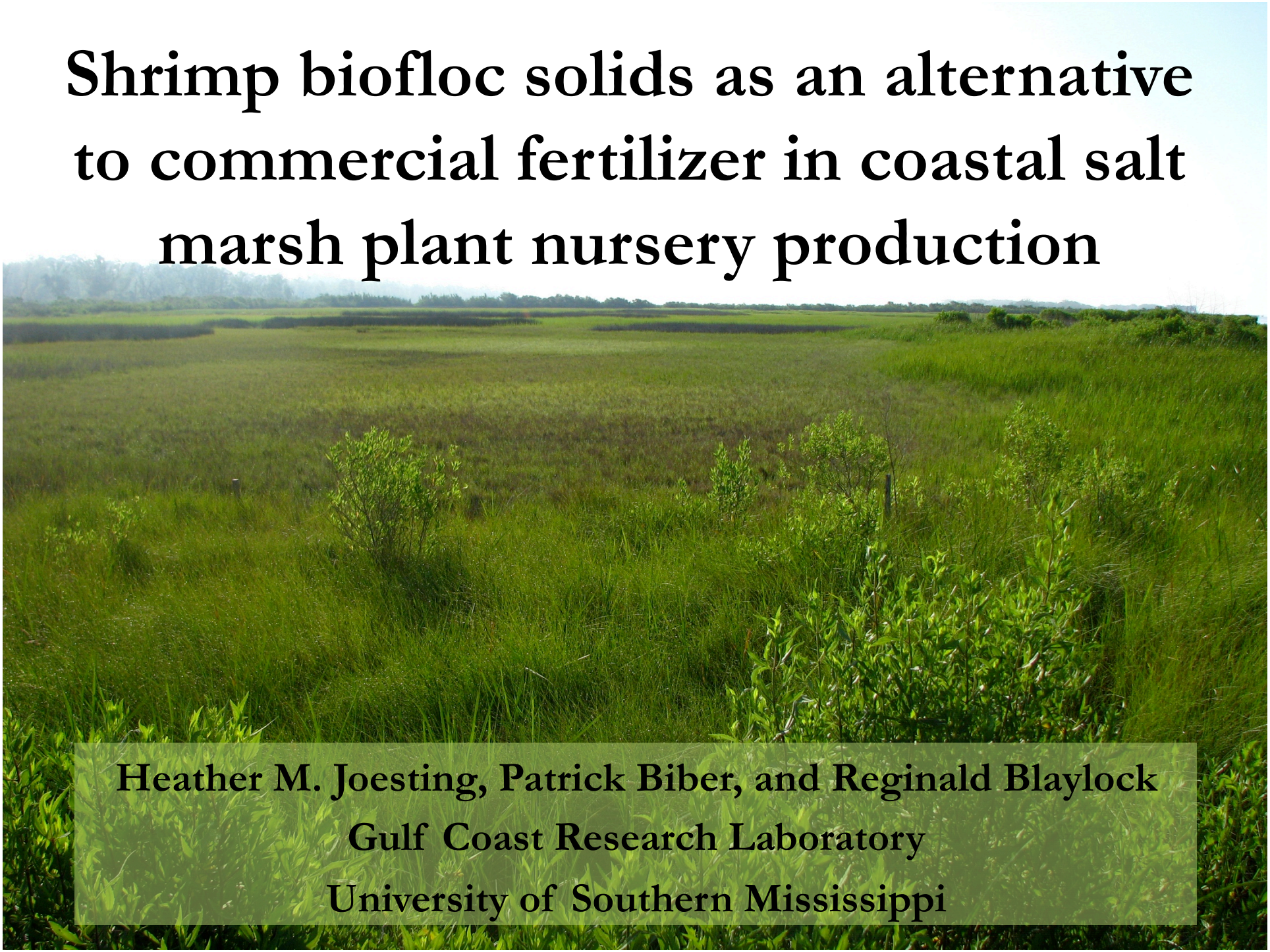
Shrimp biofloc solids as an alternative to commercial fertilizer in coastal salt marsh plant nursery production



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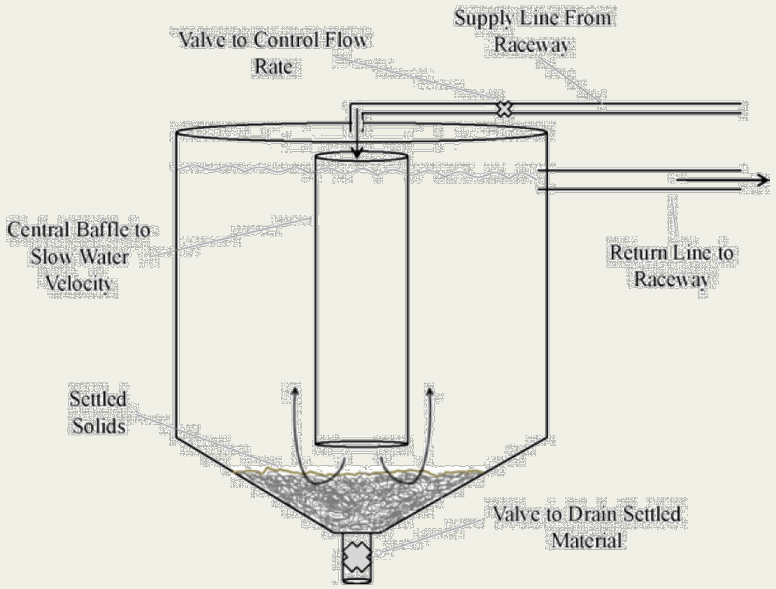
Advances in Shrimp Aquaculture

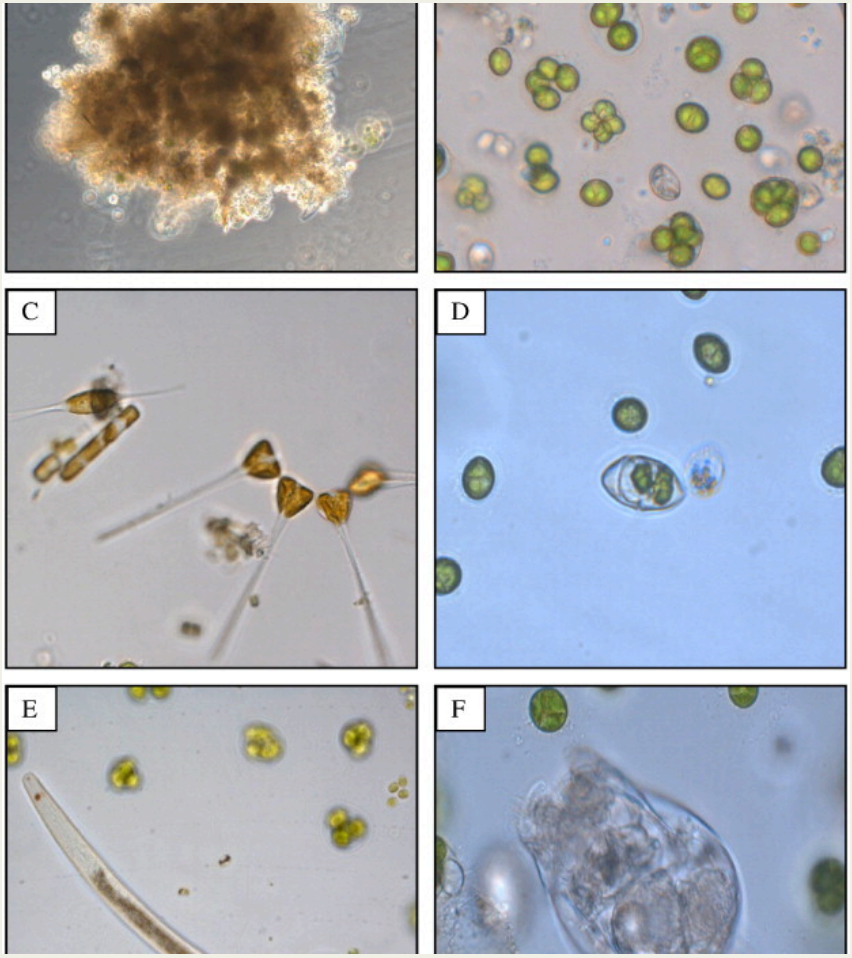


Ray et al. 2011 *Aquacultural Engineering*

- Intensive minimal-exchange shrimp culture systems
  - High stocking densities
  - Little water exchange = reduced pollutant discharge
  - Can be sited at inland locations
- Settlement chambers
  - Manages solids concentration to optimize shrimp production

Biofloc Solids

- High stocking densities = high nutrient input
- Biofloc is composed of:
  - Micro-organisms
  - Uneaten feed
  - Feces
  - Detritus
- Dried solids high in nutrients
  - 6.8% nitrogen content (0.6% NO_3 and 6.2% NH_4)
  - 1.1% phosphate content
  - Relatively high salinity



Ray et al. 2010, *Aquaculture*

Purpose of Study

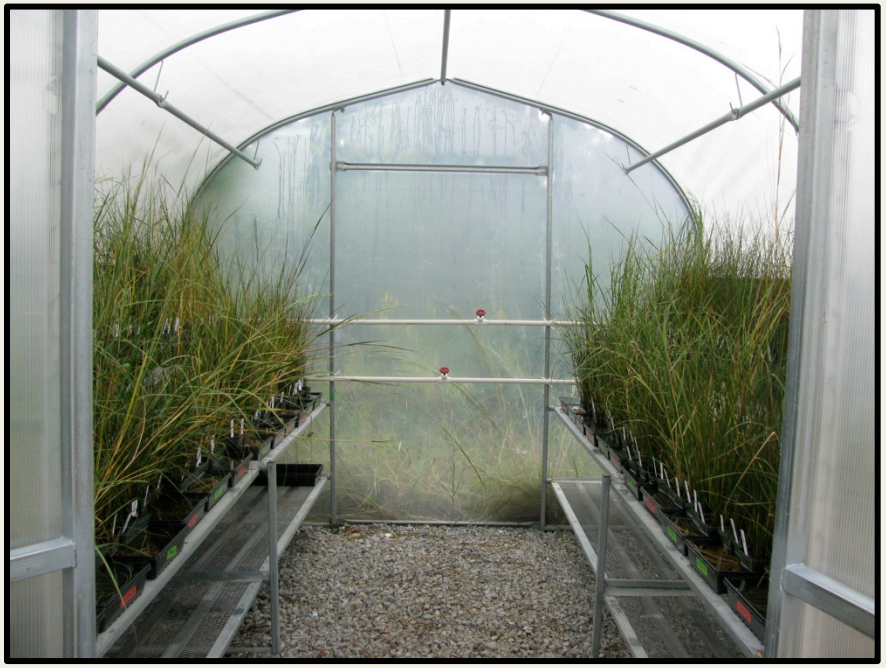
- **Question:** Large amount of salty nutrient-laden biofloc solids – how to reduce environmental and economical costs associated with disposal?
- **Purpose:** Determine if shrimp biofloc solids can be used as an alternative to commercial fertilizers in the nursery production of salt marsh plant species for restoration
- **Hypothesis**: Growth, biomass, and plant tissue nutrient content of salt marsh plants dosed with biofloc solids will *not be* significantly different than plants dosed with commercial fertilizer (Miracle-Gro®)

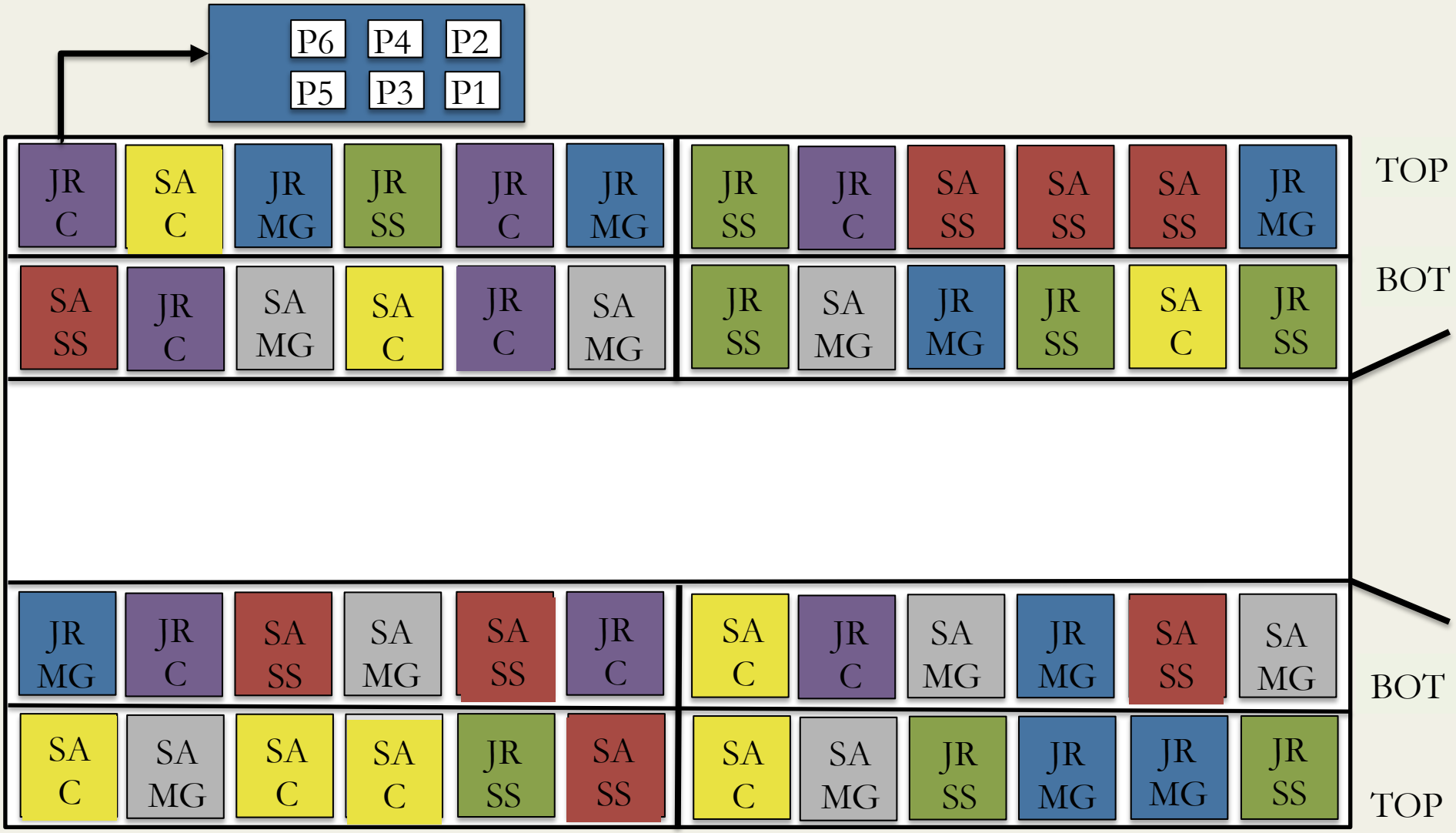
Litopenaeus vannamei **Production**

Produced at the University of Southern Mississippi's Thad Cochran Center for Aquaculture

Methods

- Two species native to salt marshes along the Gulf Coast:
  - *Juncus roemerianus* (black needlerush) – dominant species
  - *Spartina alterniflora* (smooth cordgrass) – co-dominant species





***Spartina alterniflora* (SA)**
***Juncus roemerianus* (JR)**

Treatments:
Control (C)
Miracle-Gro (MG)
Shrimp solids (SS)

Dosed once a week for total of 6 weeks → Dosing period

Methods – Data Collection

- Plant-based measurements made at:
  - End of dosing period (week 6)
  - After 12 weeks for response period (week 18)
- Four categories of measurements:
  - Plant morphology (number of shoots/ramets, plant/stem height, leaf width/diameter)
  - Plant biomass (aboveground and belowground)
  - Plant tissue nutrient content (nitrogen and phosphate)
  - Leaf chlorophyll content (chlorophyll *a* and *b*)

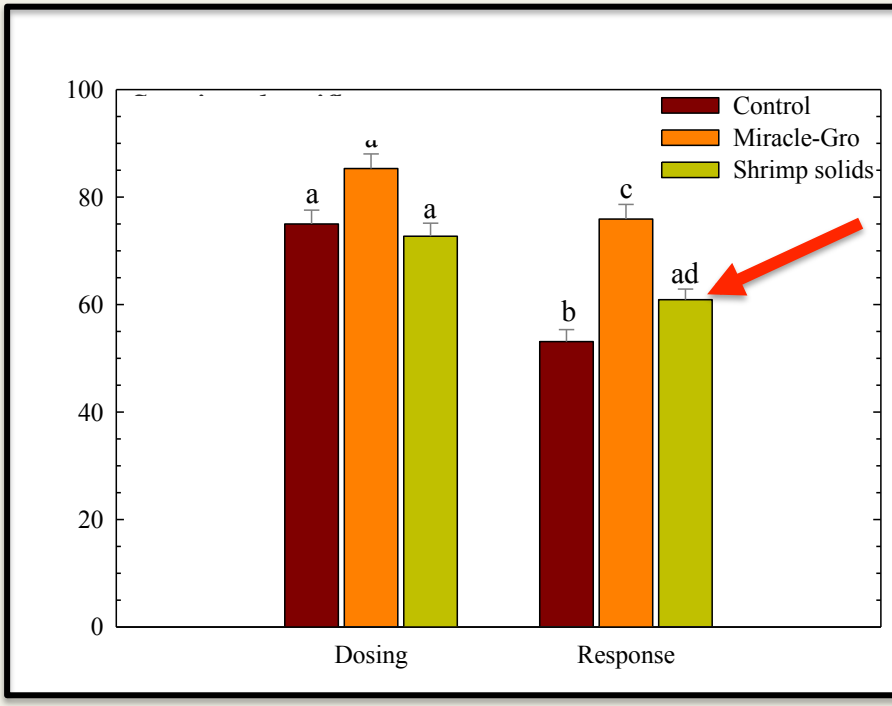
Methods – Statistical Analyses

- To compare among treatments in both the dosing period and response period
  - Three-factor nested analysis of variance (ANOVA) for plant morphology, nitrogen content, and leaf chlorophyll content
  - One-way ANOVA for biomass and phosphate content
  - Tukey's HSD used as post-hoc comparisons
- To compare between response and dosing period for all variables
  - One-way ANOVA

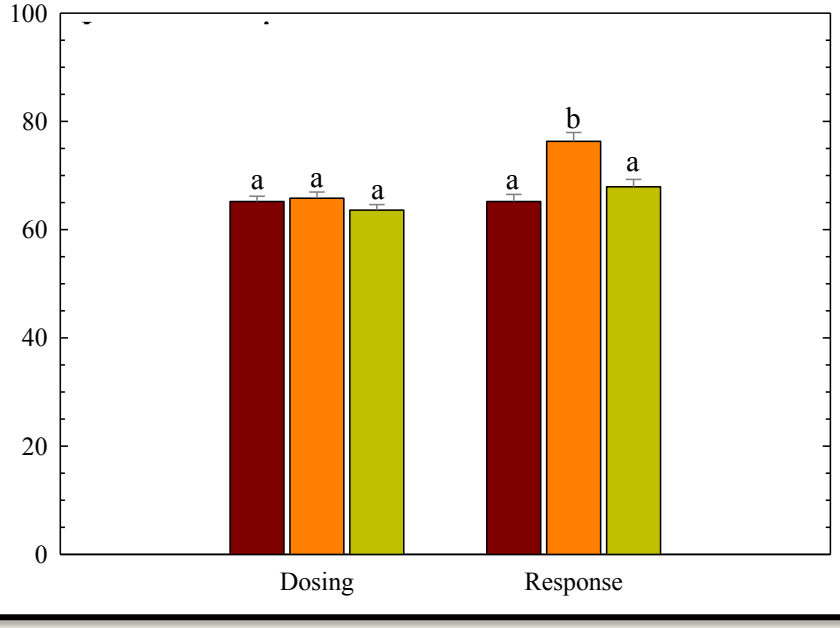
Results – Plant Morphology

- Significantly greater **plant height (cm)** in Miracle-Gro for both species

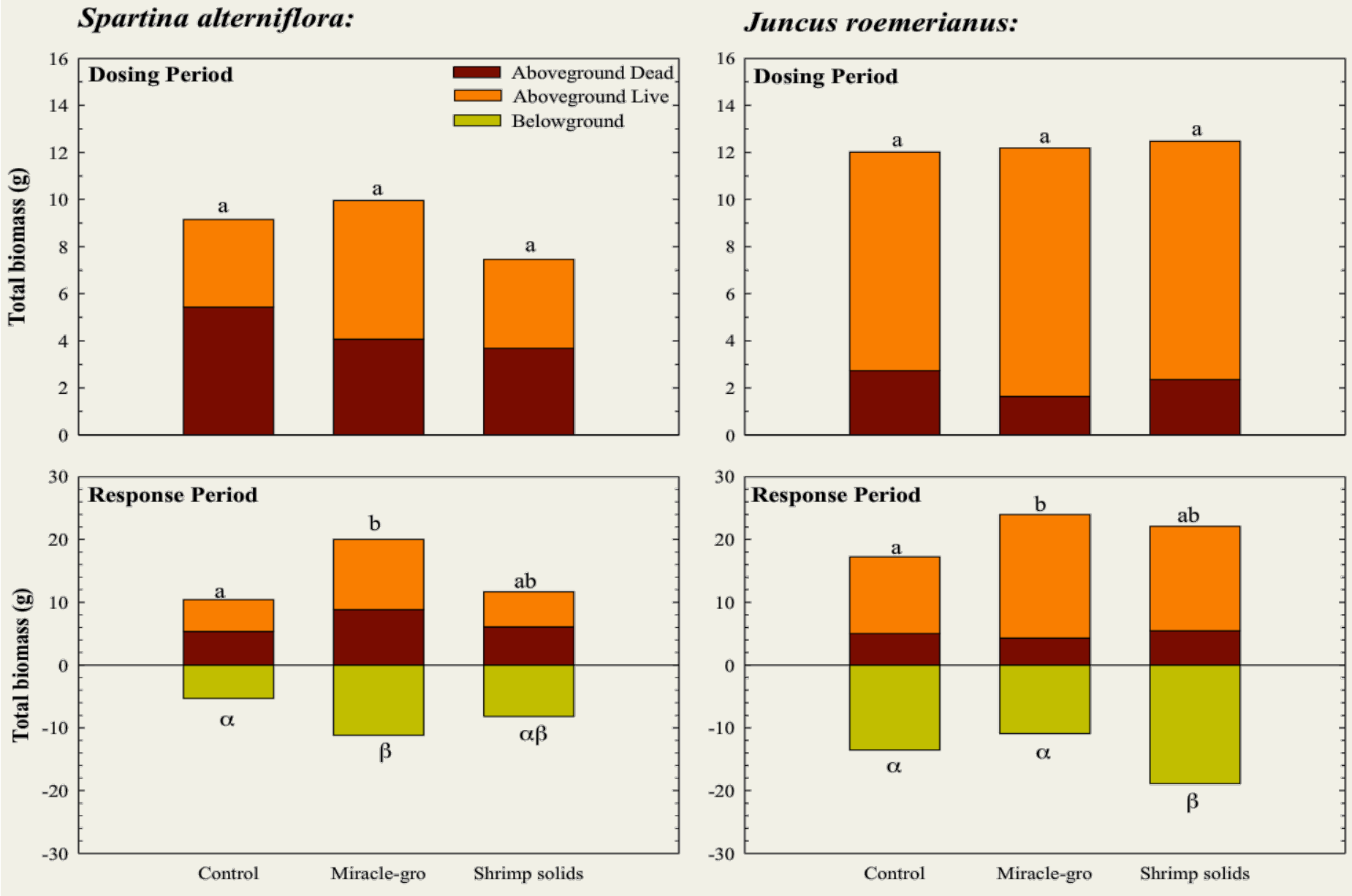
Spartina alterniflora



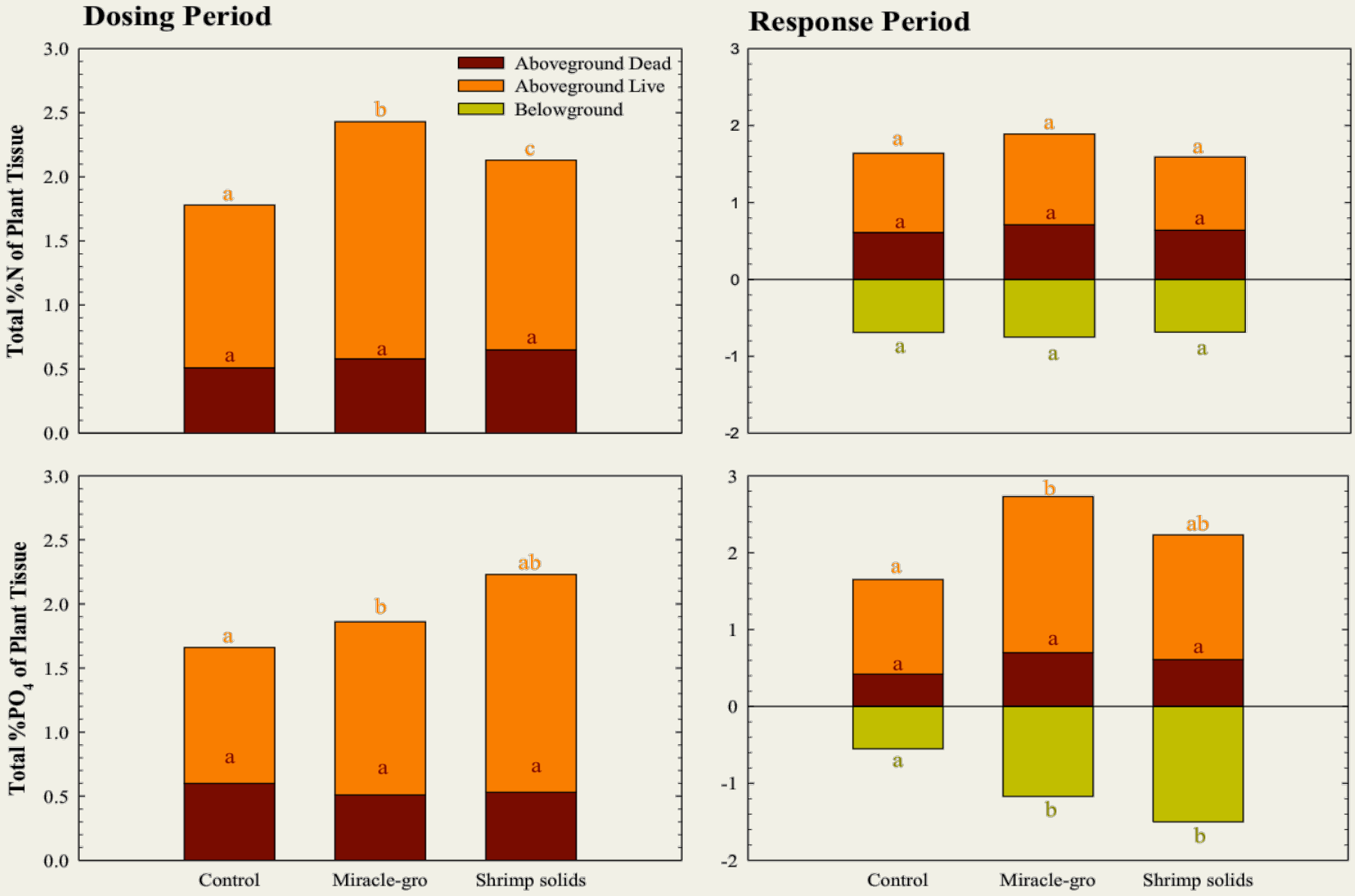
Juncus roemerianus



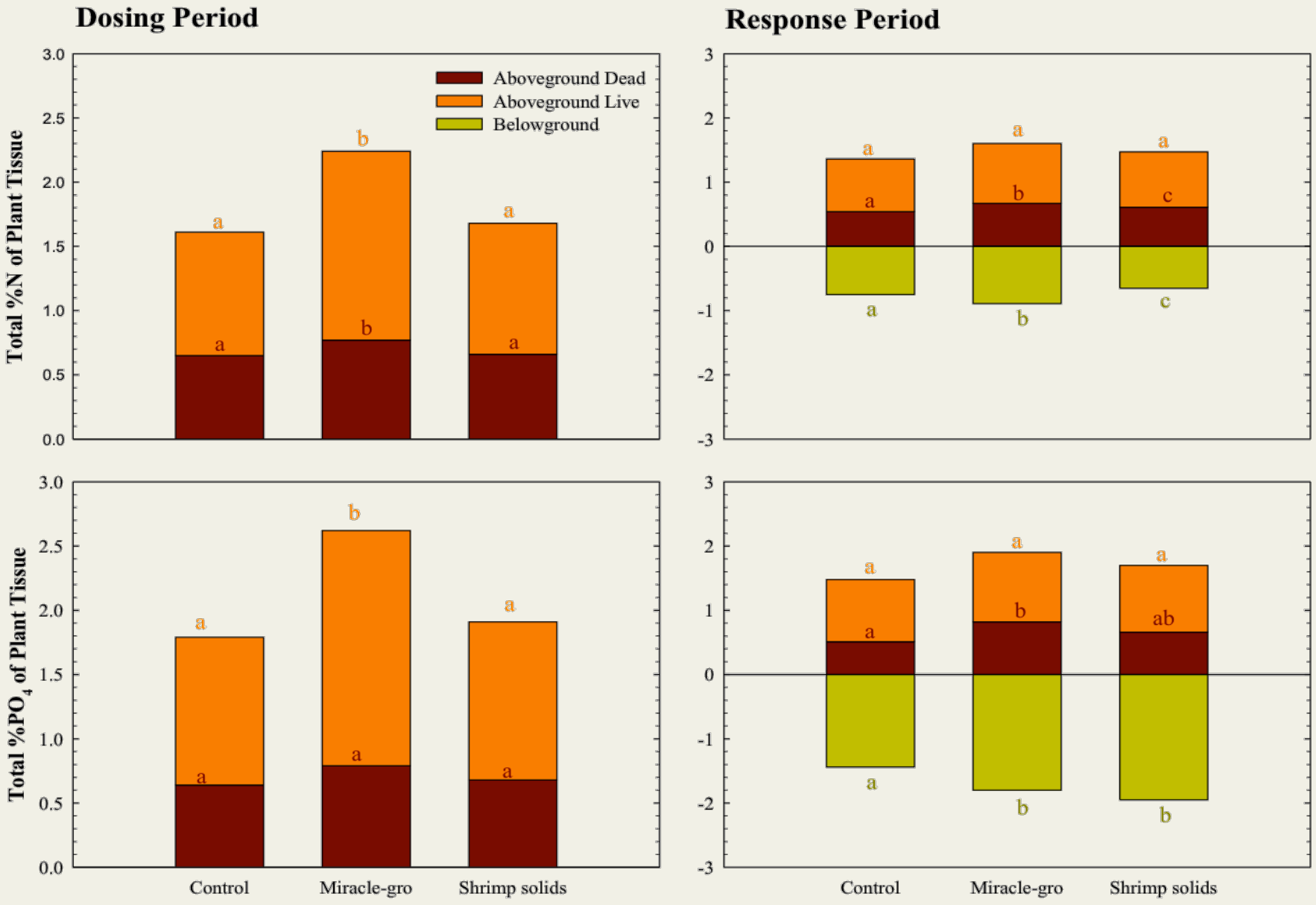
Results – Biomass



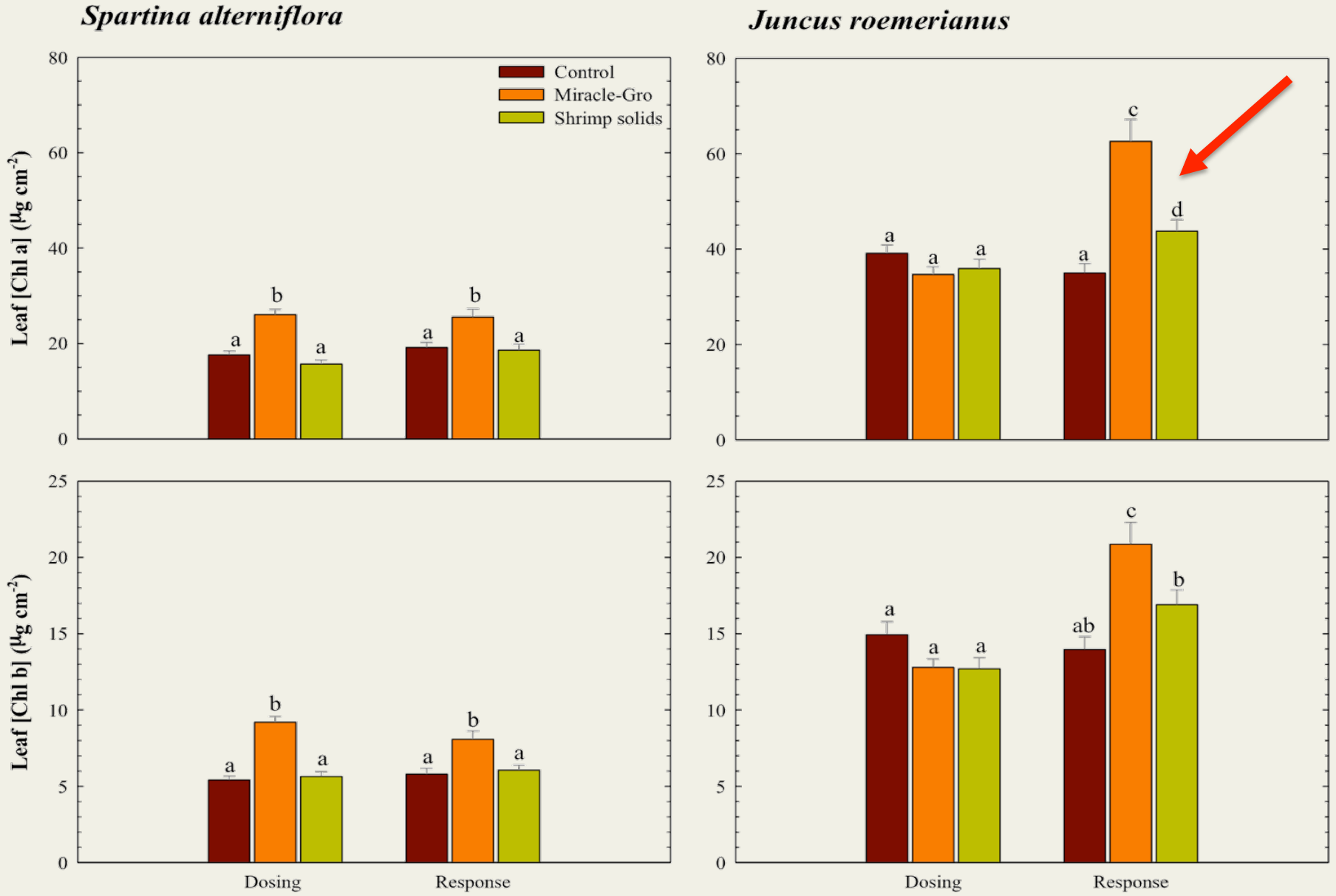
Results – Nutrients in *S. alterniflora*



Results – Nutrients in *J. roemerianus*

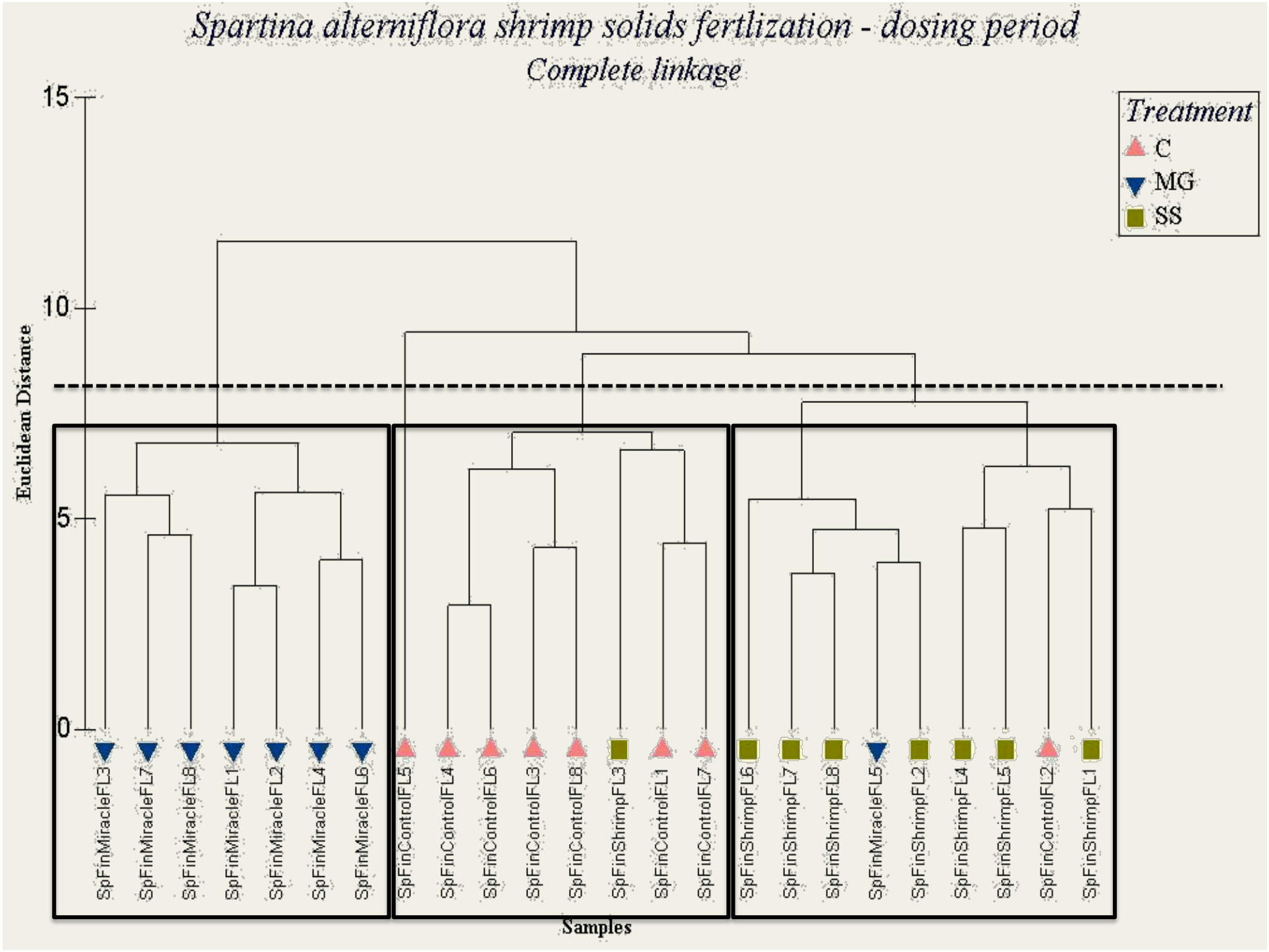


Results – Leaf Chlorophyll Content



Multivariate Analysis

- Meta-analysis of growth
- Multi-dimensional view of variable interaction and treatment effects
- Multivariate statistics:
  - Cluster analyses
  - Multi-dimensional Scaling (MDS)
  - Analysis of Similarities (ANOSIM)

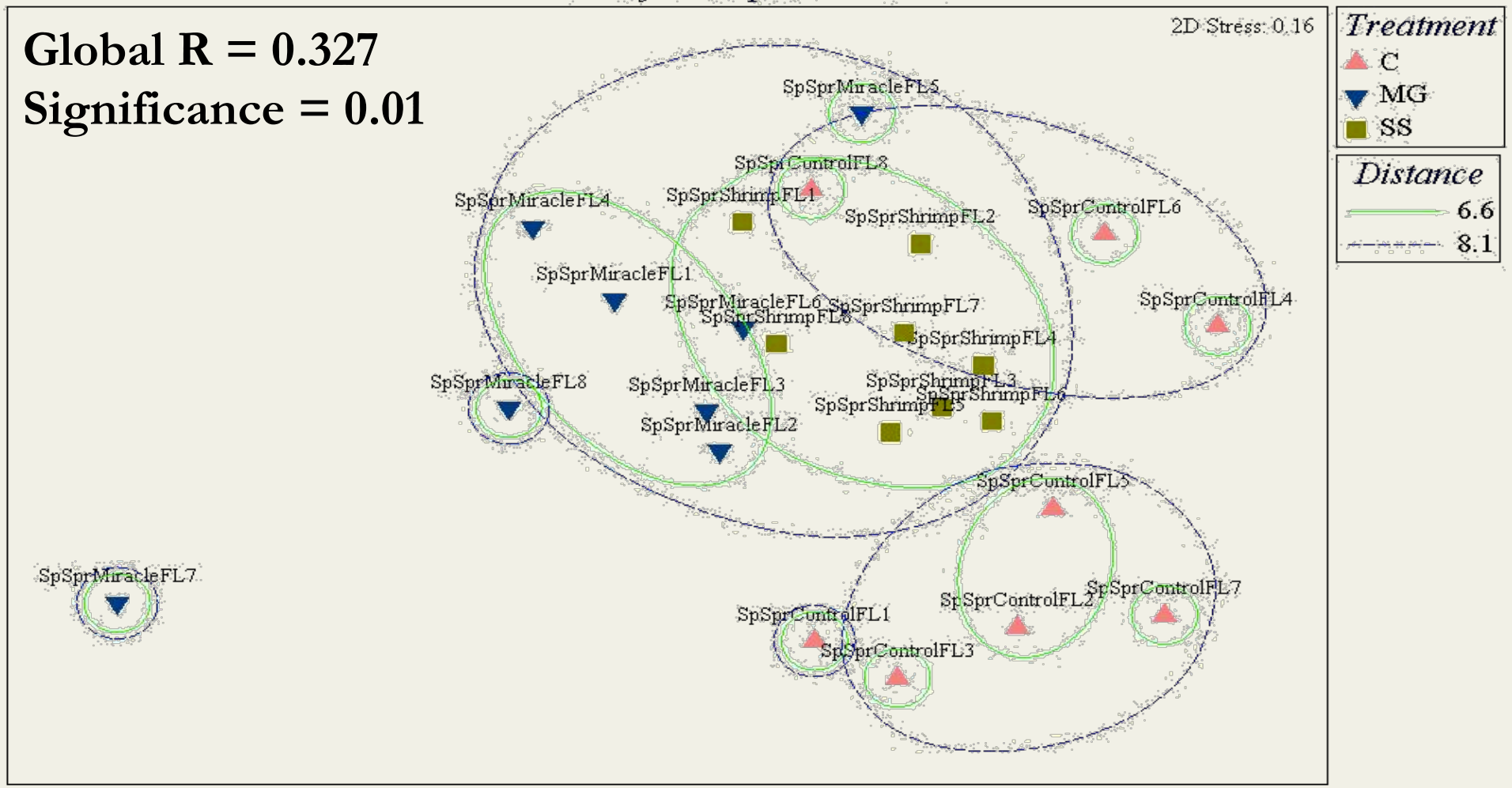

Spartina alterniflora shrimp solids fertlization - dosing period
Complete linkage
Treatment
C
MG
SS
Euclidean Distance
15
10
5
0
SpFinMiracleFL3
SpFinMiracleFL7
SpFinMiracleFL8
SpFinMiracleFL1
SpFinMiracleFL2
SpFinMiracleFL4
SpFinMiracleFL6
SpFinControlFL5
SpFinControlFL4
SpFinControlFL6
SpFinControlFL3
SpFinControlFL8
SpFinShrimpFL3
SpFinControlFL1
SpFinControlFL7
SpFinShrimpFL6
SpFinShrimpFL7
SpFinShrimpFL8
SpFinMiracleFL5
SpFinShrimpFL2
SpFinShrimpFL4
SpFinShrimpFL5
SpFinControlFL2
SpFinShrimpFL1
Samples

Spartina alterniflora Shrimp Fertilization

MDS for Response Period

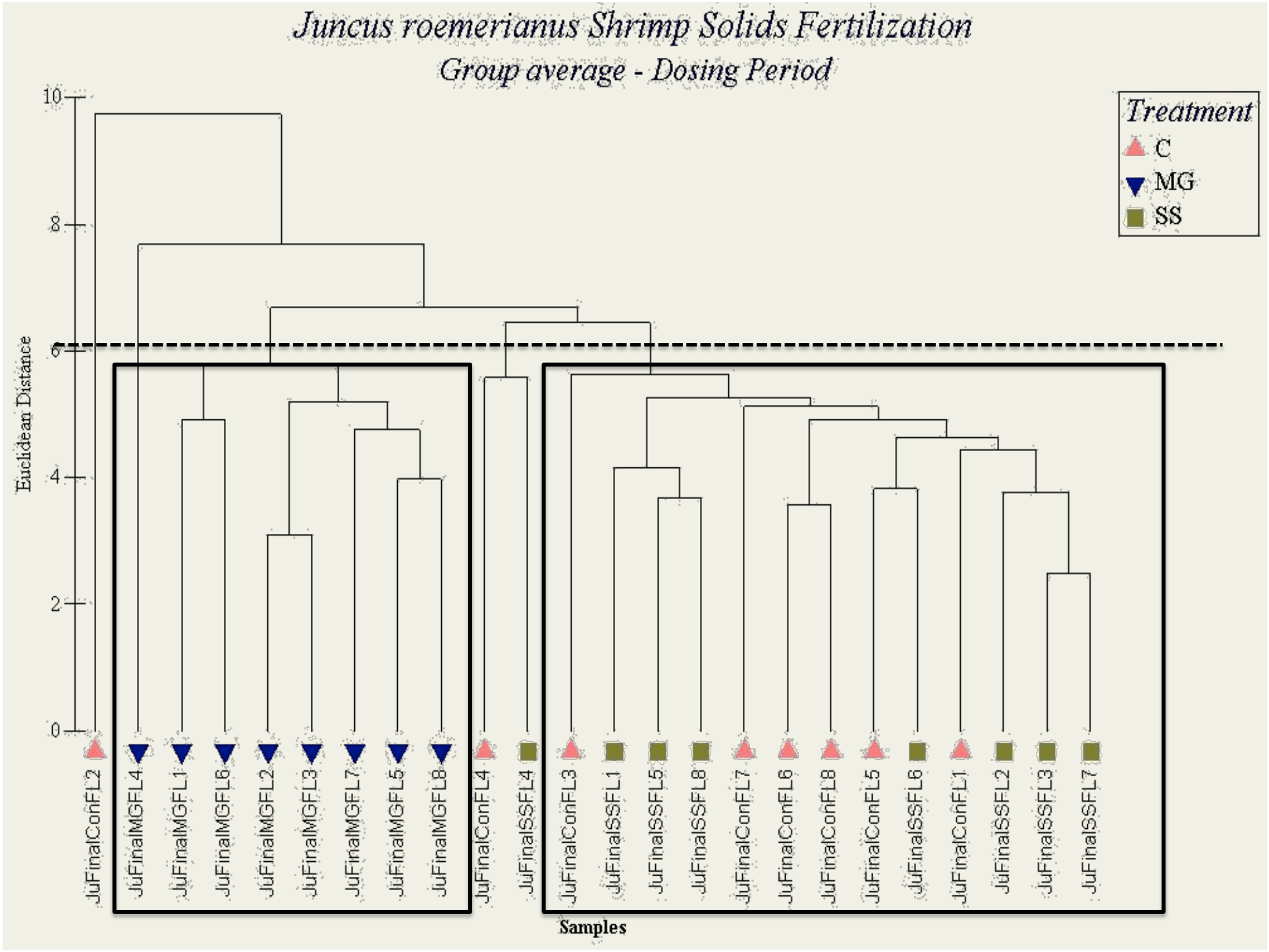
Global R = 0.327

Significance = 0.01



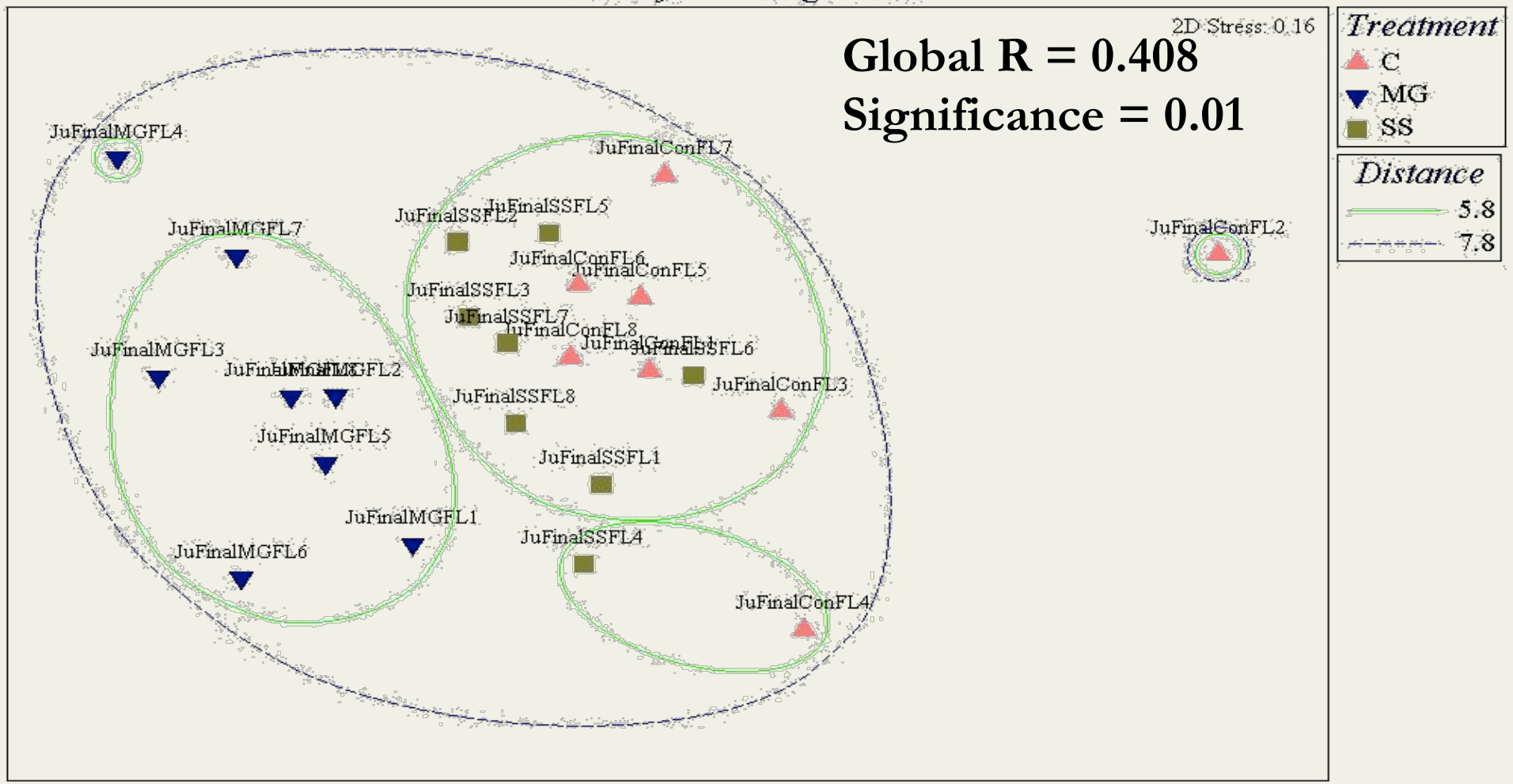
Analysis of Similarities (ANOSIM) Analysis:

Groups	R	Significance
Control-Miracle Gro	0.491	0.02
Control-Shrimp Solids	0.289	0.03
Miracle Gro-Shrimp Solids	0.323	0.10


Juncus roemerianus Shrimp Solids Fertilization
Group average - Dosing Period
Treatment
C
MG
SS
Euclidean Distance
10
8
6
4
2
0
JuFinalConFL2
JuFinalMGFL4
JuFinalMGFL1
JuFinalMGFL6
JuFinalMGFL2
JuFinalMGFL3
JuFinalMGFL7
JuFinalMGFL5
JuFinalMGFL8
JuFinalConFL4
JuFinalSSFL4
JuFinalConFL3
JuFinalSSFL1
JuFinalSSFL5
JuFinalSSFL8
JuFinalConFL7
JuFinalConFL6
JuFinalConFL8
JuFinalConFL5
JuFinalSSFL6
JuFinalConFL1
JuFinalSSFL2
JuFinalSSFL3
JuFinalSSFL7
Samples

Juncus roemerianus Shrimp Solids Fertilization

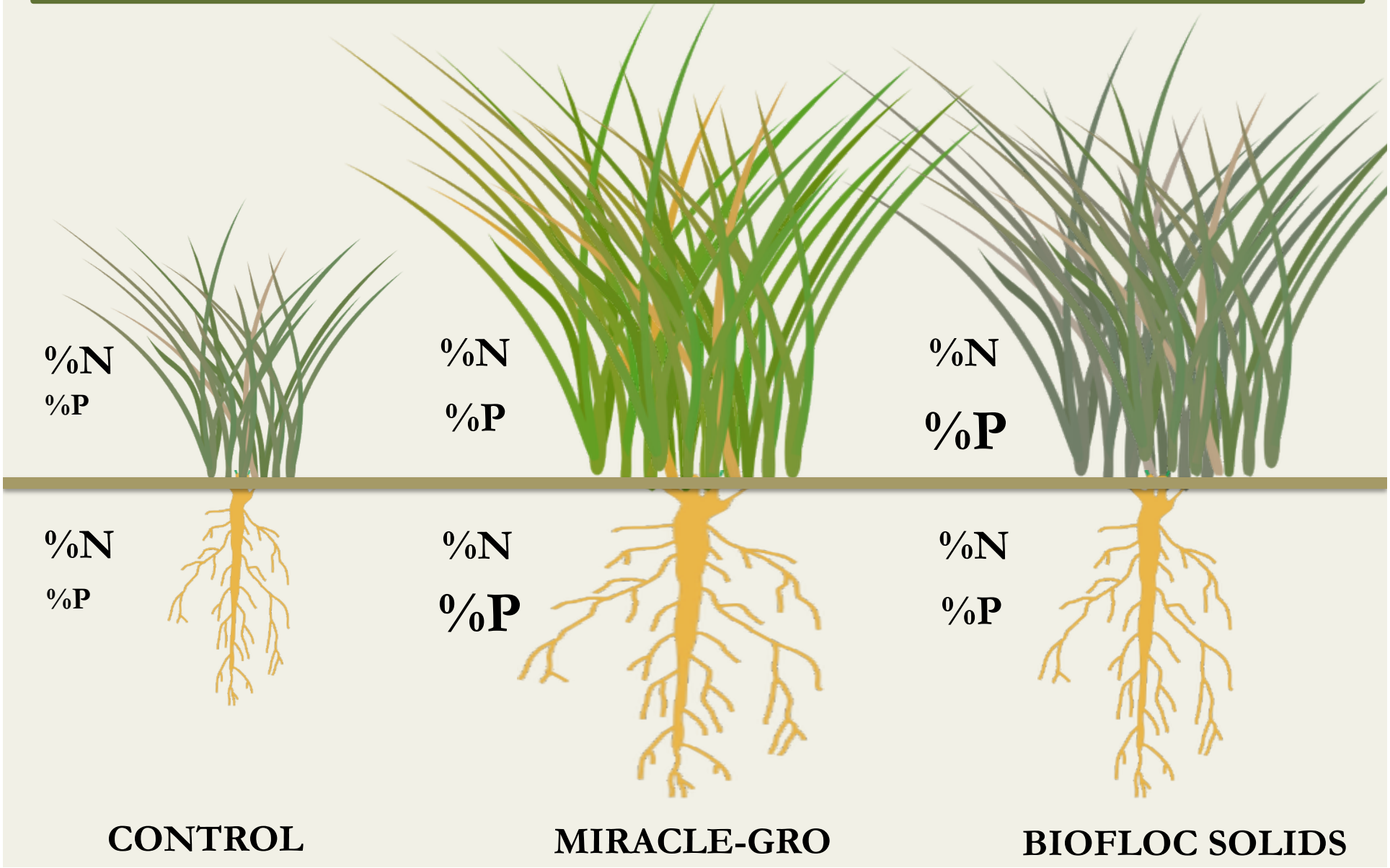
MDS for Dosing Period



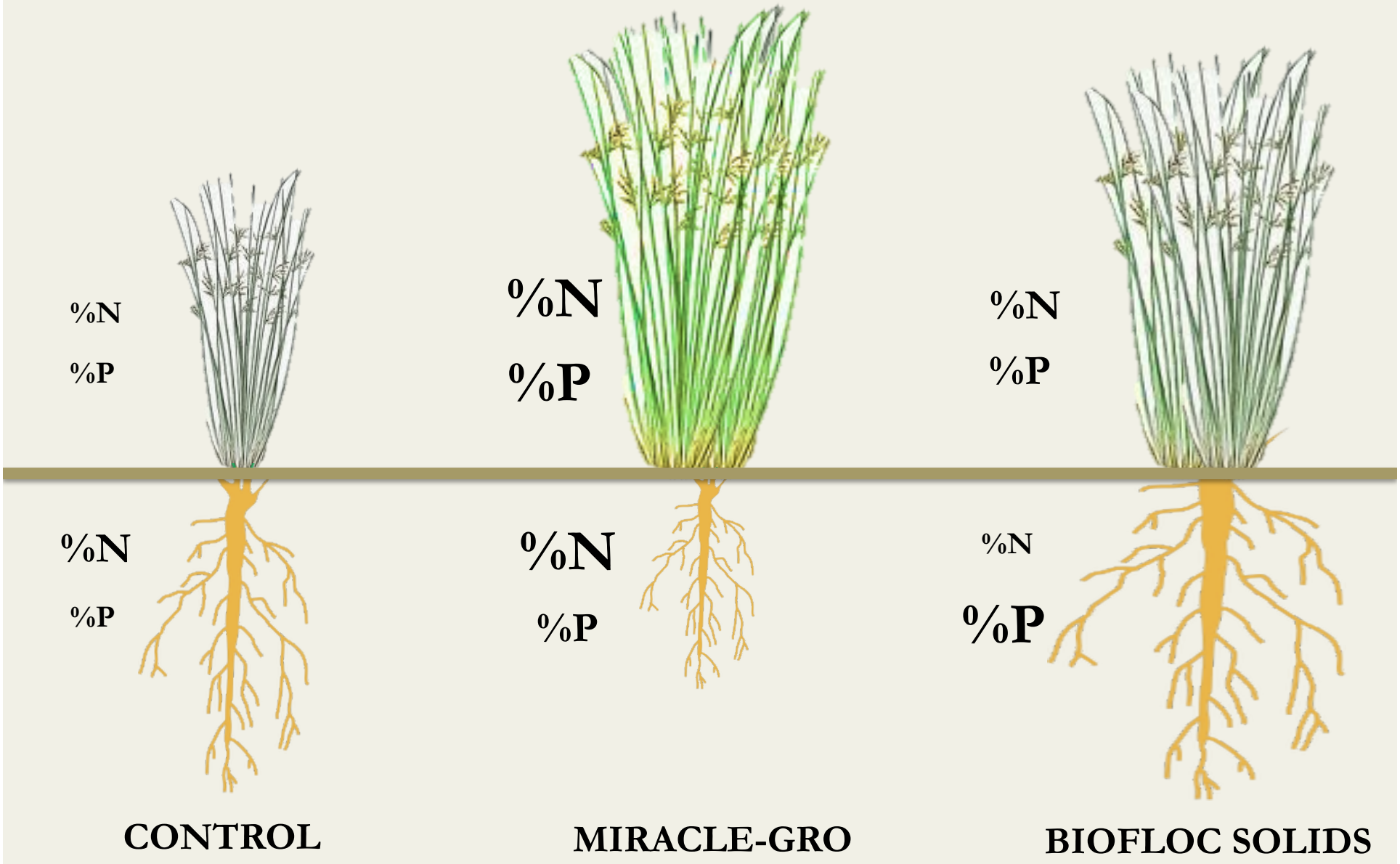
Analysis of Similarities (ANOSIM) Analysis:

Groups	R	Significance
Control-Miracle Gro	0.563	0.01
Control-Shrimp Solids	0.298	0.01
Miracle Gro-Shrimp Solids	0.382	0.02

Conclusion for *Spartina alterniflora*



Conclusion for *Juncus roemerianus*



Overall Conclusion

- **Shrimp biofloc solids are a suitable alternative to commercial fertilizers in restoration nursery production of** *Spartina alterniflora* **and** *Juncus roemerianus*
  - Both Miracle-Gro and shrimp biofloc dosing treatments resulted in taller plants with greater aboveground and belowground biomass
  - Restoration success?

Questions?