

Why C3 Plants Need More CO₂

Understanding Photosynthetic Limiting Factors and Atmospheric Deficits



Enhanced Photosynthetic Efficiency



Contextual Notes & Limitations

Atmospheric CO₂ concentration: Currently ~420 ppm, historically limiting for C3 photosynthesis. Rubisco enzyme inefficiency requires higher internal CO₂ for optimal carboxylation rates. Environmental stressors (water, temperature) can offset CO₂ gains.

Warning Thresholds

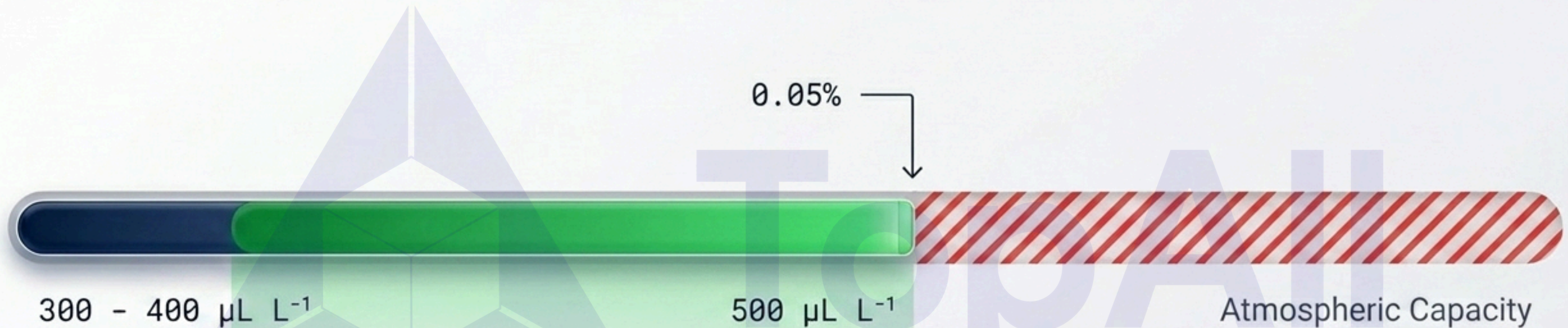
Excessive CO₂ without corresponding nutrient and water supply can lead to photosynthetic downregulation and nutrient imbalances. Extremely high CO₂ levels (>1200 ppm) can be phytotoxic in some species.

The Baseline: Atmospheric Starvation



The Major Limiting Factor: Despite being essential for photosynthesis, carbon dioxide exists at critically low atmospheric concentrations relative to plant biological capacity.

The Growth Threshold



Increased Fixation Rates: Raising atmospheric CO_2 up to this threshold drives higher photosynthetic productivity.

Toxicity Limit: Prolonged exposure to levels beyond 0.05% can damage plant tissues.



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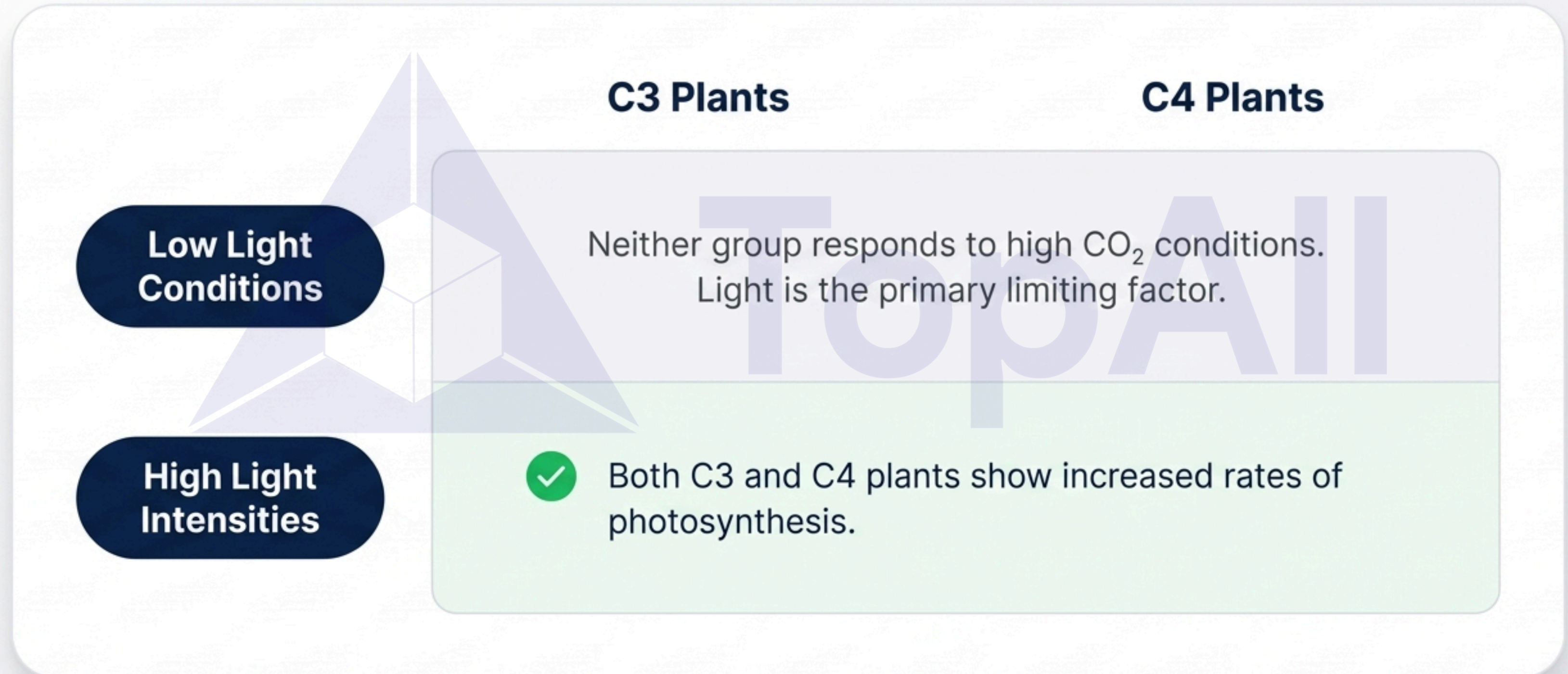
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Key Highlights

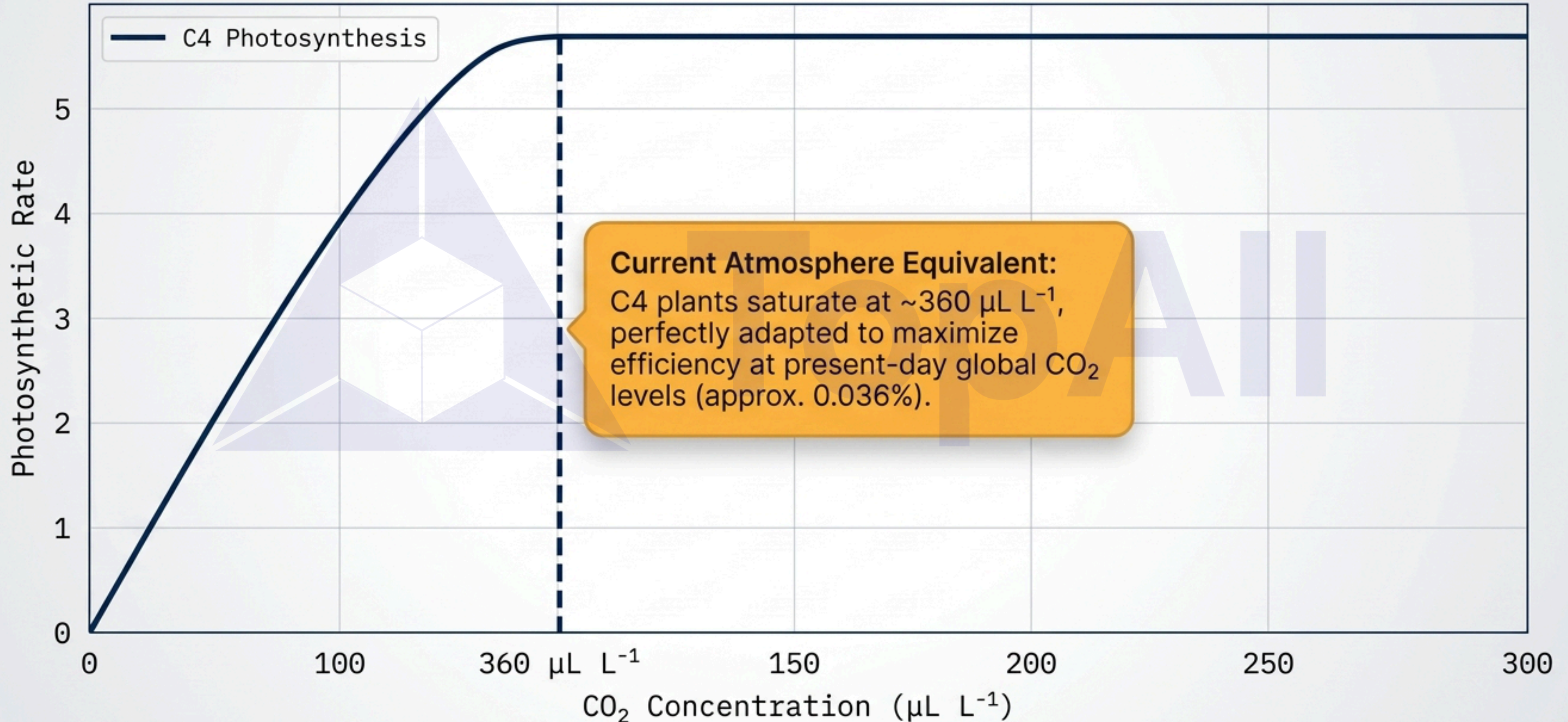
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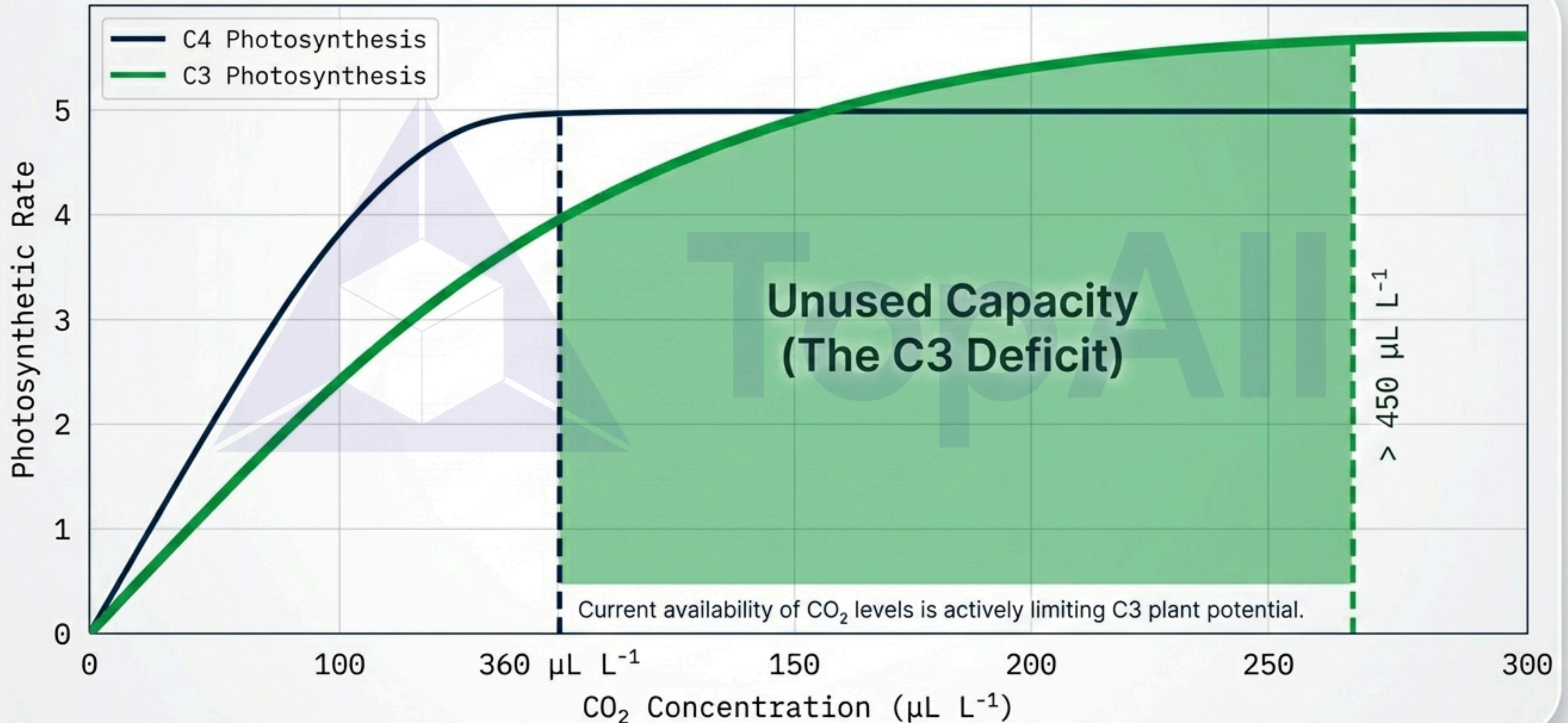
Light Dependency Matrix



The C4 Advantage: Perfect Adaptation



The C3 Deficit: Unmet Biological Potential



The Biological Reality

Because C3 saturation occurs well beyond atmospheric limits ($>450 \mu\text{L L}^{-1}$), C3 plants respond directly to artificial higher CO_2 concentrations with significantly increased productivity.

Greenhouse CO_2 Enrichment

Agronomists leverage this C3 deficit by growing crops in carbon dioxide-enriched atmospheres to drive higher yields.



Tomatoes
(C3 Crop)



Bell Peppers
(C3 Crop)



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