# Getting the Skinny on Phosphorus

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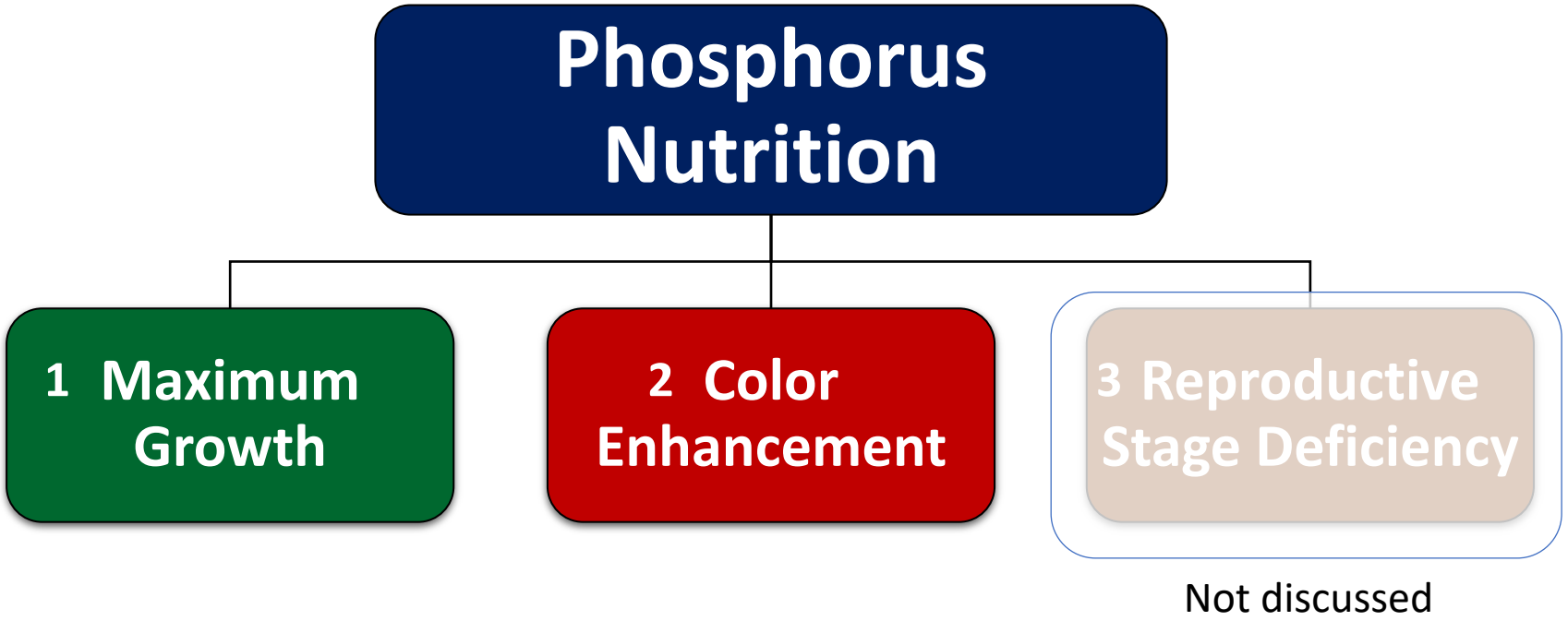
# Topic Outline



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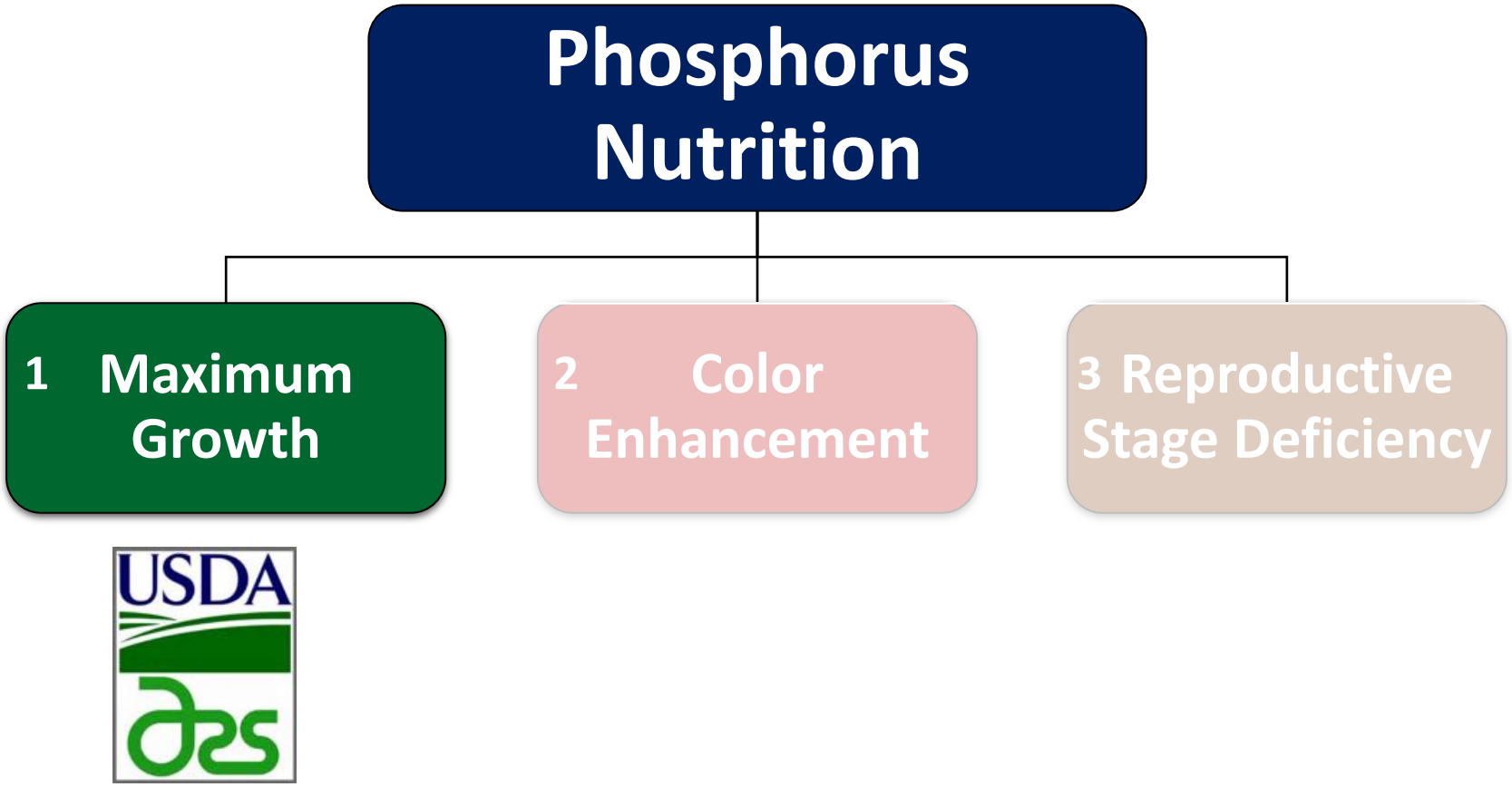
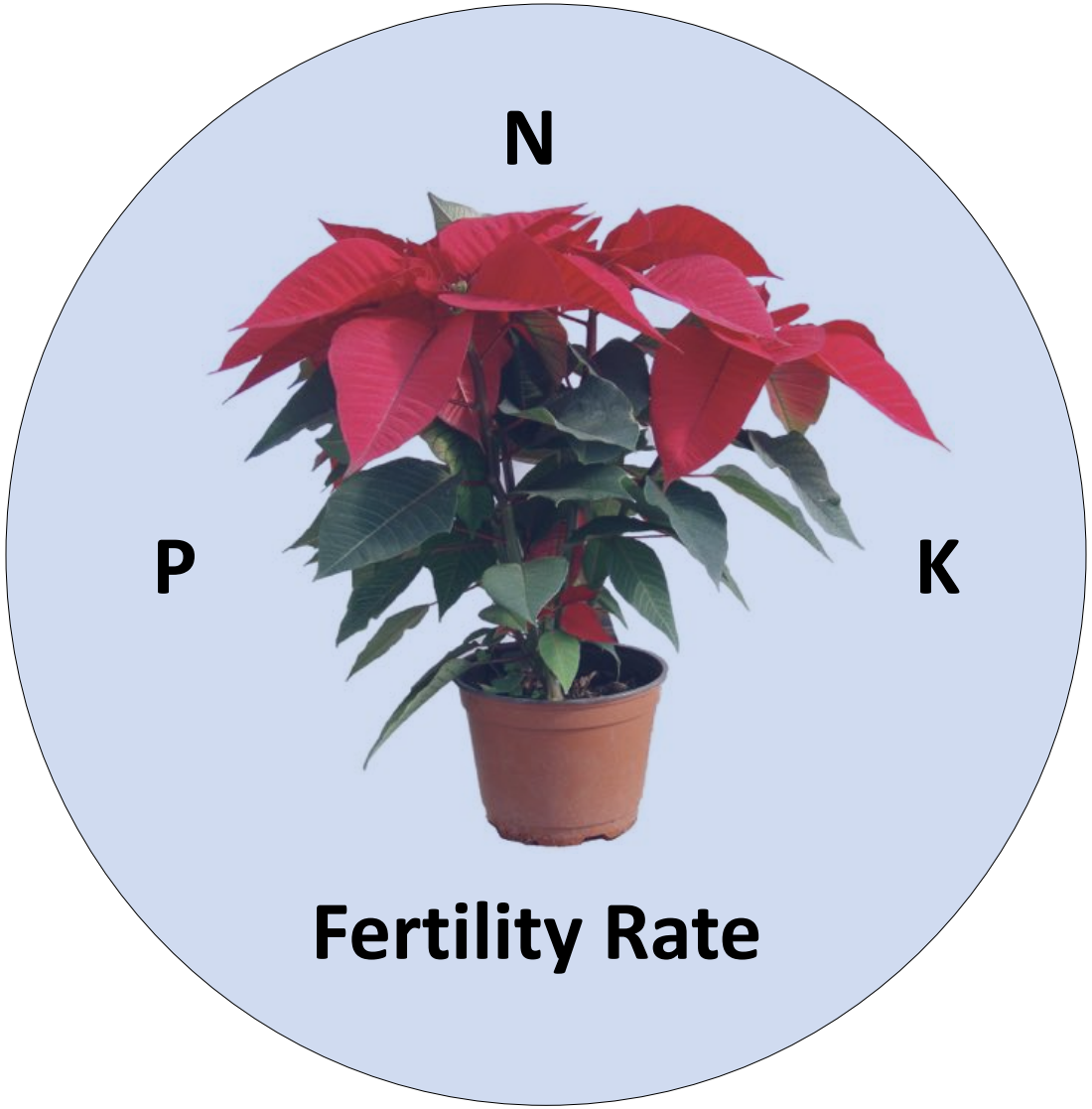


# What key nutritional factors influence plant growth?



# Understanding Fertilizer Rates


**50 75 100 200 300 400**

**Gerbera growth as fertilization rate increases (in ppm N)**

*K. Yeon Jeong, B. Whipker, I. McCall, and J. Frantz*

# Maximum Growth

- While N rate and type (nitrate vs ammoniacal) affect plant growth, P fertilization rate has a significant impact on internode stretch.
  - Paul Nelson et al., 1992
    - http://www.gpnmag.com/article/what-really-causes-stretch/

# Phosphorus Nutrition: Maximum Growth

**Phosphate vs. Compactness**

$P_2O_5$ as a % of N in post-plant fertilizer


| $P_2O_5$ = 50% of N | 15% | 7.5% | 0% |
|---|---|---|---|
| (e.g. 20-10-20) | (13-2-13) | | |

# Phosphorus Nutrition: Maximum Growth

- Low P nutrition limits internode stretch, keeping plants compact
  - Easy to implement for short-term crops like plugs
- Current research recommends P rates of 0.01 to 10 ppm for growth control of finished plants

# Phosphorus Nutrition: Maximum Growth

- 0.01 ppm P is extremely low!
- Many studies use non-commercial substrates
    - P buffered clay
- Not necessarily applicable to floriculture production

# Phosphorus Deficiency:
## Lower Leaf Purpling

# Phosphorus Deficiency:
## Lower Leaf Olive Green Spots

# Phosphorus Nutrition: Maximum Growth

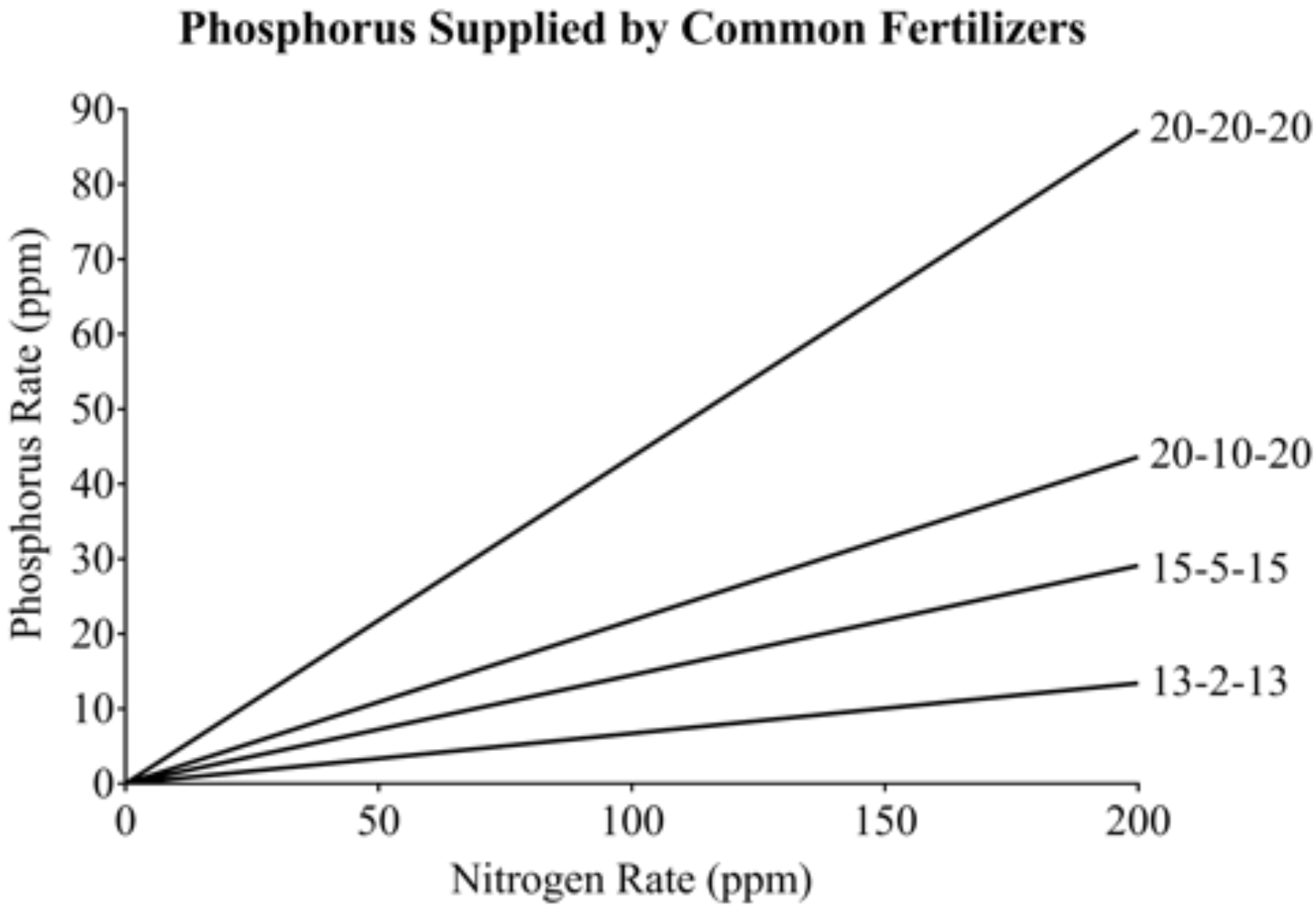
- Common fertilizers provide P as phosphate ($P_2O_5$)
  - Research reported here is in P, so you need to know the conversions

*P x 2.33 = phosphate ($P_2O_5$)*

*Phosphate ($P_2O_5$) x 0.43 = P*

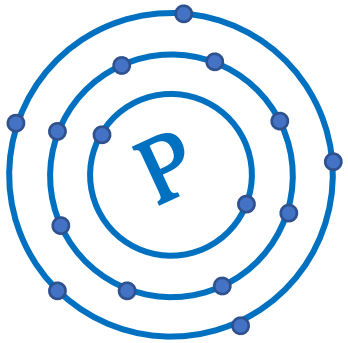
*Example* 20-10-20 @ 200 ppm N provides:

100 ppm $P_2O_5$ ⇌ 43 ppm P


Phosphorus Supplied by Common Fertilizers
Phosphorus Rate (ppm)
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
Nitrogen Rate (ppm)
20-20-20
20-10-20
15-5-15
13-2-13

# Phosphorus Nutrition: Maximum Growth

- The Challenge: Soilless substrates have a low P holding capacity, so it is easy to go too low
  - This poses some questions




# Questions

Using commercial floriculture production practices:

*What P rates maximize growth?*

- OR -

***What P rates control growth?***

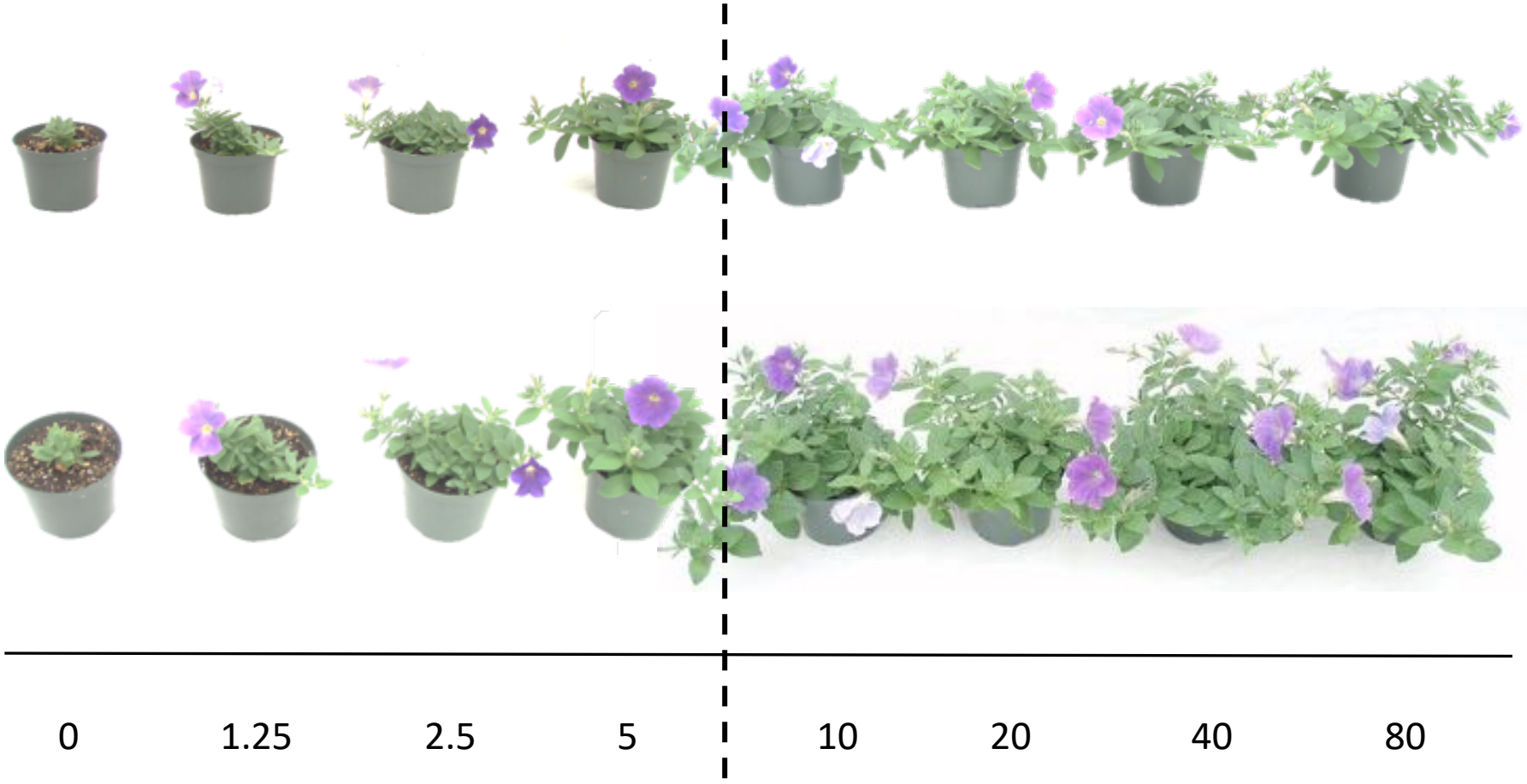
*What Phosphorus Rates Control Growth?*

# Experiment

- Grew several species with range of P rates holding other nutrients constant
  - Used 0 – 80 ppm
- Measured height, diameter, and dry mass
  - Determined growth index

$$\text{Growth Index} = \frac{\text{height} + \text{diameter} + \text{dry mass}}{3}$$

# Petunia ‘Surprise Sky Blue’



# Petunia ‘Surprise Sky Blue’

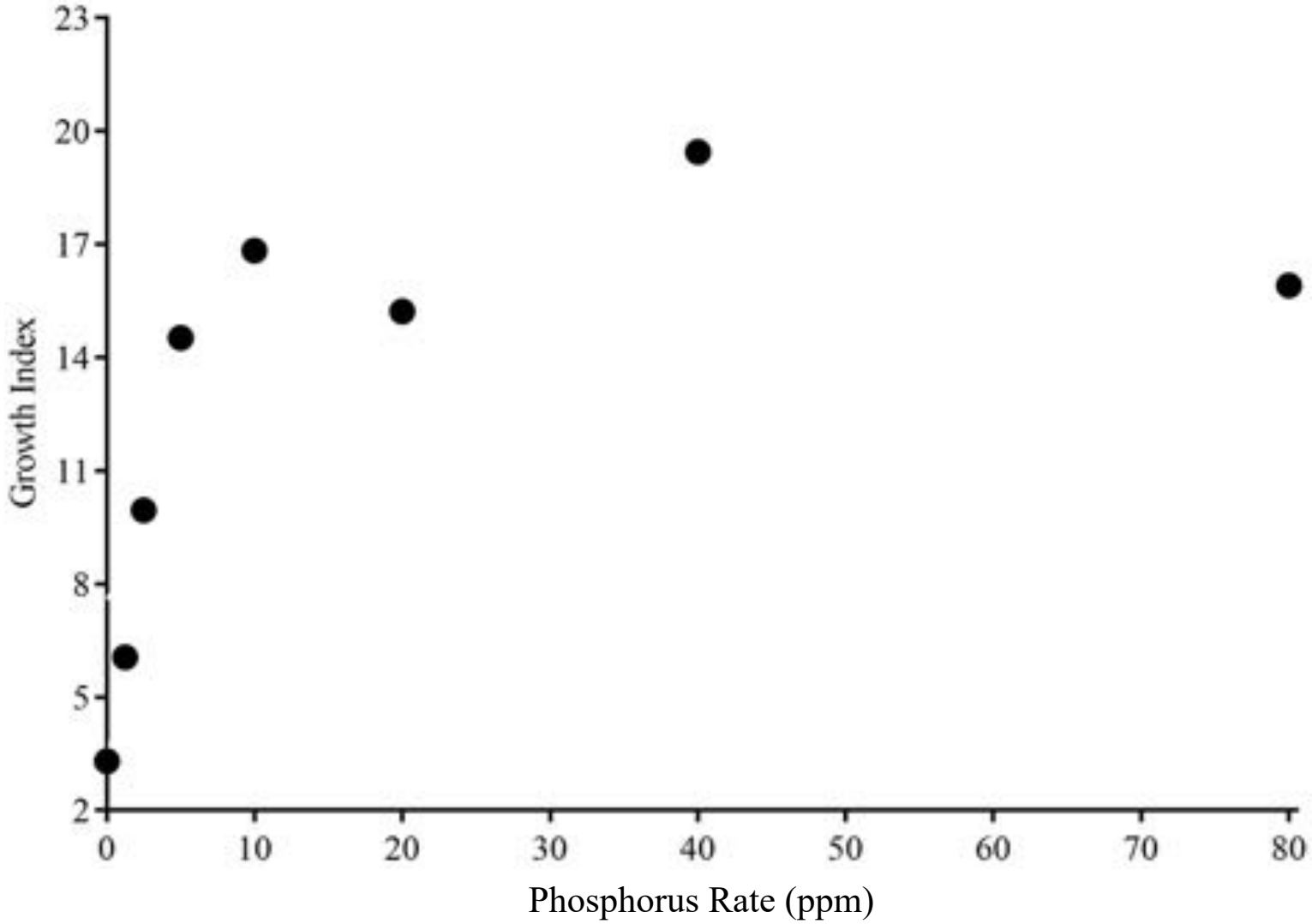
0 1.25 2.5 5

Phosphorus Rate (ppm)

10 20 40 80

Phosphorus Rate (ppm)

# Petunia Regression Analysis



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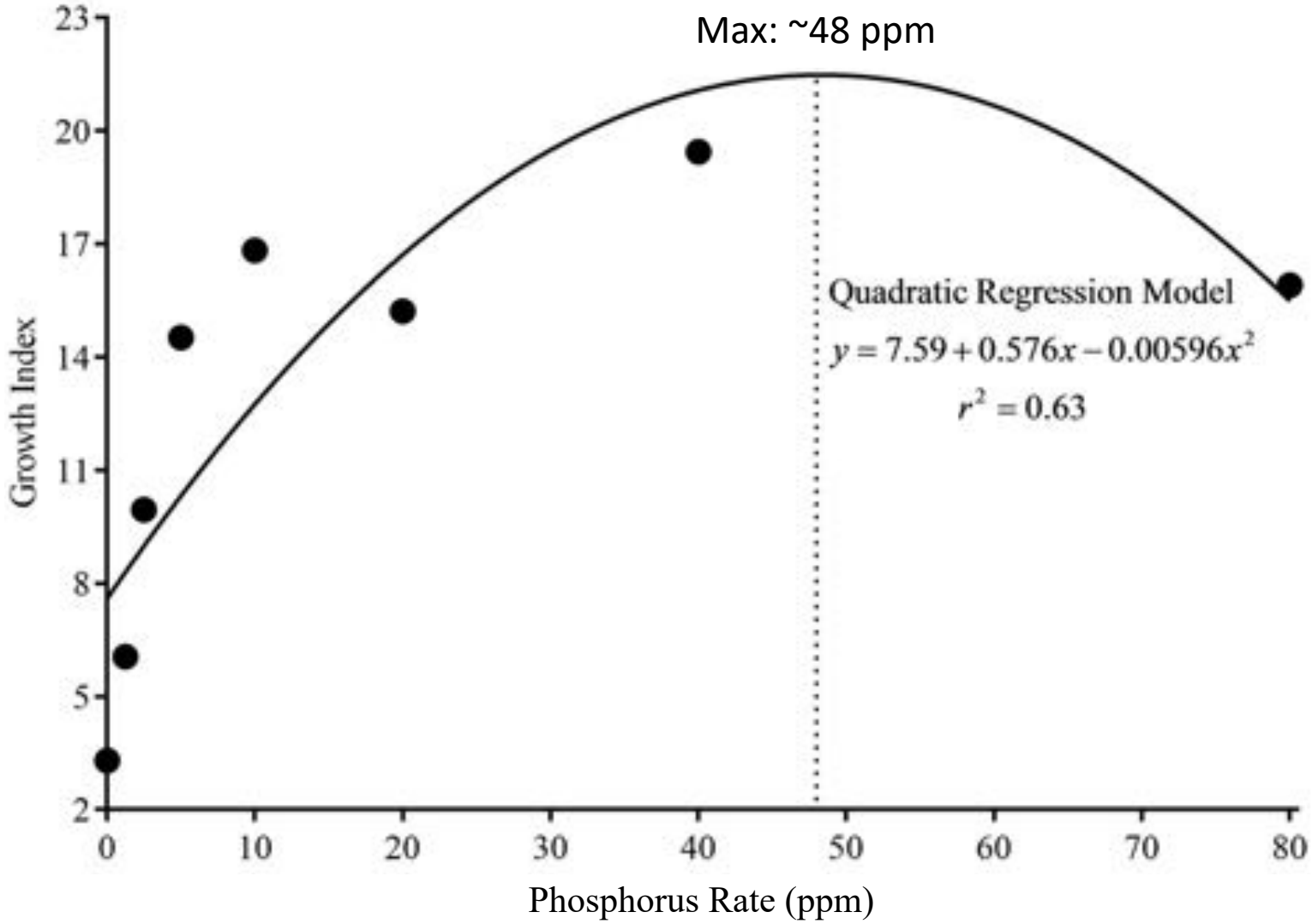

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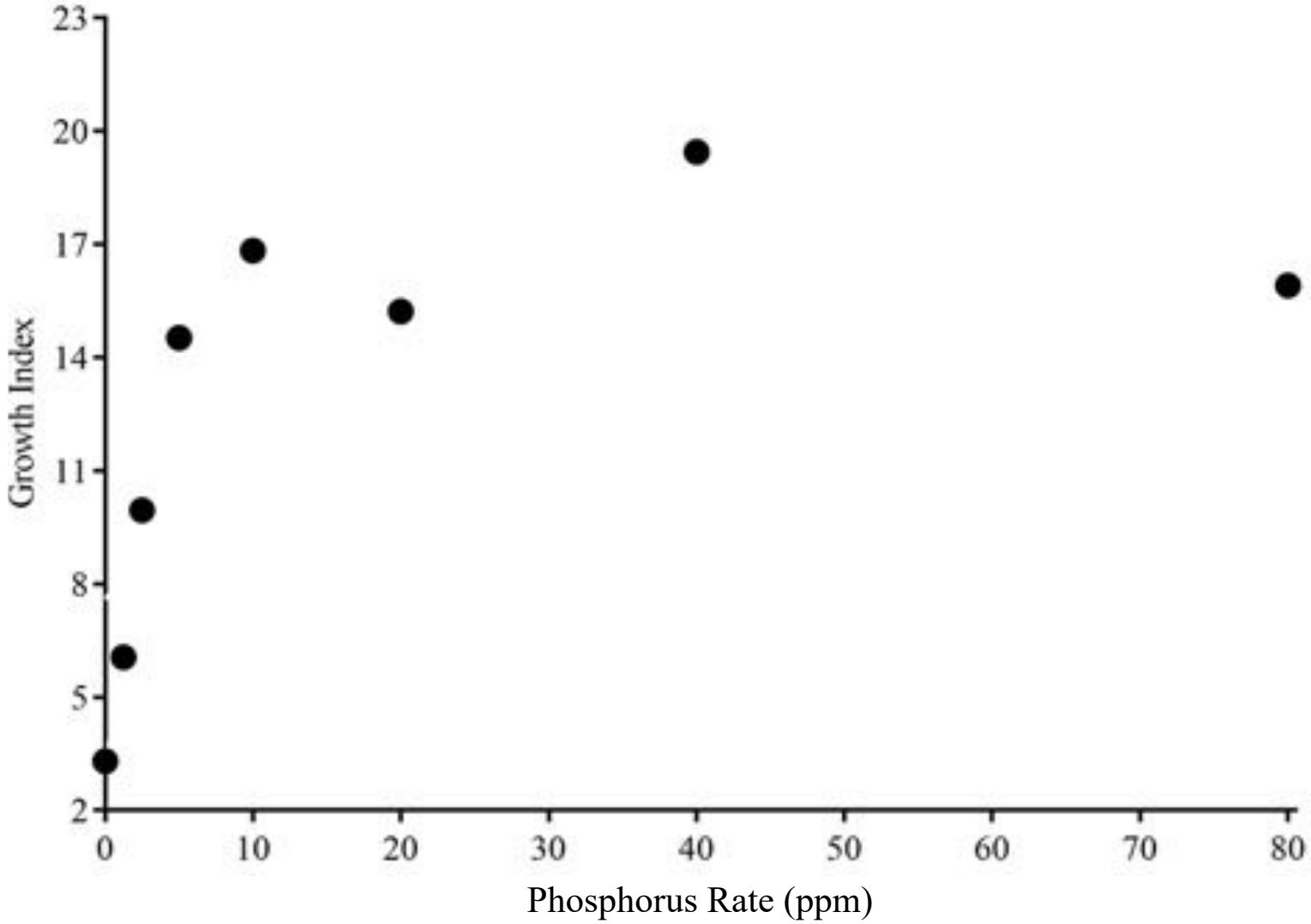

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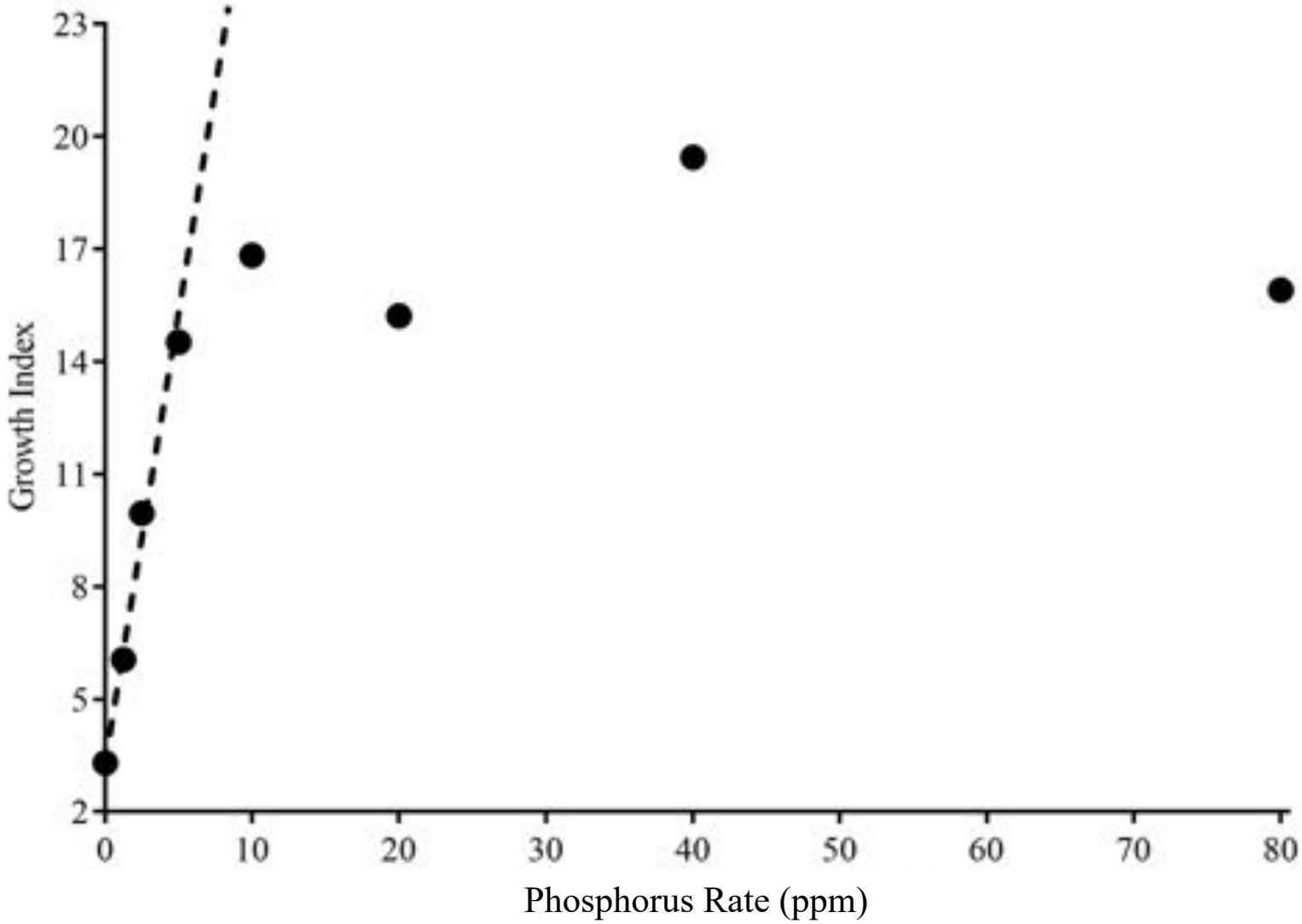

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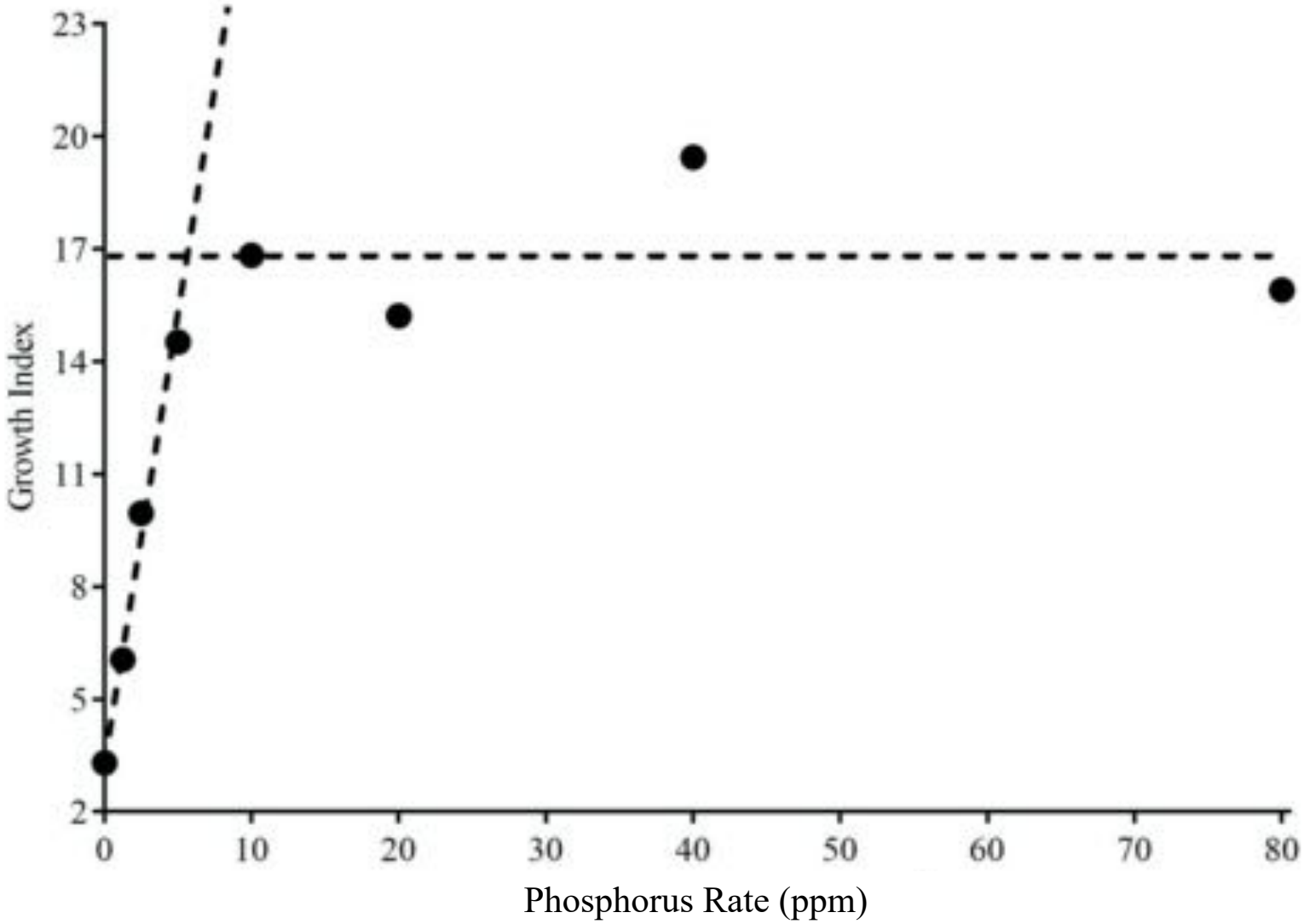

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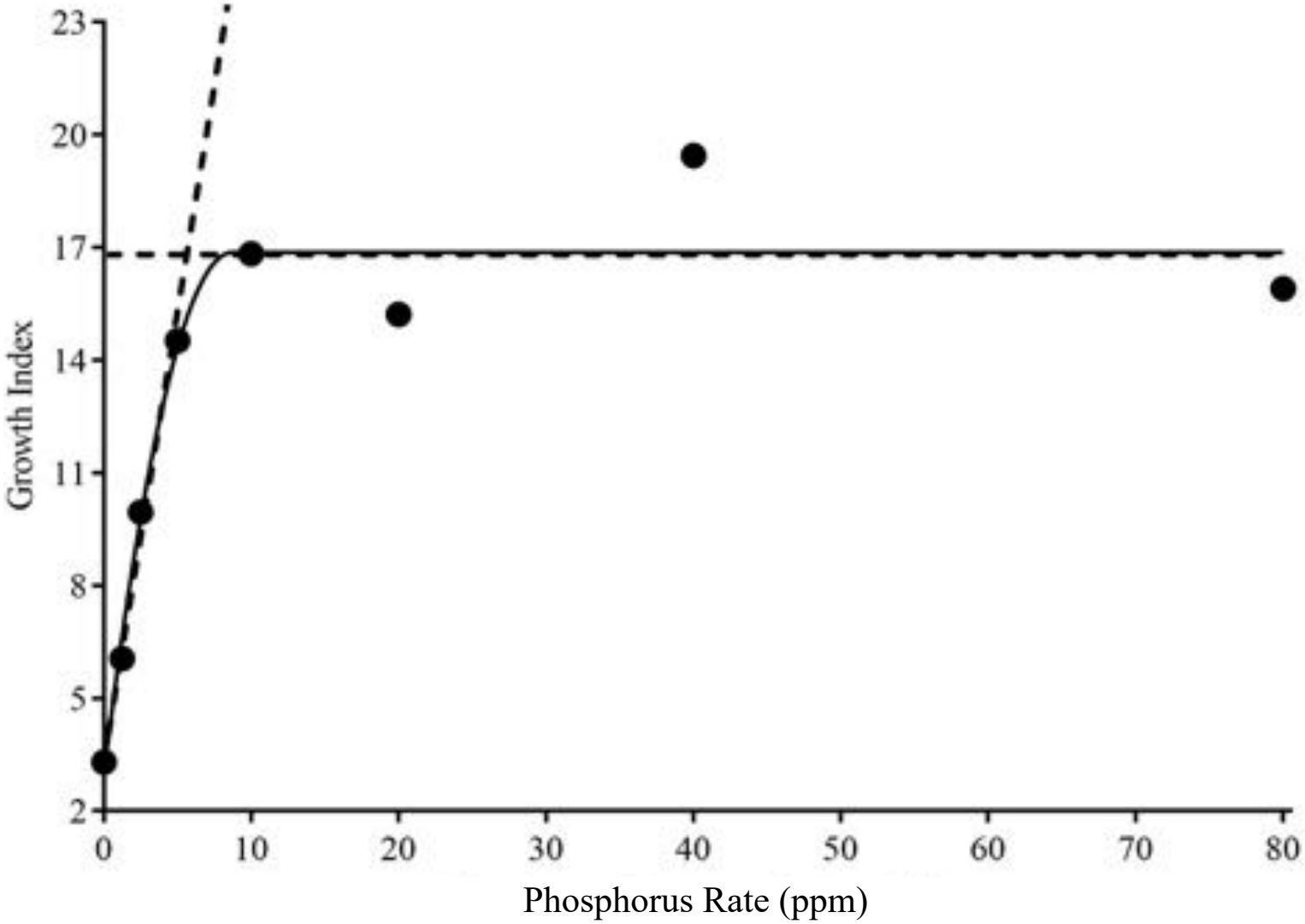

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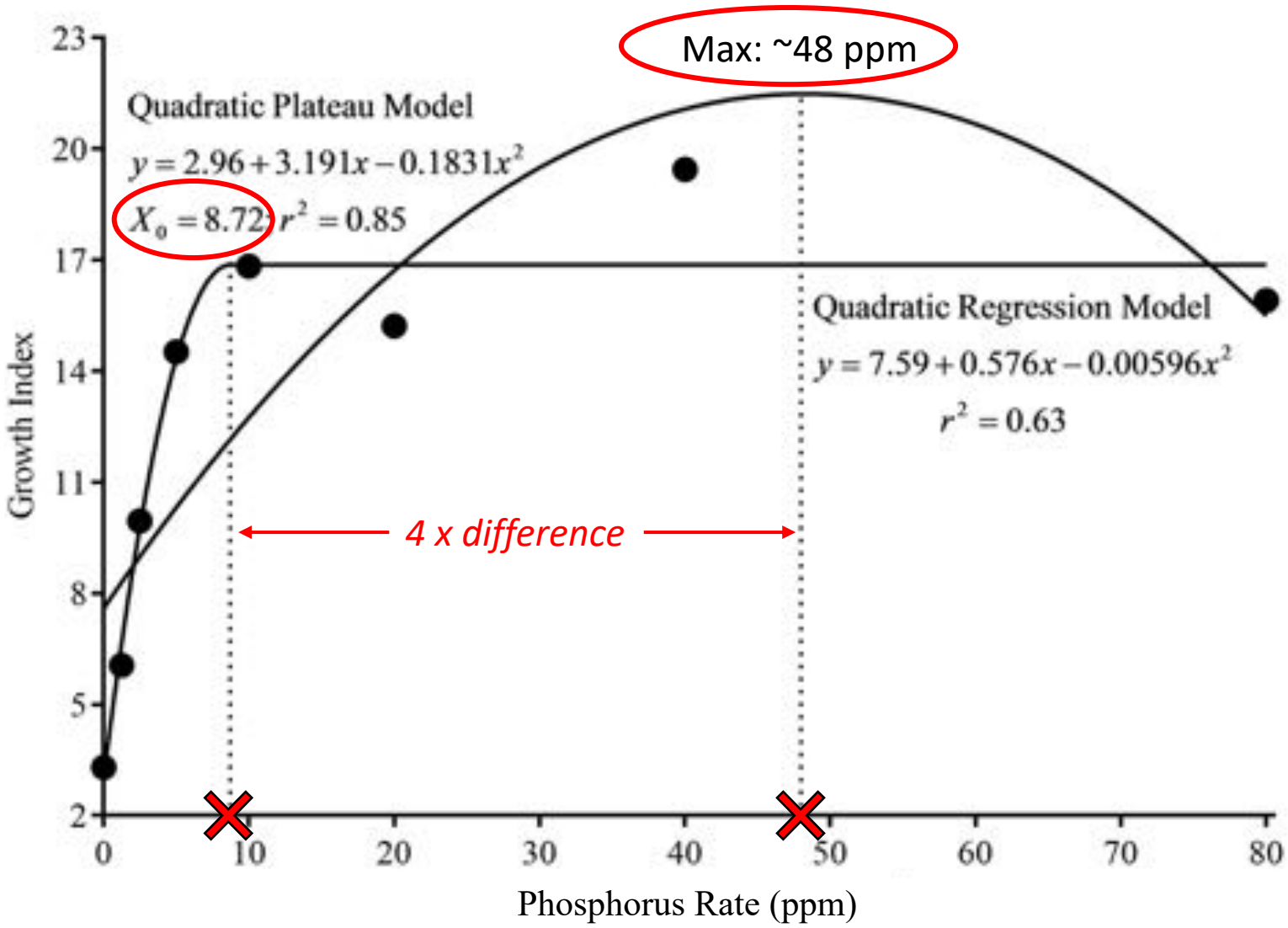
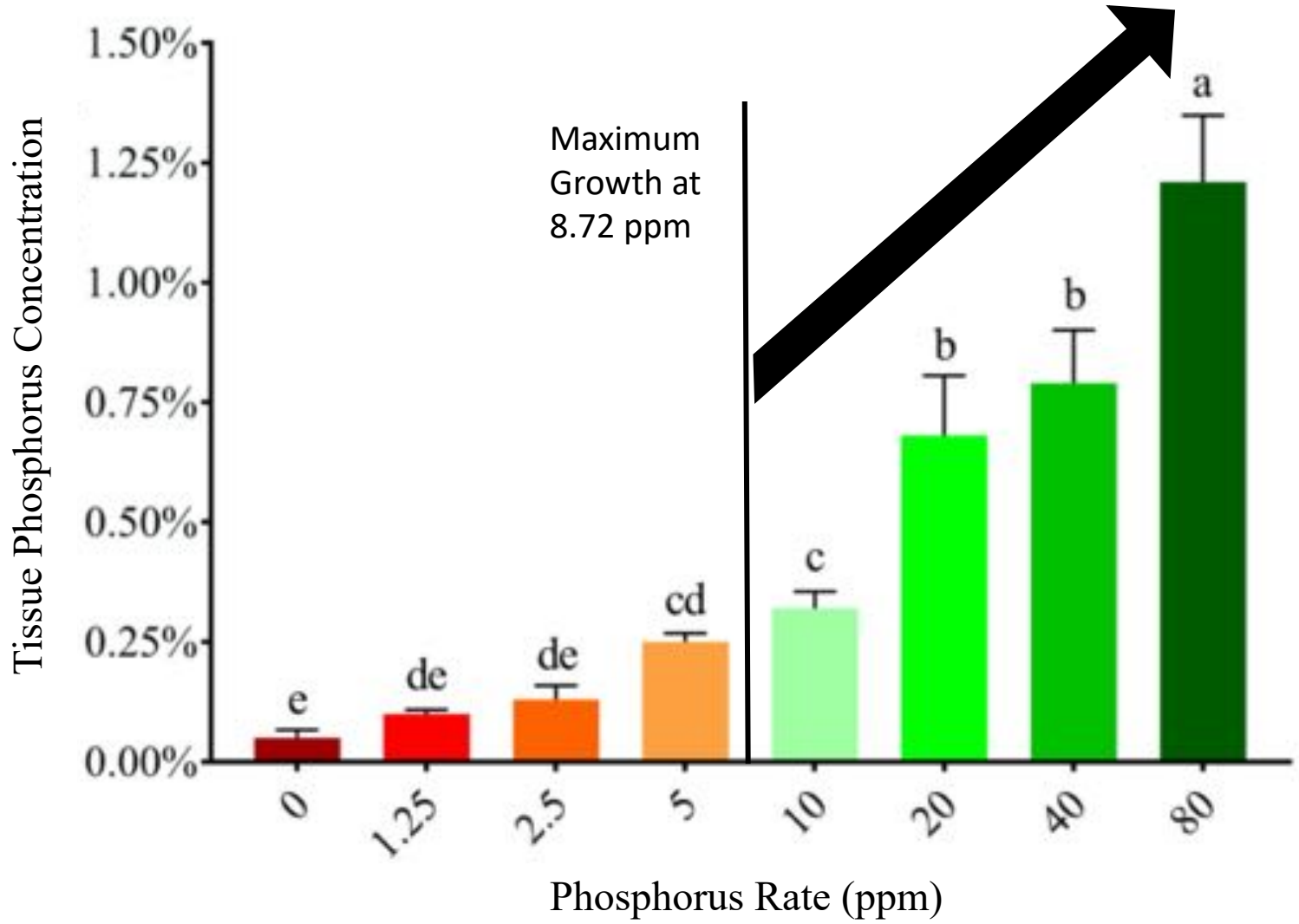


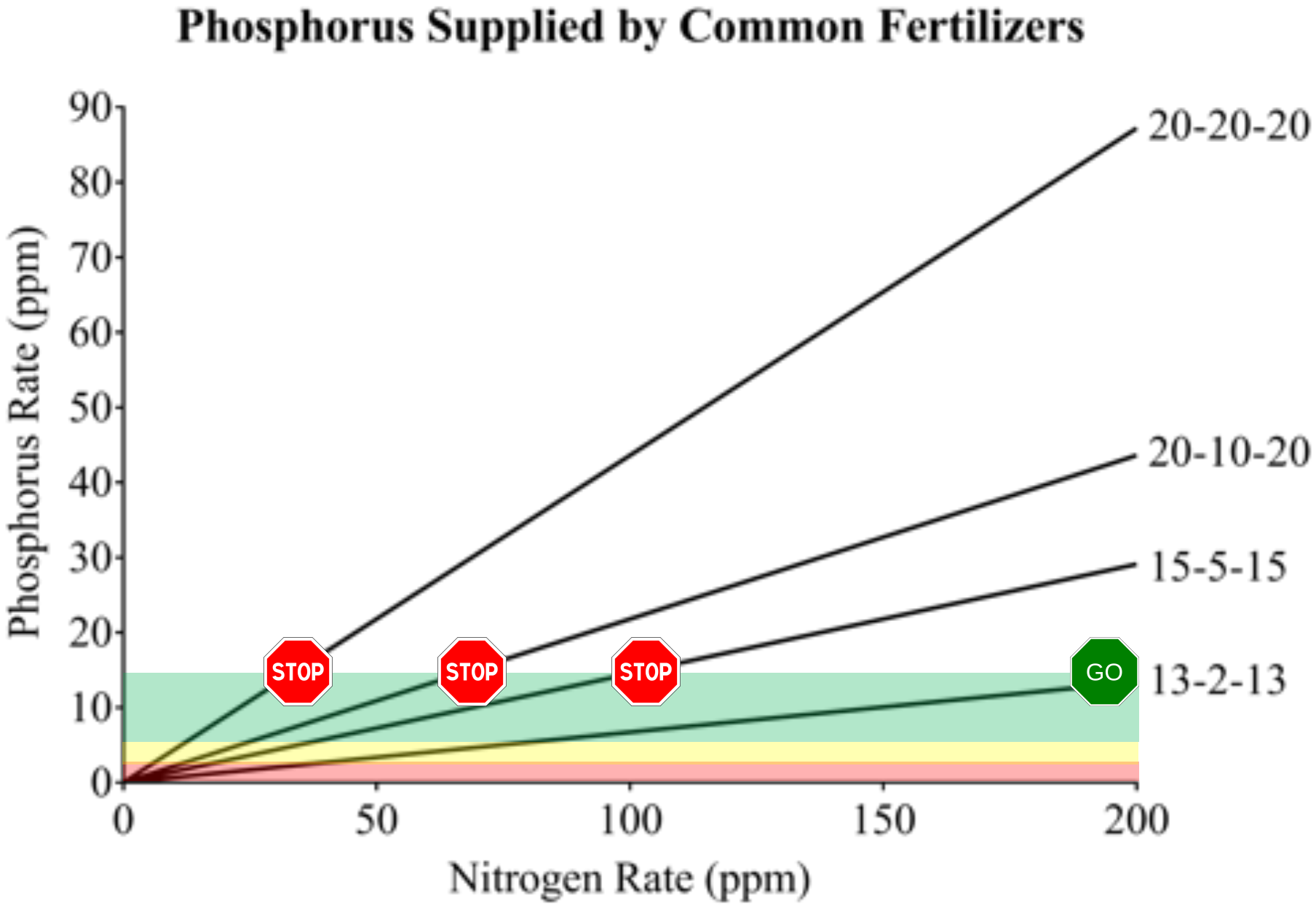
# Petunia Foliar P Concentrations



# Maximum Growth

- 5 – 15 ppm P resulted in maximum growth index values
  - 2.5 ppm P or less resulted in deficiency symptoms
- 3 – 5 ppm P provided growth control

| Plant Species 'Cultivar' | Phosphorus Concentration ($mg \cdot L^{-1}$) |
|---|---|
| *Alternanthera brasiliana* | |
| 'Brazilian Red' | 5.50 |
| *Angelonia angustifolia* | |
| 'Sungelonia Blue' | 8.78 |
| 'Sungelonia White' | 7.27 |
| *Capsicum annuum* | |
| 'Tango Red' | 13.1 |
| *Catharanthus roseus* | |
| 'Cora Burgundy' | 6.74 |
| 'Pacifica XP Blush' | 6.43 |
| *Impatiens hawkeri* | |
| 'Pure Beauty Red on Pink' | 12.4 |
| 'Tamarinda Dark Red' | 9.64 |
| *Petunia atkinsiana* | |
| 'Potunia Neon' | 9.08 |
| 'Surprise Sky Blue' | 8.72 |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Phosphorus Rate (ppm)
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20
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0
50
100
150
200
Nitrogen Rate (ppm)
20-20-20
20-10-20
15-5-15
13-2-13
STOP
STOP
STOP
GO

# Phosphorus Nutrition: Growth Control

- Plant growth retardants (PGRs) are most commonly used method in floriculture
- A concern with PGRs is that they are not labeled for all crops
  - This is especially true for vegetable growers who are limited on chemicals options
- P restriction is an alternative way to control growth in greenhouse crops

# Experiment

- Grew New Guinea impatiens with P rates of 0 – 20 ppm
  - After several weeks, half were sprayed with paclobutrazol
- Measured height, diameter, and dry mass
  - Determined growth index and compared maximum height of PGR treated plants with untreated plants

# ‘Tamarinda Dark Red’ New Guinea Impatiens

Paclobutrazol

No PGR

0 2.5 5 10 20

Phosphorus Rate (ppm)

# ‘Tamarinda Dark Red’ New Guinea Impatiens

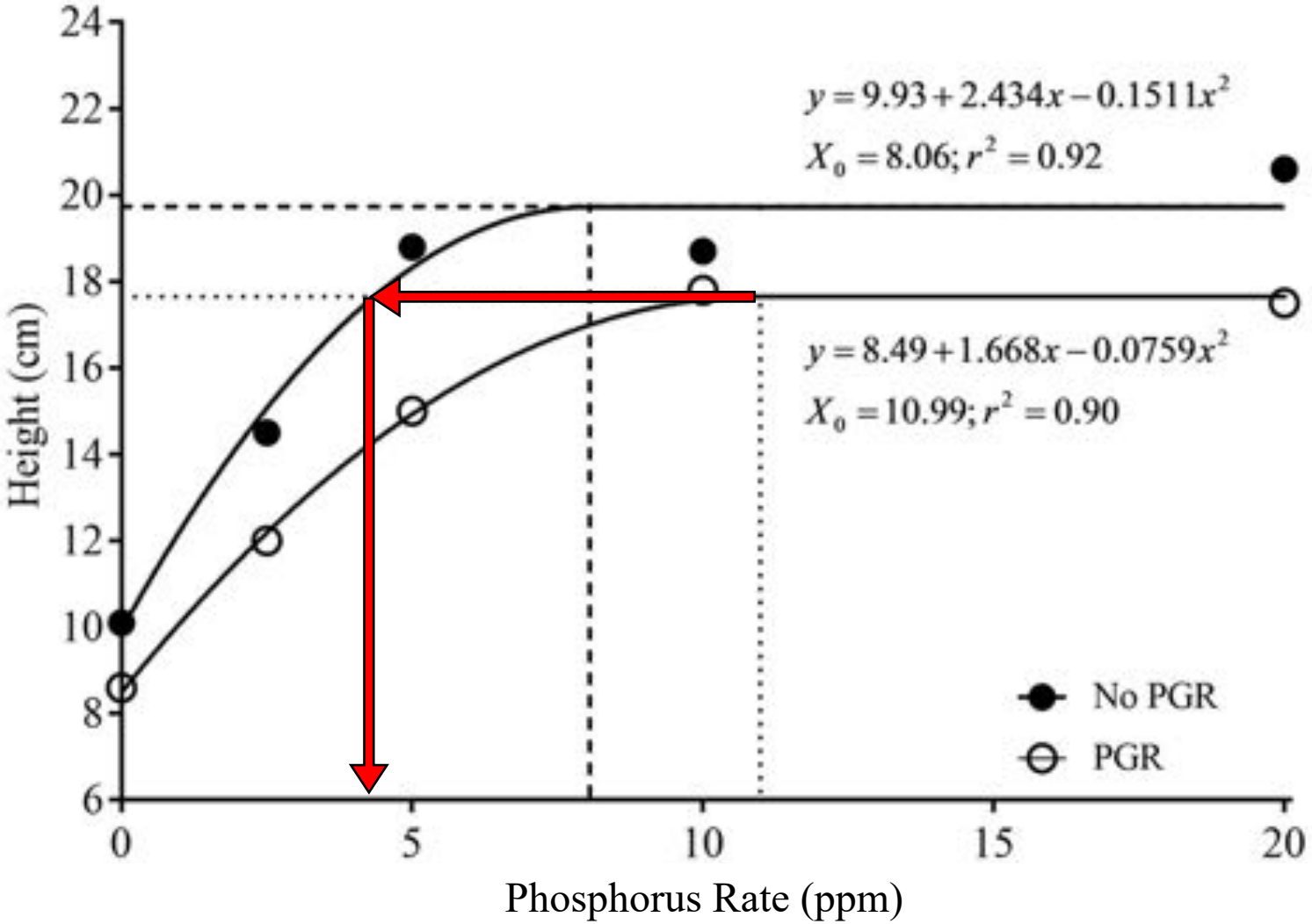
Paclobutrazol

20 ppm P

No PGR

5 ppm P

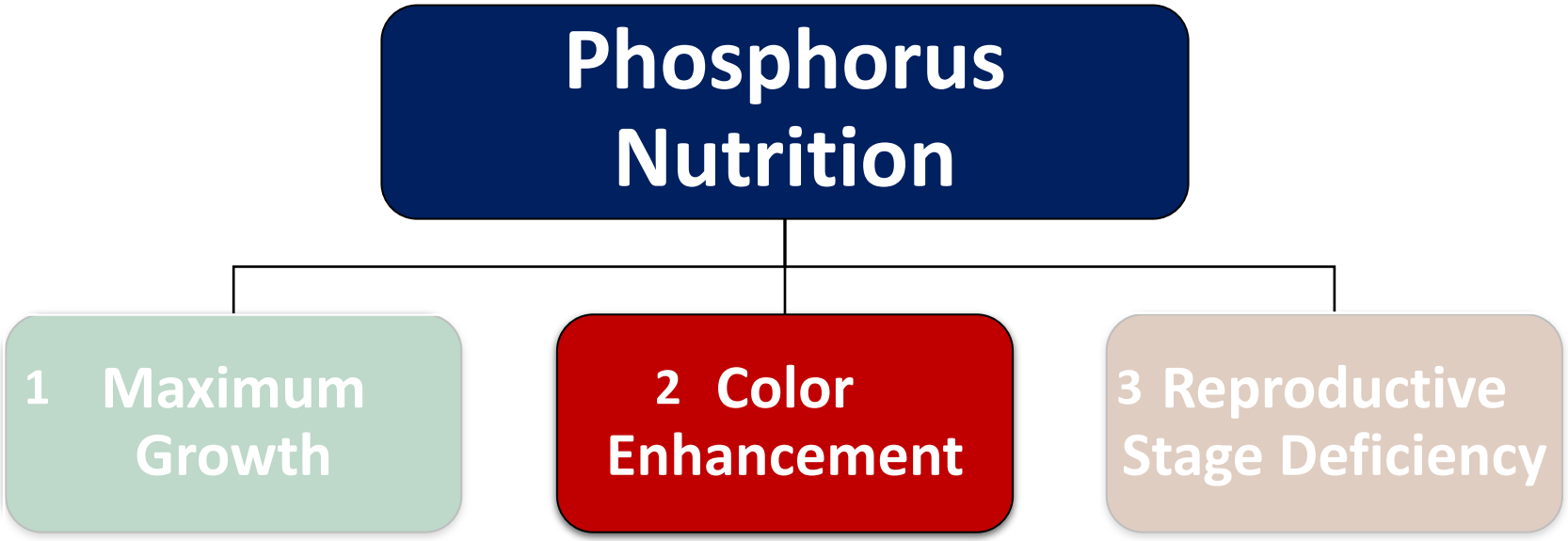
# ‘Tamarinda Dark Red’ Height Control



# Conclusions

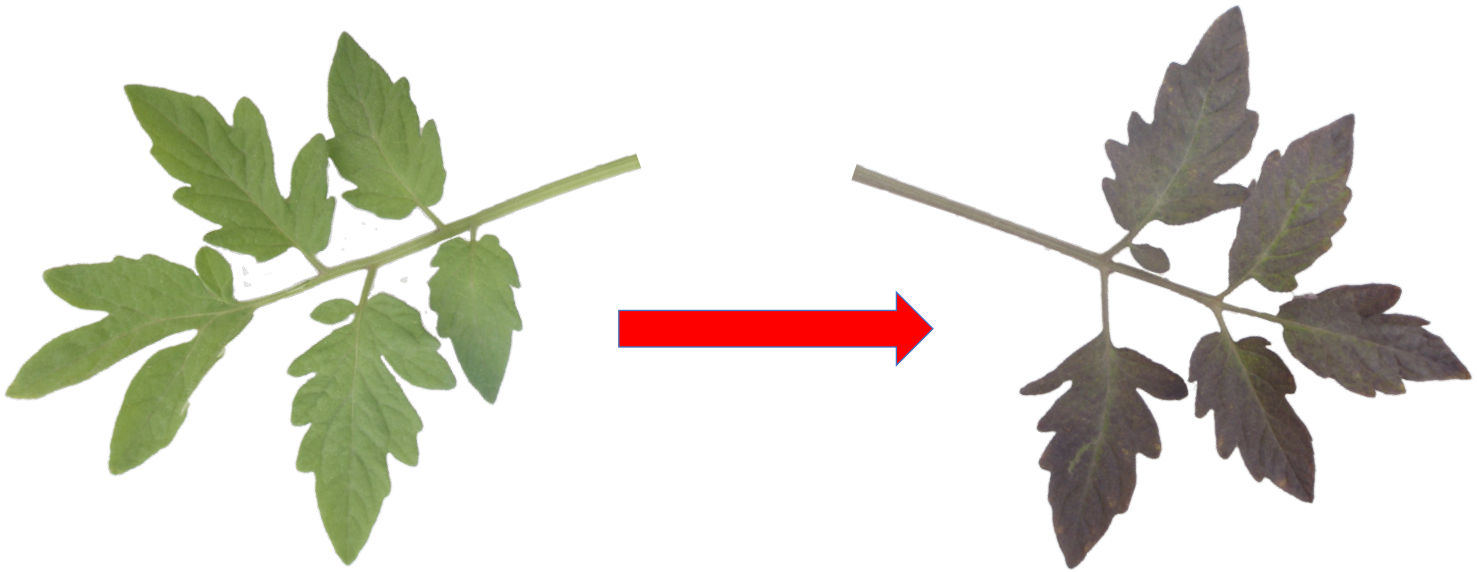
- Depending on species, 5 – 15 ppm P resulted in maximum growth
- 3 – 5 ppm P resulted in similar height for non-PGR treated plants as plants receiving 20 ppm P and a PGR application
- Low P fertilization can successfully control growth without negative issues of P deficiency symptoms

# Topic Outline



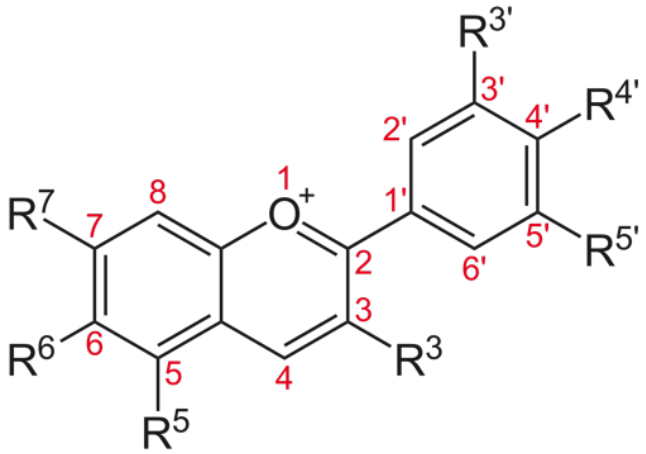
# Phosphorus Nutrition: Effects on Coloration

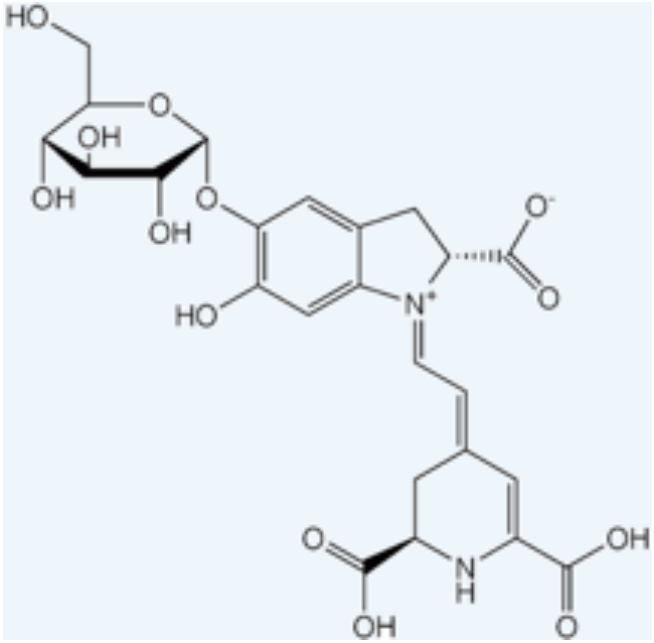
- Red leaf color is a desirable trait found in several ornamental species
  - Zonal geraniums
  - Alternanthera
  - Iresine
  - Coleus



# Phosphorus Nutrition: Effects on Coloration

- What does P nutrition have to do with coloration?
- P deficiency increases red leaf pigmentation
  - Increase in anthocyanins and betacyanins



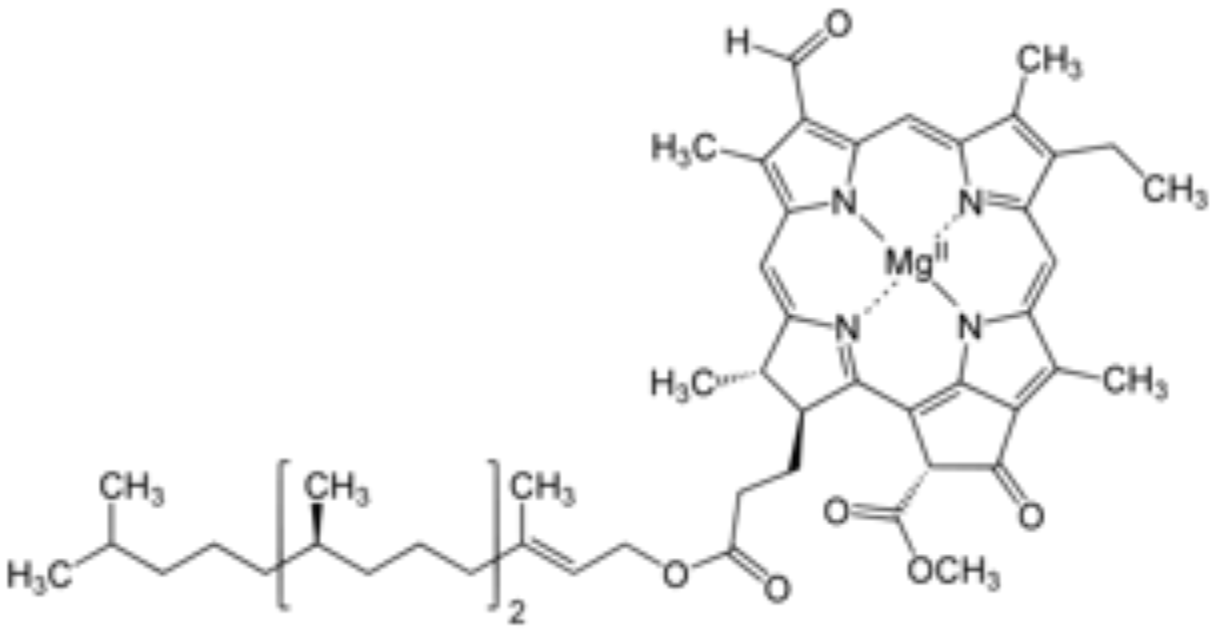
# Phosphorus Nutrition: Effects on Coloration

- Anthocyanins: Common red pigment found in plants such as zonal geraniums and coleus
  - Relationship with P nutrition well established

- Betacyanins: Less common red pigment found in amaranths such as alternanthera, and some other species such as carnations
  - Relationship with P nutrition not previously established

# Phosphorus Nutrition: Effects on Coloration

- Chlorophyll: Pigment responsible for green coloration and photosynthesis
  - Low P stress limits chlorophyll production



# Phosphorus Nutrition: Effects on Coloration

- Several plant pigments affected by P nutrition
  - These pigments determine what color the plant looks like
  - Color is a significant driver of consumer preferences

# Question:

*Can low P fertilization enhance foliar coloration in red leafed species?*

# Overall Conclusions

PROS

- From these experiments, growers can obtain numerous benefits from low P fertilization
  - Growth Control (3 – 5 ppm P)
  - Enhanced Coloration

CONS

- Due to poor nutrient holding capacity of soilless substrates, P must be supplied to avoid deficiency
  - Symptom development in 2 – 3 weeks
  - For most species, 5 – 10 ppm P will prevent symptom development

# *Questions?*

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