# Biannual N and P evaluation in young D. Asper Bamboo in a greenhouse setting

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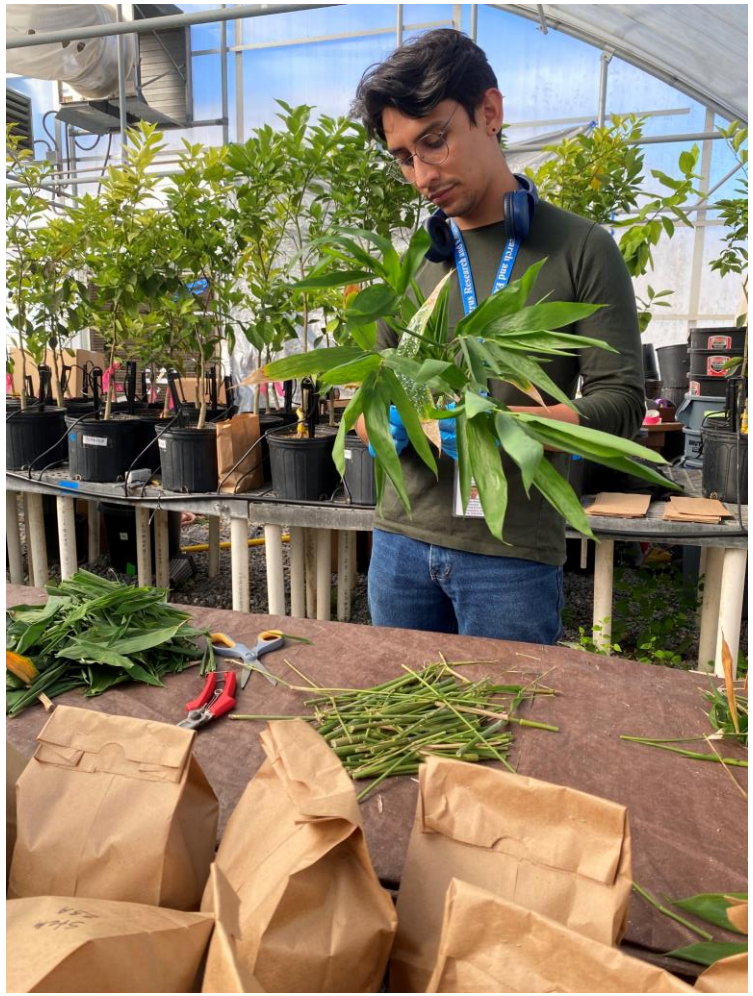
# Outline

- Bamboo phosphorus and nitrogen requirements
- Irrigation water requirements
- Potassium fertilization
- Summary

# Introduction



- A considerably high number of growers exploring bamboo production in Florida.
- No existing best management practices (BMPs) on bamboo production adapted to Florida.
- There is need to develop and establish recommendations on fertilizer use in bamboo based on Florida soils for optimal production.

Photo credit: Cyrus Januarie

# Objectives

1. Evaluate the growth of young asper bamboo plants in response to four different N and P rates grown in two different years.

1. Determine the optimal rates of N and P for the sustainable D. asper bamboo production.

Photo credit: Cyrus Januarie

# Experimental setup

- Pot mix was used as a growth media
- ~5 months for each study and year in two years
- Completely randomized experimental design

**Table 1**. Experimental design for both N and P studies

| N(lb./ac) | P (lb./ac) | Replicates | Method |
|---|---|---|---|
| 0 | 0 | 5 | Soil applied |
| 100 | 20 | 5 | Soil applied |
| 200 | 40 | 5 | Soil applied |
| 300 | 80 | 5 | Soil applied |

N-Study

P-Study

Photo credit: Cyrus Januarie

# Methods

## Variables for both studies

- Clump height, number of culms, and diameter were done biweekly.
- Tissue nutrient analysis and chlorophyll content were done monthly.
- Total biomass was quantified at the end of the experiment.

## Agronomic management

Nitrogen study
- Applied ¼ lbs./pot of 0-20-20
- Onetime application, quick release

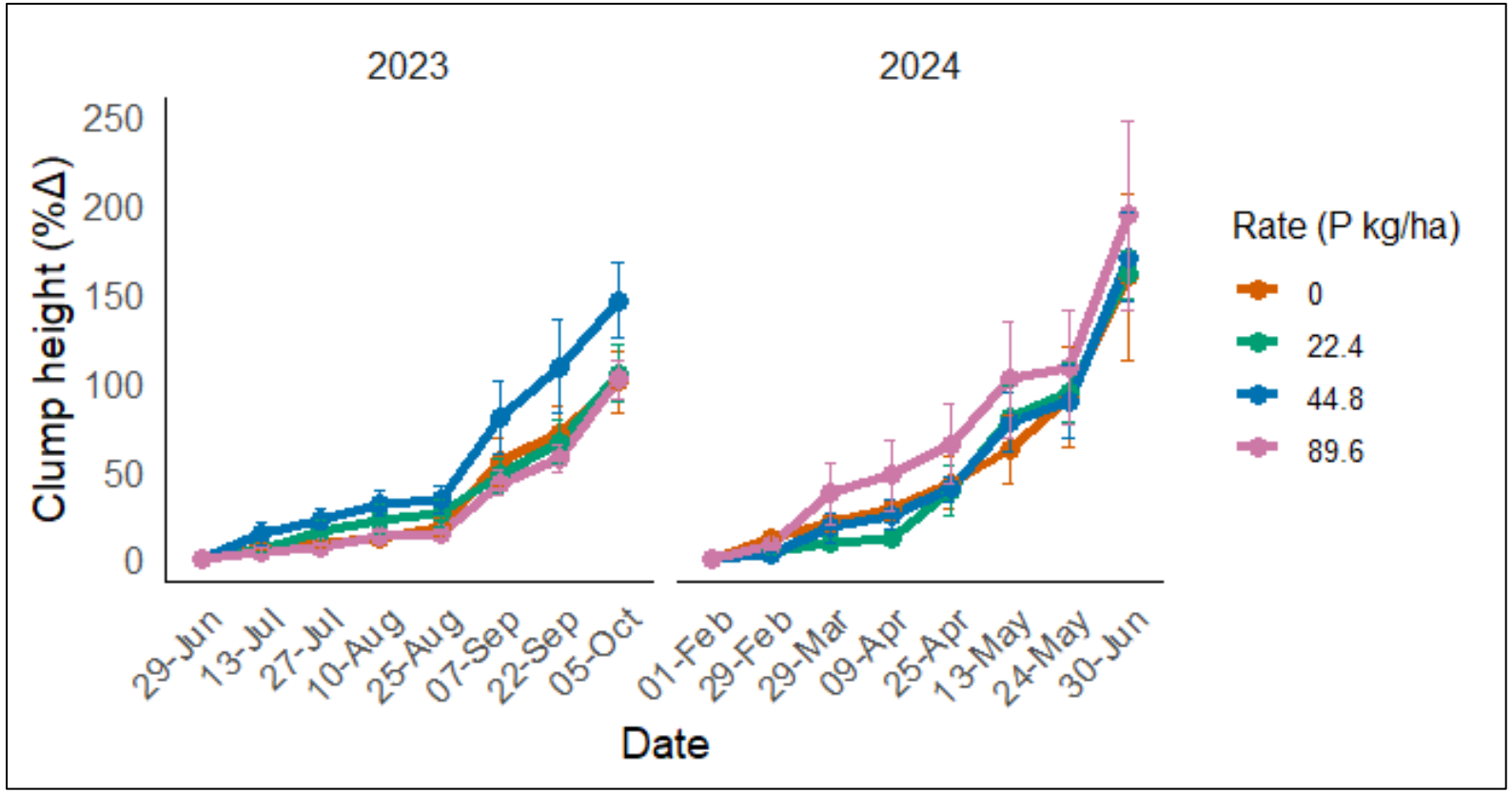
Phosphorus study
- Applied 3/8 lbs./pot of 26-0-11
- Onetime application, slow release

Automated drip irrigation
- 8 L/h drippers

Data analysis was done in R software using one-way ANOVA in a Linear Mixed Model for Repeated Measures (LMMRM) followed by HSD Tukey's test (a=0.05) for both studies.

# Results: Phosphorus rate study

## Clump height




0, 22.4, 44.8, 89.6 kg/ha = 0, 20, 40, 80 lbs./ac respectively.

- In both years, growth was comparable.
- In 2023, 40 lb./ac maintained a greater clump height.
- In 2024, 80 lb./ac showed better clump height.

# Results: Phosphorus (P) rate study

## Table 2. Effects of phosphorus application on various variables bamboo

| Year | Rate | Clump height | Culm diameter | P tissue concentration | Chlorophyll content |
|---|---|---|---|---|---|
| | (N lb/ac) | (m) | (mm) | (%) | (SPAD Values) |
| 2023 | 0 | 1.07±0.06a | 4.83±0.34b | 0.36±0.09a | 28.74±2.83ab |
| | 20 | 1.23±0.05b | 4.40±0.37ab | 0.35±0.08a | 29.9±2.67b |
| | 40 | 1.02±0.05a | 4.19±0.32a | 0.33±0.06a | 27.87±2.73a |
| | 80 | 1.20±0.05b | 4.58±0.31b | 0.36±0.06a | 30.36±2.85ab |
| | | *** | *** | ns | *** |
| 2024 | 0 | 0.93±0.06ab | 4.16±0.43a | 0.10±0.01a | 33.87±0.96a |
| | 20 | 0.86±0.05a | 4.25.±0.50a | 0.14±0.01bc | 34.99±1.23a |
| | 40 | 0.99±0.06b | 4.11±0.46a | 0.12±0.01b | 33.24±1.52a |
| | 80 | 0.92±0.06ab | 4.72±0.56a | 0.15±0.01c | 35.11±1.66a |
| | | *** | ns | *** | ns |

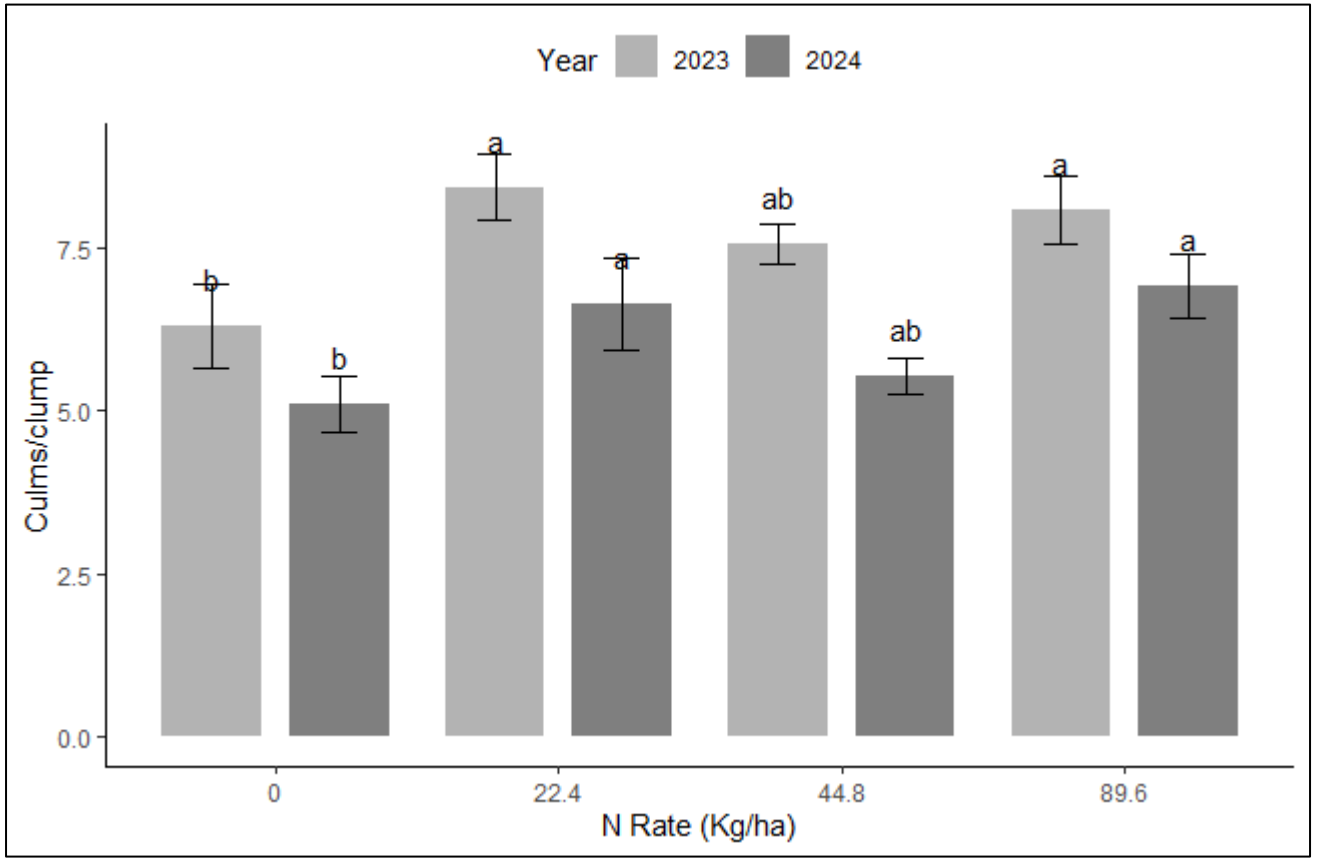
*, **, *** = significance at p-value < 0.05, 0.01, 0.001 respectively.

- Differences were observed in clump height in both years.
- Diameter was different in 2023 but not in 2024.
- No differences were noticed for tissue P concentration in 2023 but in 2024.
- Chlorophyll content was comparable in 2023 but no differences in 2024.

# Results:Phosphorus rate study

- The number of culms increased with higher P rates suggesting increased P demand for culm production.
- The trend was similar for both years.

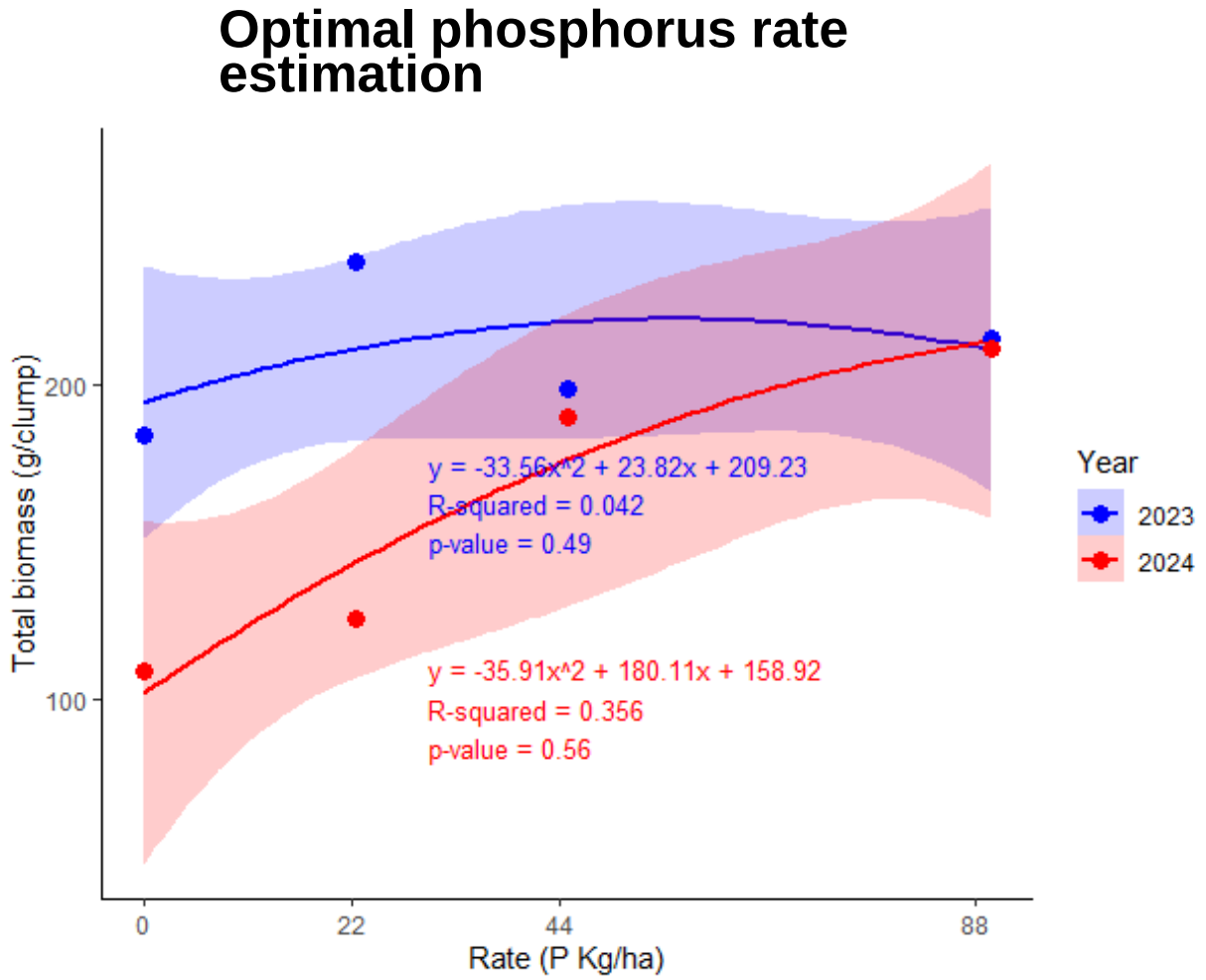
## Culm production




0, 22.4, 44.8, 89.6 kg/ha = 0, 20, 40, 80 lbs./ac respectively.

# Results: P-Study

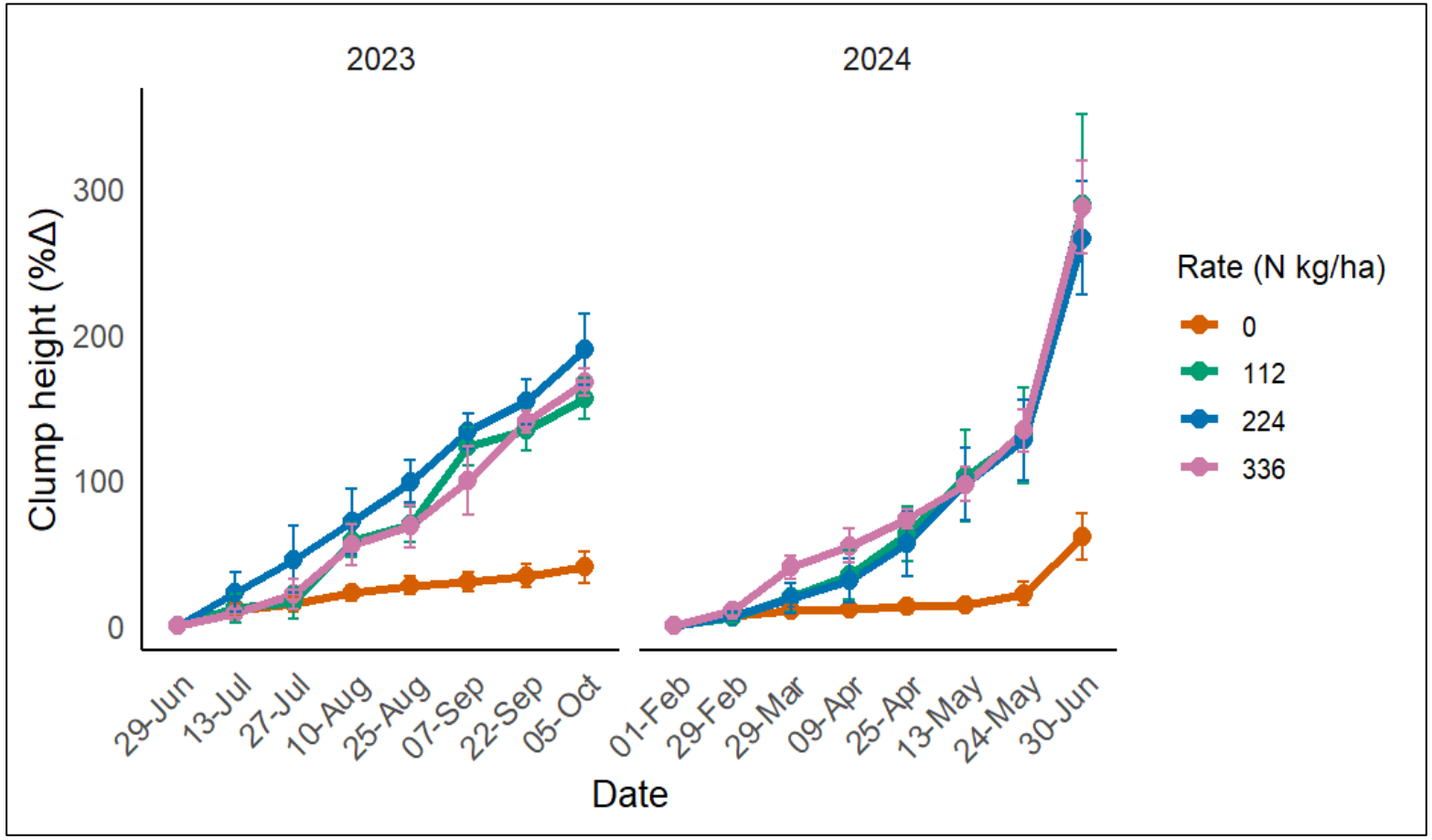
No clear optimal P rate was observed for both years, but higher total biomass was accumulated at higher rates.




0, 22.4, 44.8, 89.6 kg/ha = 0, 20, 40, 80 lbs./ac respectively.

# Results: Nitrogen rate study

## Clump Height




- In both years, growth in was comparable among the treatments.
- In 2023, 200 lb/ac N maintained a consistently greater clump height.
- In 2024, 300 lb./ac showed greater clump height.
- The lowest growth rate was observed in the control for both years, highlighting the importance of N supply for bamboo growth.

0, 112, 224, 336 kg/ha = 0, 100, 200, 300 lbs./ac respectively.

# Results: N-study

**Table 3. Effects of nitrogen application on various variables in bamboo**

| Year | Rate (N lb./ac) | Clump height (m) | Culm diameter (mm) | N tissue concentration (%) | Chlorophyll content (SPAD Values) |
|---|---|---|---|---|---|
| 2023 | 0 | 0.89±0.09a | 3.82±0.21a | 2.03±0.21a | 25.30±1.88a |
| | 100 | 1.28±0.07b | 4.27±0.22b | 2.38±0.18ab | 39.78±2.19b |
| | 200 | 1.41±0.08c | 4.52±0.26b | 2.65±0.16bc | 42.69±1.49b |
| | 300 | 1.30±0.07bc | 4.23±0.22b | 2.74±0.15c | 43.86±2.12b |
| | | *** | *** | *** | *** |
| 2024 | 0 | 0.66±0.09a | 5.23±0.23c | 1.96±0.20a | 28.19±3.91a |
| | 100 | 1.11±0.08b | 4.99±0.24c | 2.74±0.11b | 40.54±2.95b |
| | 200 | 1.06±0.09b | 4.07±0.29a | 2.97±0.10c | 42.26±2.81b |
| | 300 | 1.02±0.08b | 4.62±0.21b | 3.11±0.09c | 41.63±2.73b |
| | | *** | *** | *** | *** |

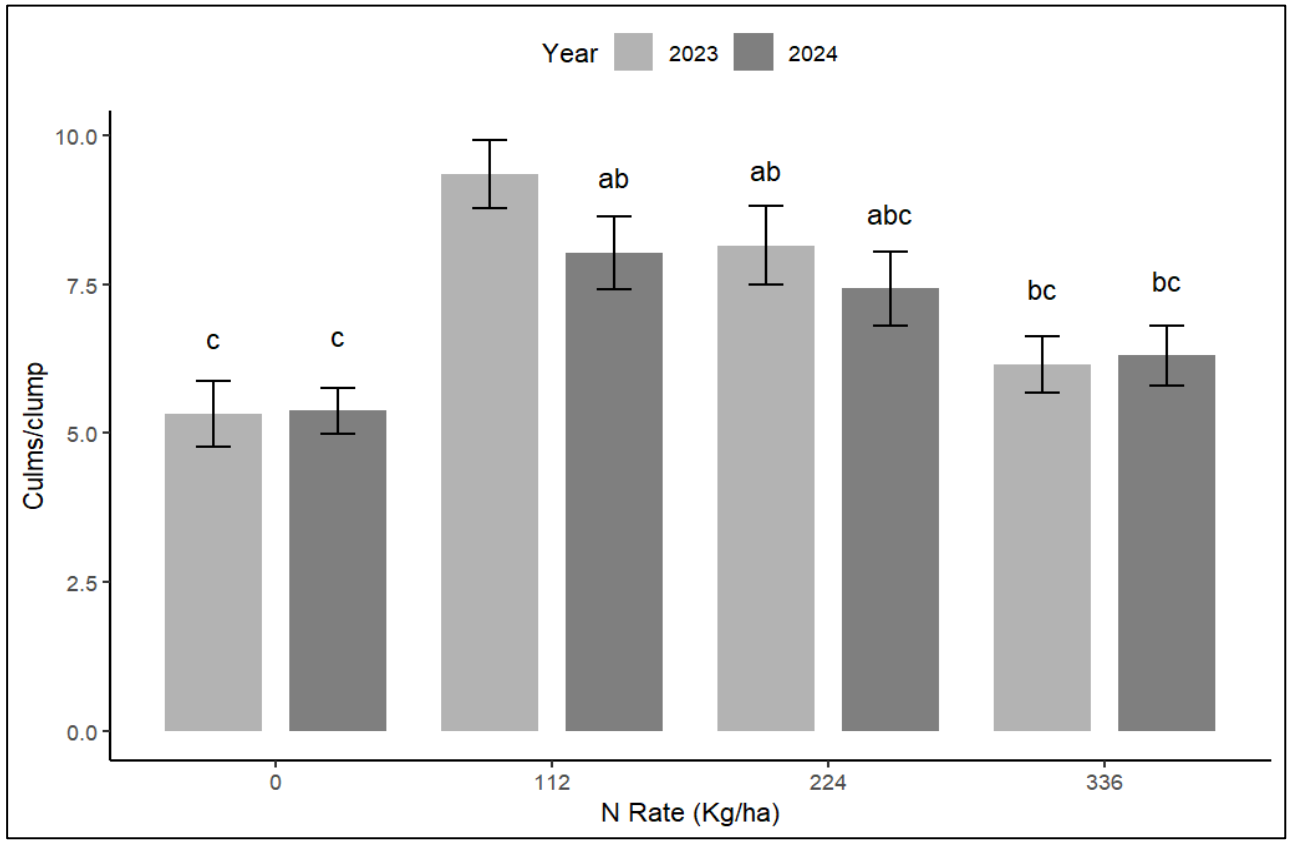
- Differences were observed in clump height in both years.
- Diameter was different in both years.
- Differences were noticed for tissue N concentration in both years where higher rates had high concentration.
- Chlorophyll content showed similar trends in both years where higher rates showed more chlorophyll than the control.

*, **, *** = significance at p-value < 0.05, 0.01, 0.001, respectively.

# Results: Nitrogen rate study

- The number of culms increased with moderate N rates suggesting mid N demand for culm production.
- The trend was similar for both years.

## Culm production

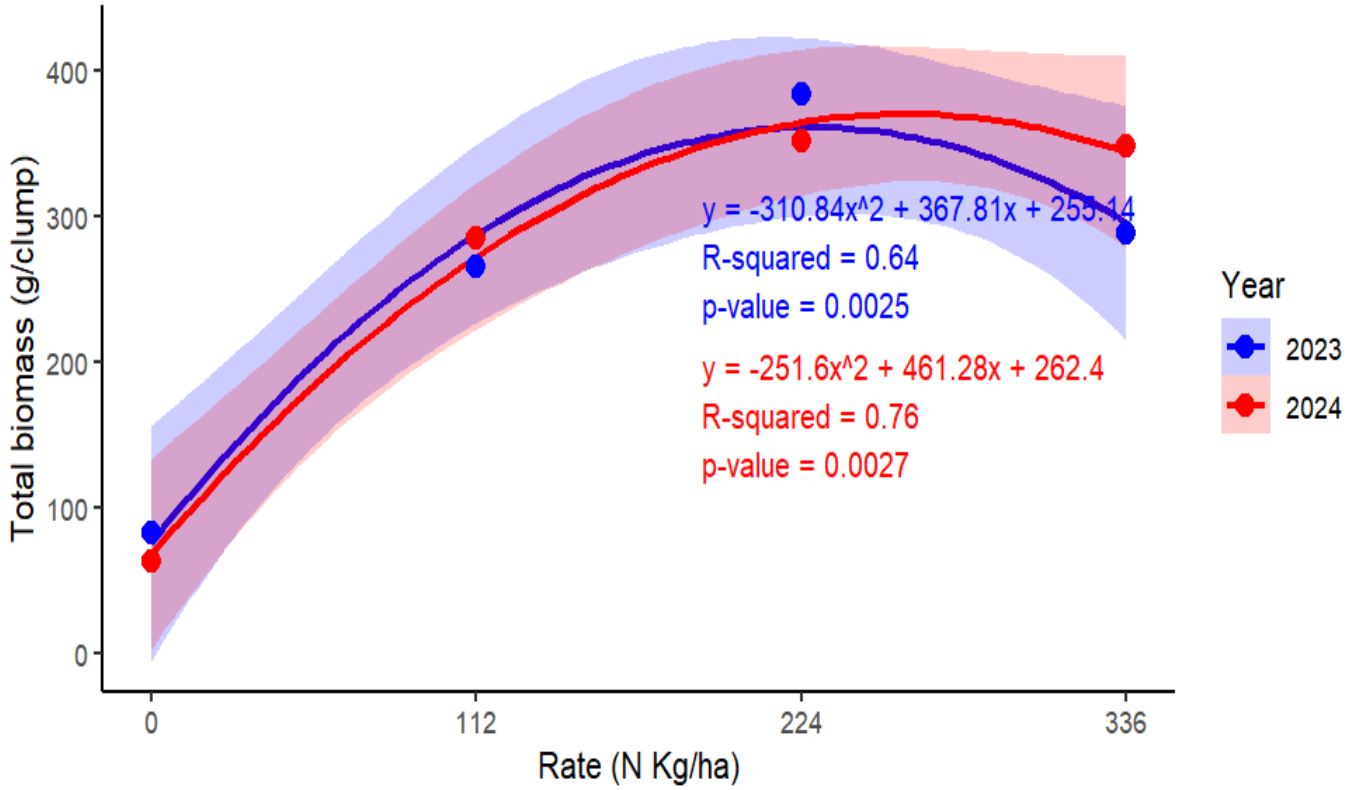



0, 112, 224, 336 kg/ha = 0, 100, 200, 300 lbs/ac respectively.

# Results: Nitrogen rate study

- Total biomass peaked at 200 N lb./ac with increased N rates leading to reduced yield in biomass suggesting that 200 N lb./ac might be optimal for young D. asper bamboo.
- This was consistent for both years.

## Optimal N rate estimation




0, 112, 224, 336 kg/ha = 0, 100, 200, 300 lbs/ac, respectively.

# Summary

1. Growth rates of young asper bamboo plants were comparable in both studies during the two years.
2. *D. asper* bamboo showed a tendency for increased P demand, especially in 2024.
3. More studies for P with adjusted rates are needed to determine the optimal rate.
4. For both years, N at 200 lb/ac seems to be optimal for young bamboo.
5. Further field studies will determine optimal rates for older bamboo (>3 years~).

# Integrated potassium and irrigation management

- Studies have showed that N, P, and K fertilization improves yield and is crucial for the sustainability of bamboo production.
- Potassium is an essential macronutrient and might enhance water and nutrient use efficiency through stomatal regulations.
- Water is essential in agricultural systems, but water availability is continuously affected by climate change due to increasing temperatures, reduced rainfall and extended drought periods.
- Irrigation management is essential to improve water conservation and plant nutrient availability for bamboo cultivation.

Photo credit: Labake Agunbiade

## Rationale for this study

To achieve the full potential of bamboo, it is imperative to understand the interaction between bamboo plants, irrigation efficiency and nutrient uptake for sustainable production.

In Florida, there is no information on nutrient (potassium) and irrigation management requirements for optimal bamboo production.

## Objectives of the study

1. To evaluate the growth response of bamboo to varying rates of irrigation and potassium fertilization in Florida sandy soils.

2. To estimate the ideal irrigation rate for bamboo crop production for Florida sandy soils.

# Materials and Methods

Photo credit: L. Agunbiade

## Experimental Design

- The experiment is conducted at UF, Citrus Research and Education Center (CREC), Lake Alfred, FL.
- The growing media is a mixture of soil, peatmoss and perlite at the ratio of 60:30:10 by volume prepared in a 56L plastic pots.
- The experimental design is a 4 x 4 factorial experiment with 5 replicates.

**Potassium rates**
K0 = 0lb $K_2O$/acre
K1=100lb $K_2O$/acre
K2= 200lb $K_2O$/acre
K3= 300lb $K_2O$/acre

**Irrigation rates by evapotranspiration (ET)**
50% ET =2L/hr (7.6 gal/hr) (2 mins)
75% ET=2L/hr (7.6 gal/hr) (4 mins)
100% ET= 2L/hr (7.6 gal/hr) (6 mins)
125% ET= 8L/hr (30.3 gal/hr) (2 mins)

# Preliminary Results

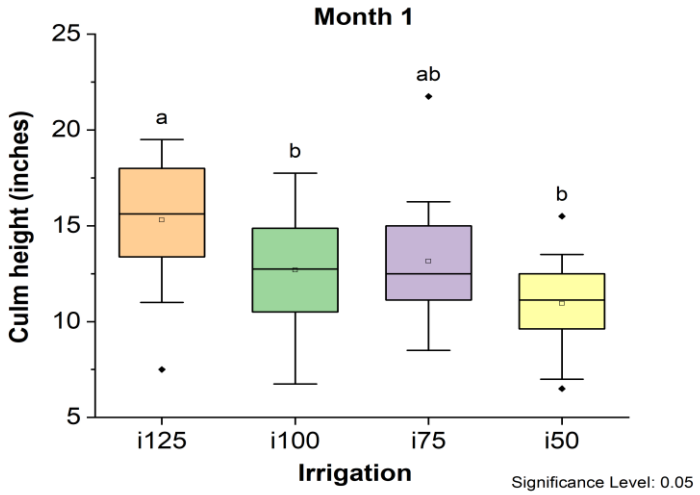



**Figure 1.** Effect of varying irrigation rates on culm height for the first month

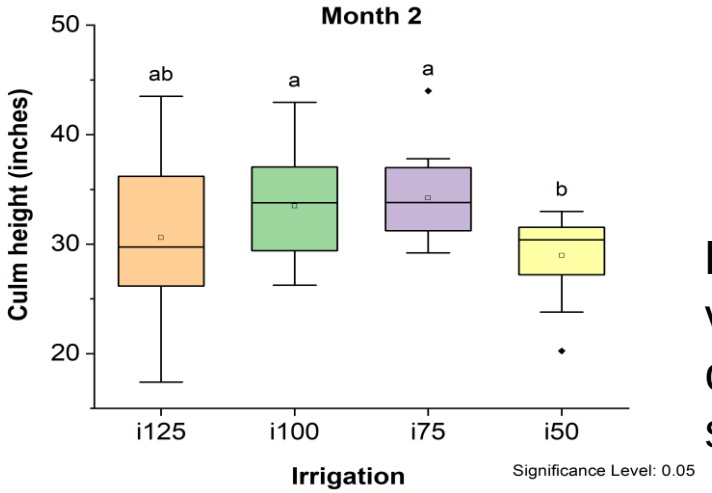



**Figure 2.** Effect of varying irrigation rates on culm height for second month

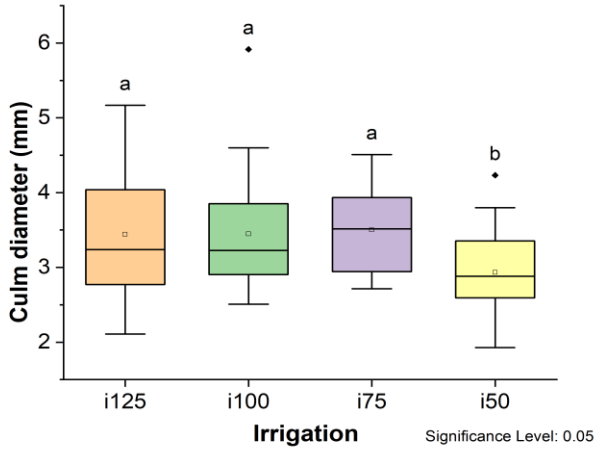



**Figure 3.** Effect of varying irrigation rates on culm diameter

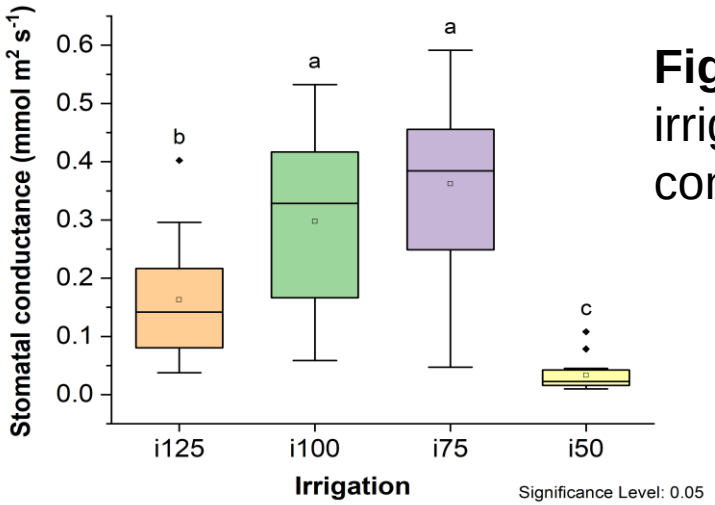



**Figure 4.** Effect of varying irrigation rates on stomatal conductance

## Summary

- The 125% ET showed the highest culm height in the first month but in the following month, the 75% ET and 100% ET had the highest height suggesting that reasonable culm height can still be achieved while conserving water.

- The 100% ET and 75% ET had high comparable stomatal conductance which is statistically different from 125% ET and 50% ET. This implies that over-irrigation and low irrigation rates may affect stomatal regulations.

- The different K levels did not show any significant effect on the measured parameters.

Photo credit: L. Agunbiade

# Next steps in 2025

- Nitrogen and phosphorus field studies in Eden and Pioneer Farms
- Irrigation, nitrogen and phosphorus studies in CREC 30-acre block
- Frostproof irrigation
- Evaluation of nutrient and water vs shoot production
- A few extension articles published

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# Acknowledgements


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