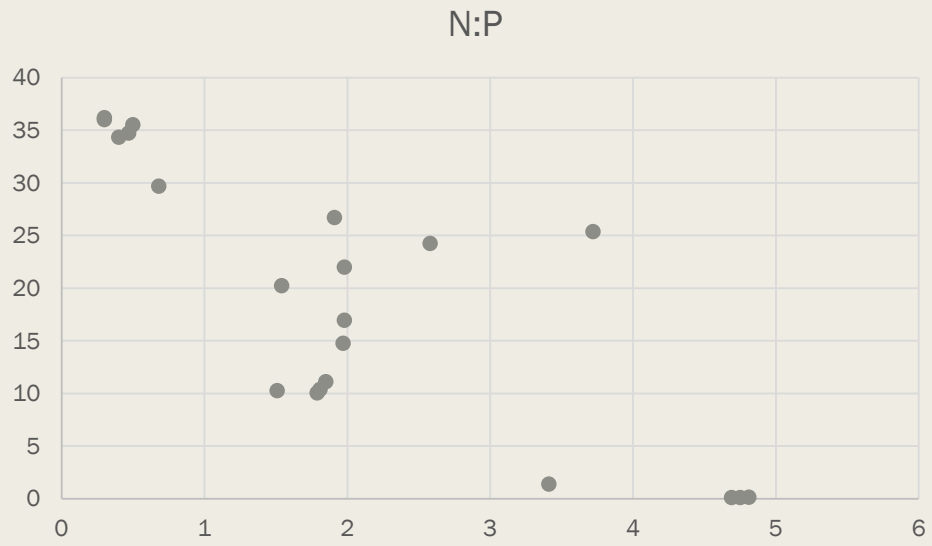
- OSU
- GRDA
- Steve Nikolai
- Richard Zamor
- The Jeyasingh Lab

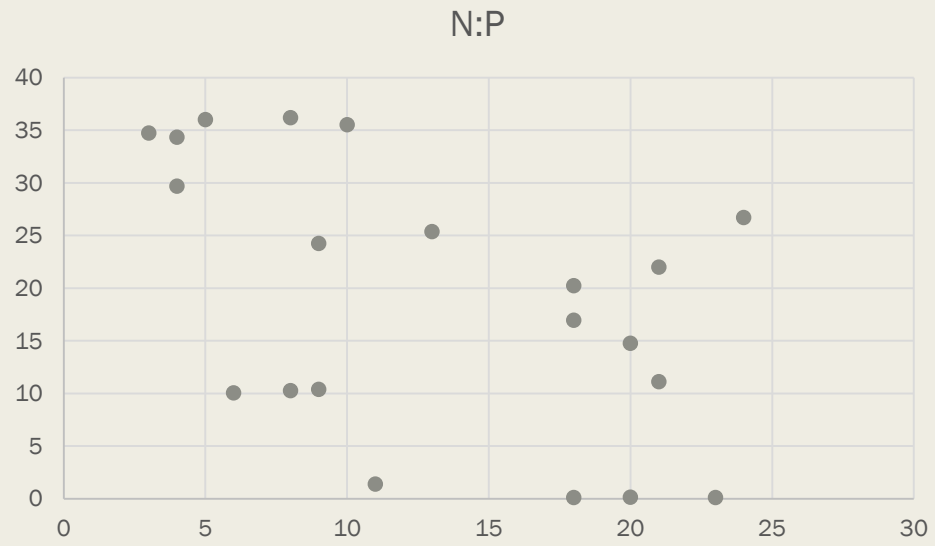
Results

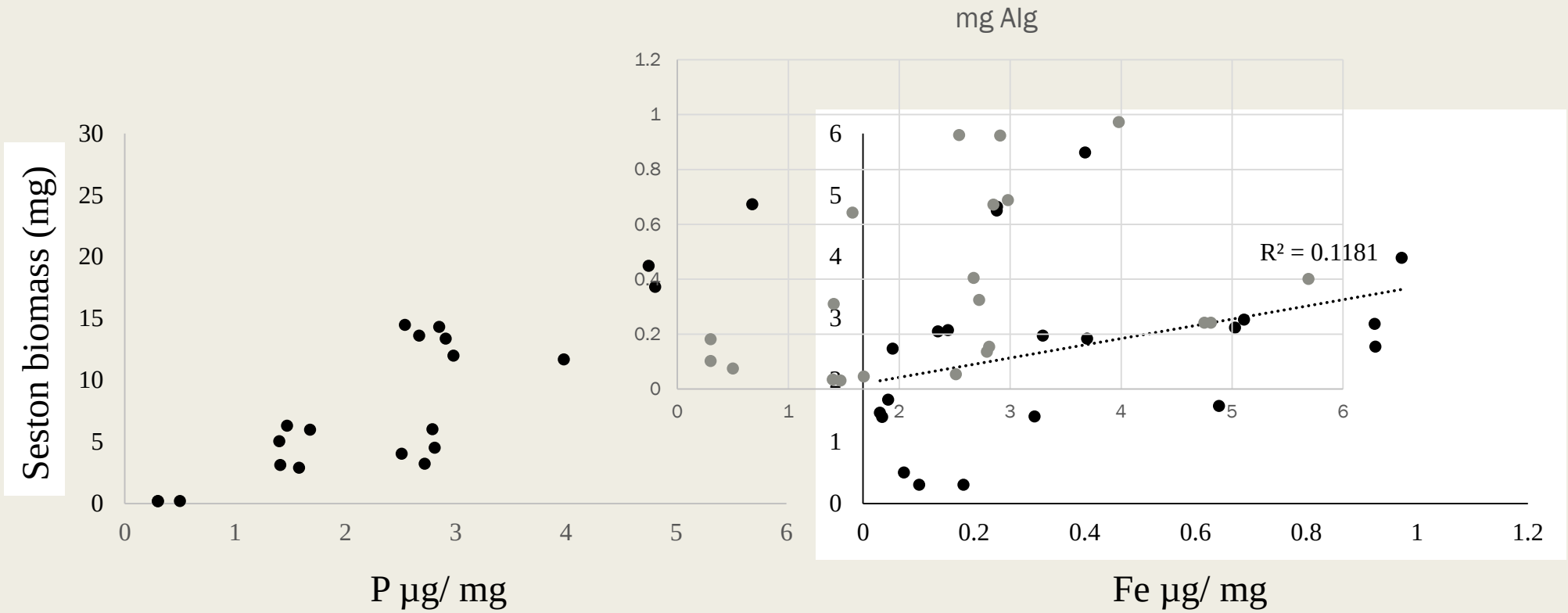

35
30
25
20
15
10
5
0
mg Seston/L
Control
Add .25mg/L Fe
Add .5mg/L Fe
Add 1mg/L Fe
Treatment

Results


BGA Count/0.03mL
80
70
60
50
40
30
20
10
0
A
B
C
B, C
Control
Add .25mg/L Fe
Add .5mg/L Fe
Add 1mg/L Fe
Treatment

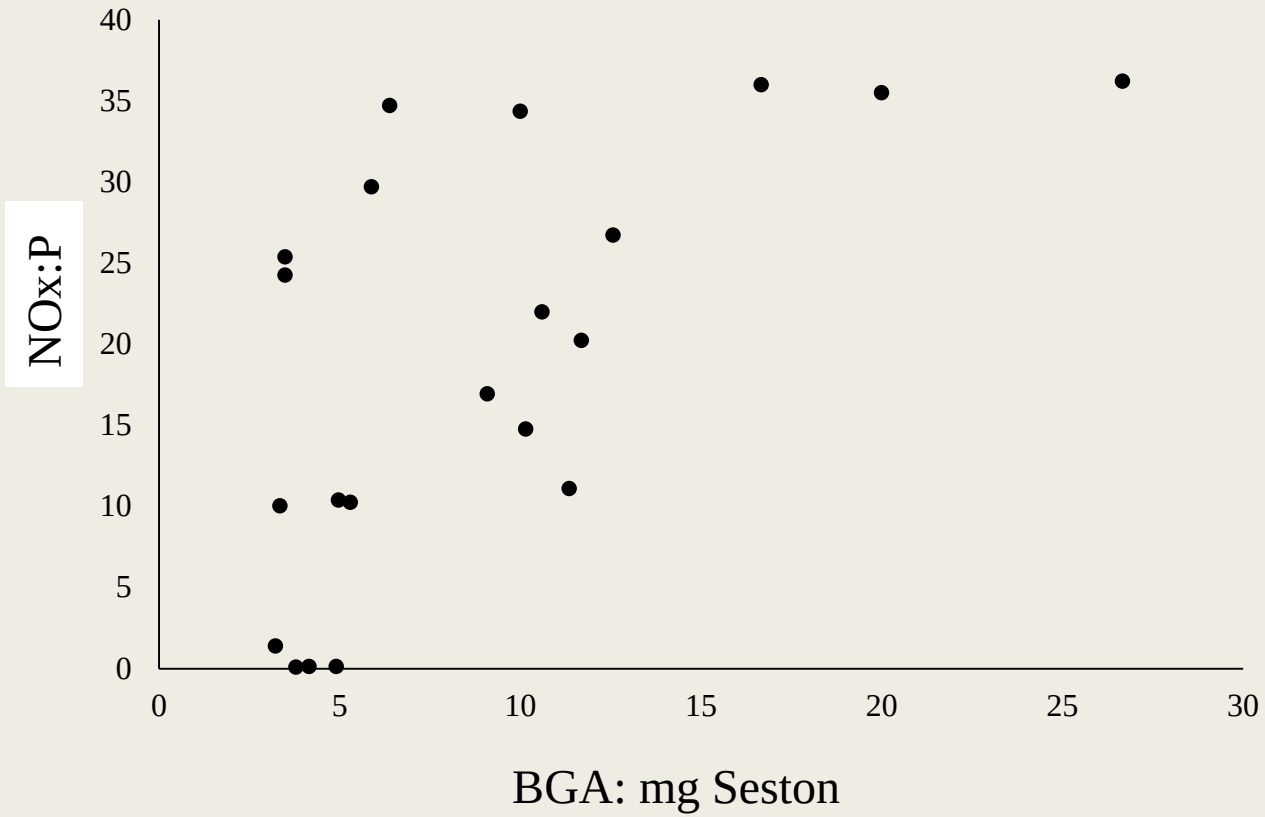

N:P
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6


N:P
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30

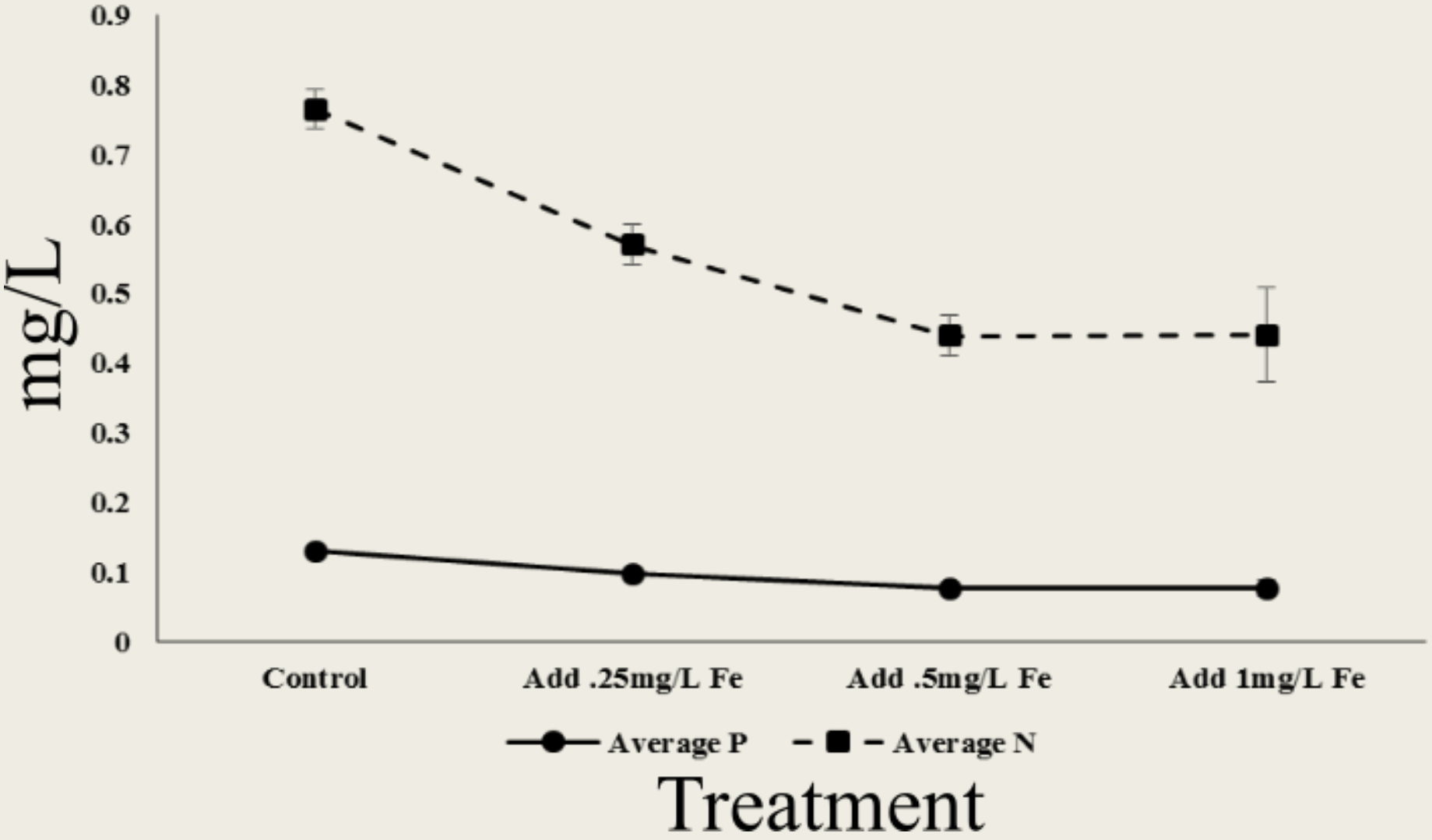

Seston biomass (mg)
30
25
20
15
10
5
0
0
1
2
3
4
5
6
P µg/ mg
mg Alg
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
R² = 0.1181
0
0.2
0.4
0.6
0.8
1
1.2
Fe µg/ mg

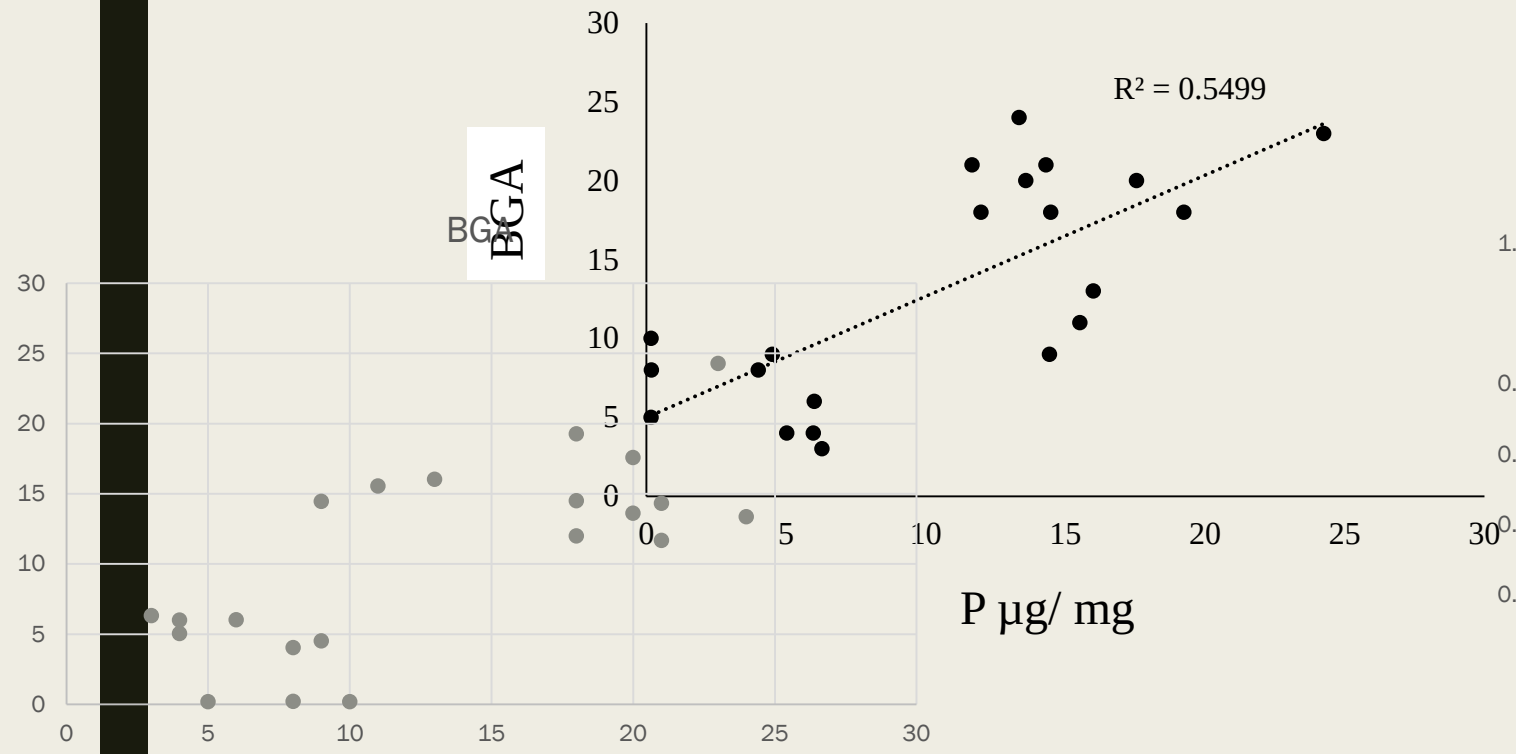
p=<0.001

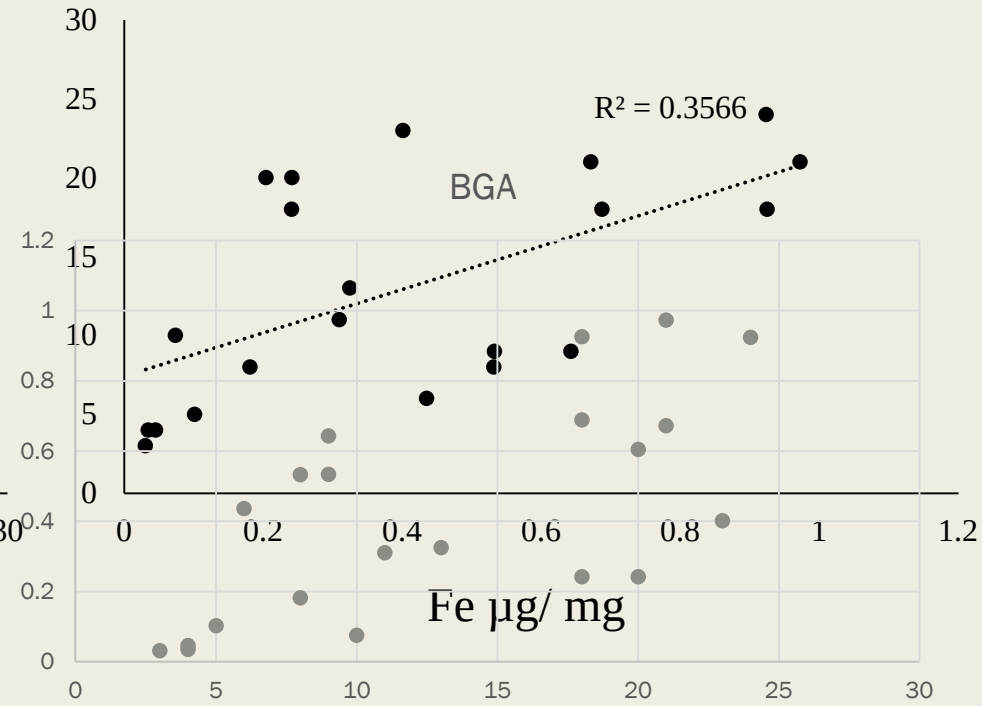
p=0.46


NOx:P
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
BGA: mg Seston

Results


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
mg/L
Control
Add .25mg/L Fe
Add .5mg/L Fe
Add 1mg/L Fe
Average P
Average N
Treatment

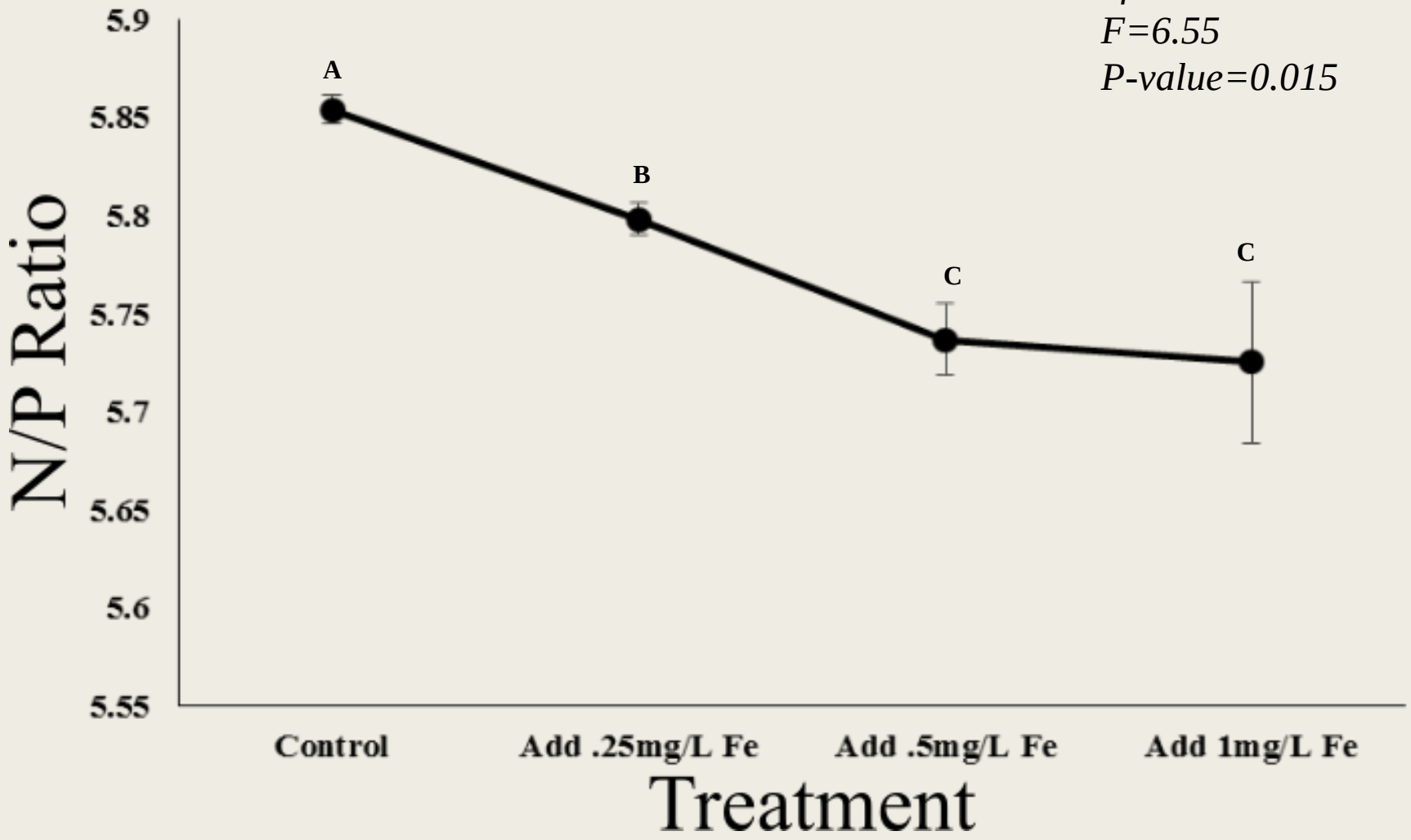




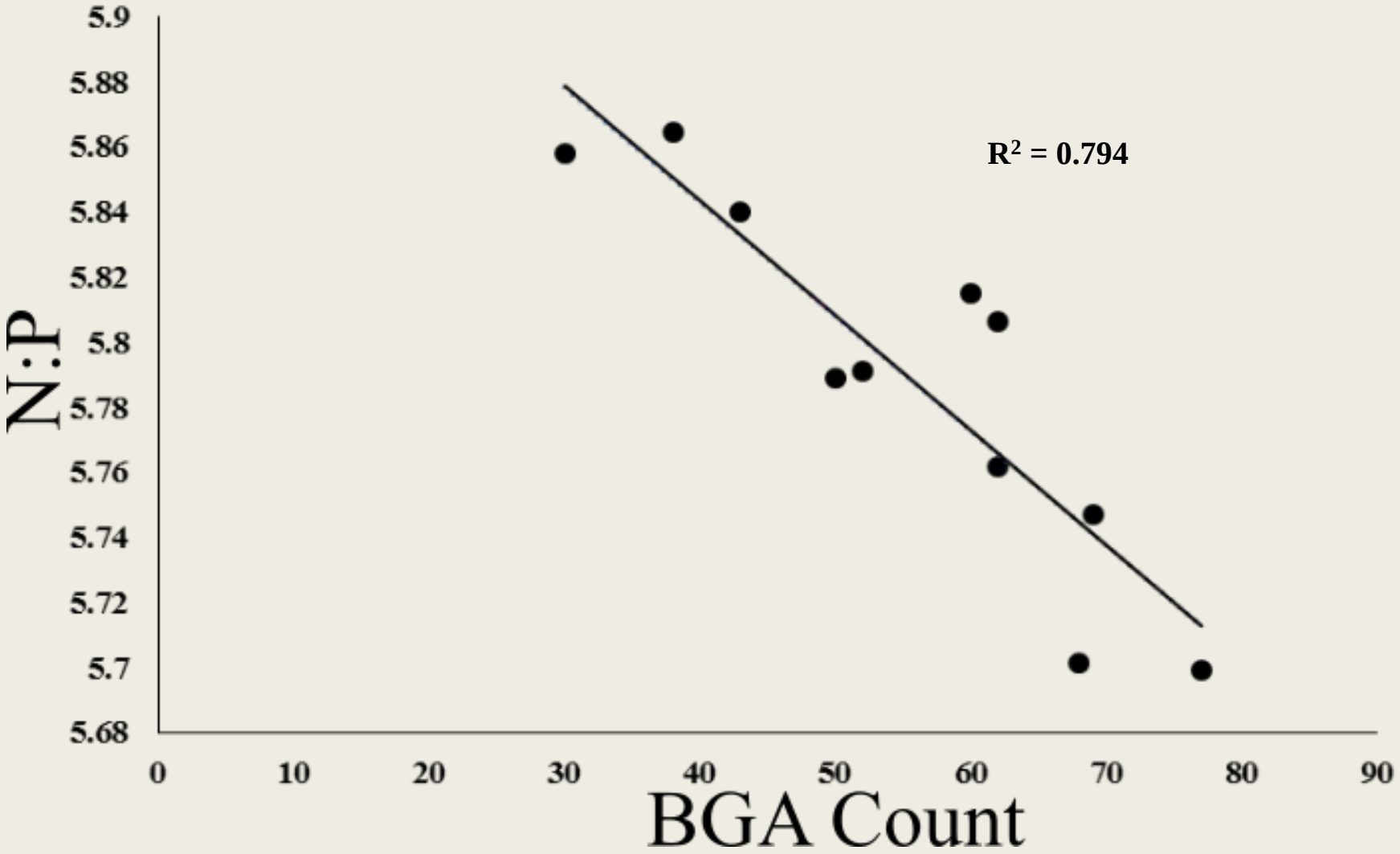
p=<0.001

p=0.001

Results


df=3
F=6.55
P-value=0.015
5.9
5.85
5.8
5.75
5.7
5.65
5.6
5.55
N/P Ratio
A
B
C
C
Control
Add .25mg/L Fe
Add .5mg/L Fe
Add 1mg/L Fe
Treatment

Results


5.9
5.88
5.86
5.84
5.82
5.8
5.78
5.76
5.74
5.72
5.7
5.68
N:P
0
10
20
30
40
50
60
70
80
90
BGA Count
R2 = 0.794