ALGAE-DERIVED BIOFUELS: COMPARATIVE ALGAL YIELD OF AUTOTROPHIC, HETEROTROPHIC, AND MIXOTROPHIC GROWTH CONDITIONS

Rowan University

Andrea McFarland
Kassandra Grimes

2012 MAREA
Breinigsville, PA

Overview

- Background and Introduction
- Purpose and Measure of Experiment
- Experimental Setup
- Results and Discussion
- Conclusions

Background

- Fossil fuels becoming scarcer
  - Attention directed to biofuel research
- Algal colonies are easy to grow and harvest
  - Produce more lipids when stressed

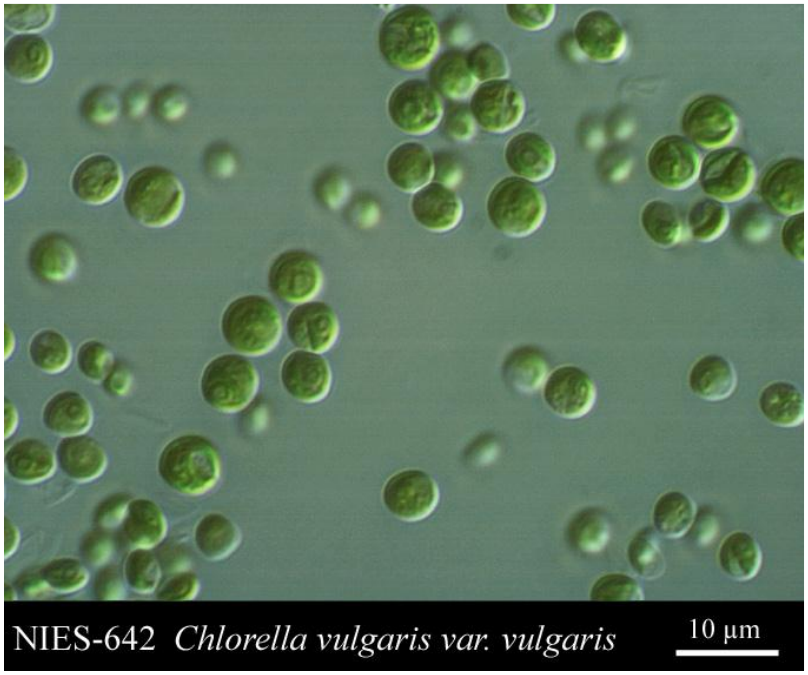
Crop	Oil Yield Gallons/acre
Corn	18
Cotton	35
Soybean	48
Mustard seed	61
Sunflower	102
Rapeseed/Canola	127
Jatropha	202
Oil palm	635
Algae (10 g/m^2/day at 15% TAG)	1,200
Algae (50 g/m^2/day at 50% TAG)	10,000

Background – Growth Conditions

- Autotrophic
  - Algae gain energy from a light source using photosynthesis
- Heterotrophic
  - Photosynthesis is inhibited and algae gain energy from dissolved organic matter
- Mixotrophic
  - Algae gain energy using both photosynthesis and dissolved organic matter

Background – Microalgal Species

- *Chlorella vulgaris*
  - Circular shaped algae, 2-5 µm in size
  - Widely studied algal species for biodiesel production
  - Lipid content 14-22% dry cell weight (DCW)



Purpose of Experiment

- Explore the advantages of light-deprived algae
  - Reduce energy consumption
  - Reduce cost of algal cultivation
  - Provide a more feasible method of algae production
- Compare autotrophic, heterotrophic, and mixotrophic growth analyses
  - Determine optimal growth method for lipid yield and algal growth

Measures of Experiment

- Algae Growth
  - Monitored daily with a spectrophotometer using optical density at 625 nm wavelength
- Glucose Extraction
  - Monitored using a HACH Test N Tube Chemical Oxygen Demand
- Lipid Yield
  - Taken at the conclusion of the experiment using the Bligh and Dyer Lipid Extraction Method

Experimental Setup

- 1,000 mL beakers
  - 600:400mL Medium to Algae
  - 500 mg/L glucose concentration
  - 4.7 mg/L DCMU concentration (Dichlorophenyl dimethylurea)
- Modified Jar test setup
  - 90 rev/min
  - 18:6 hour light-dark cycle (Light)
  - 400 ft-c (Light)
  - Retrofitted cardboard boxes behind blackout curtain (Dark)

Experimental Setup

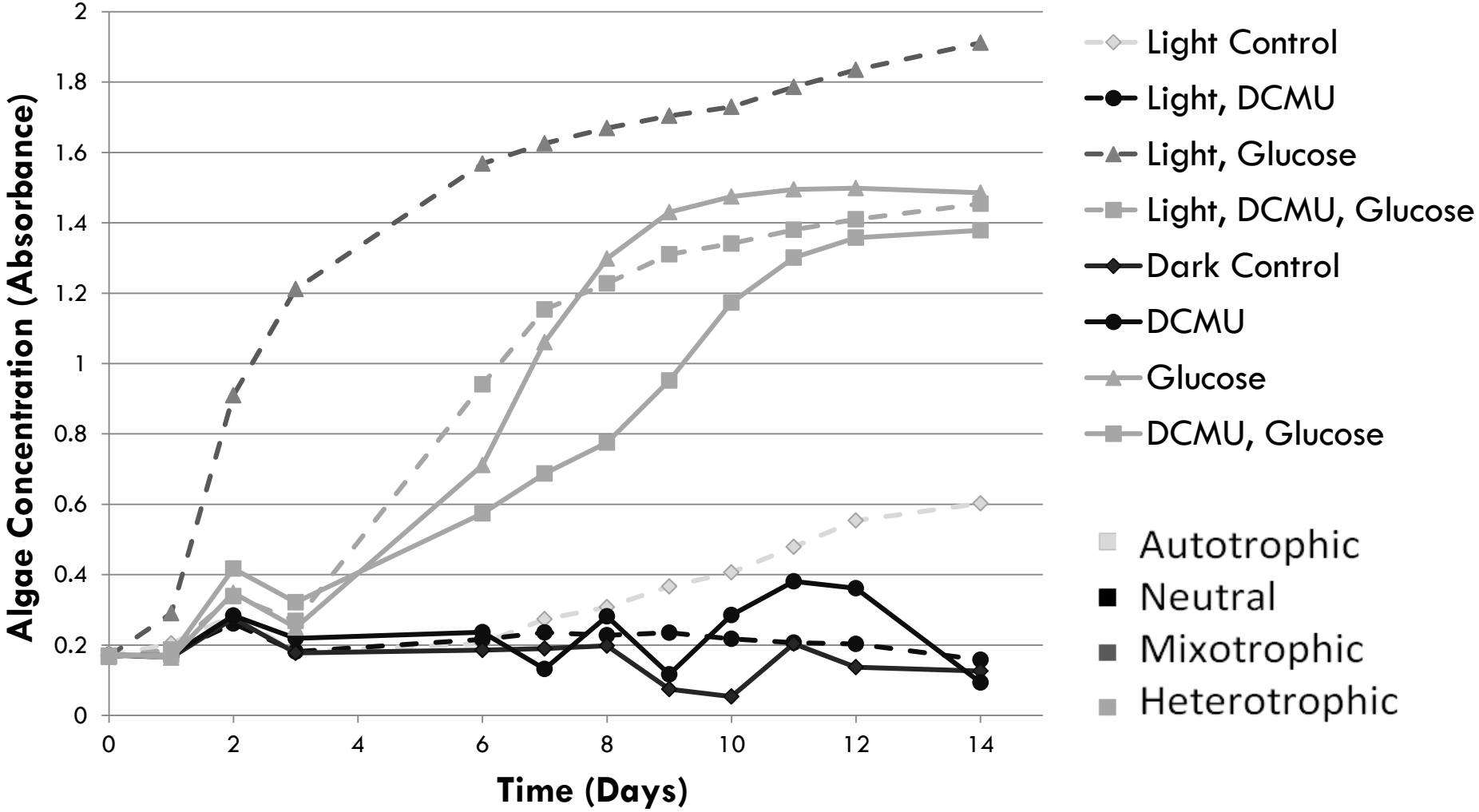
Light Experiments

Light Control 1	Light Control 2	Light DCMU 1	Light DCMU 2	Light Glucose 1	Light Glucose 2	Light DCMU Glucose 1	Light DCMU Glucose 2

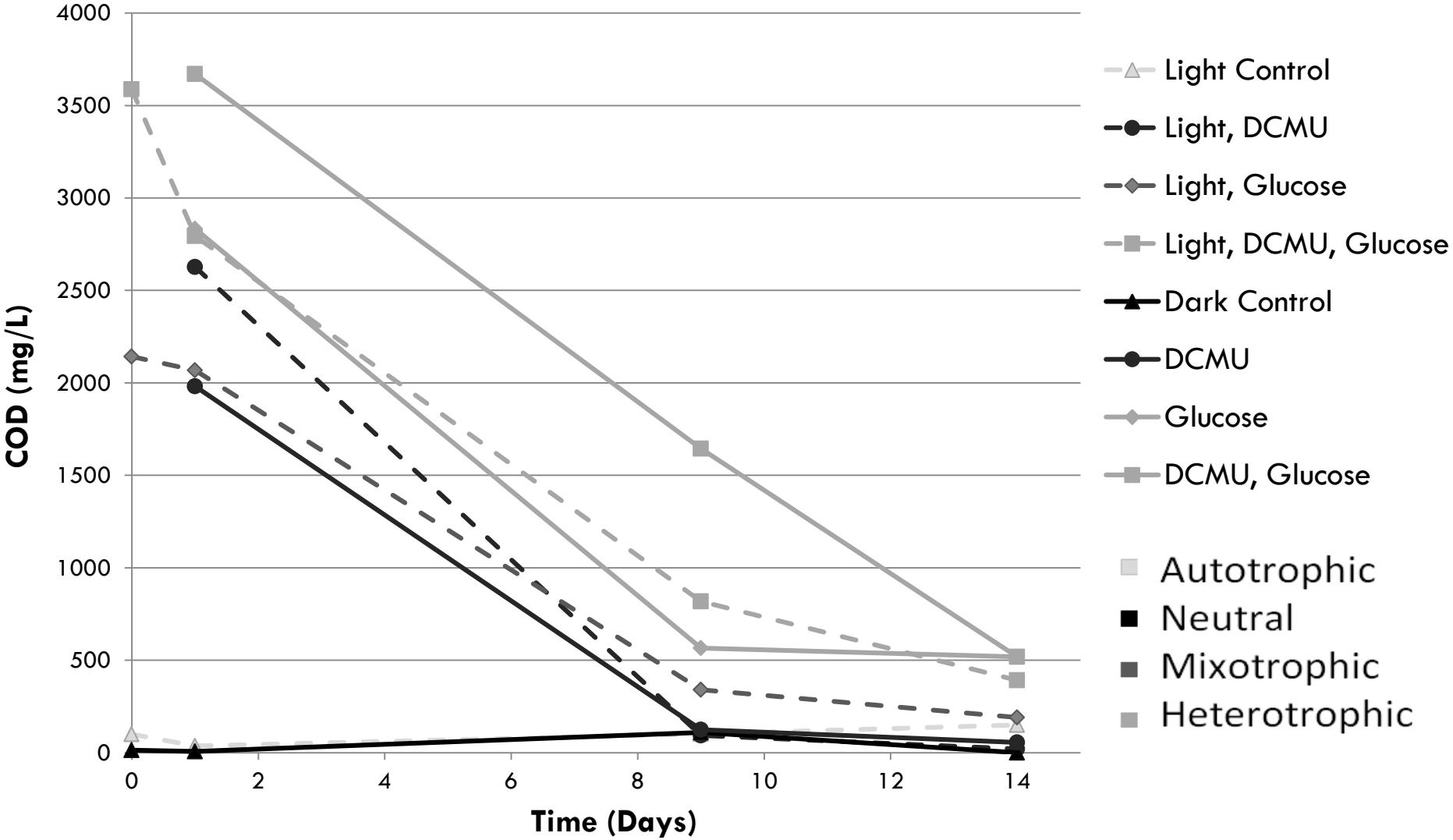
Dark Experiments

Dark Control 1	Dark Control 2	DCMU 1	DCMU 2	Glucose 1	Glucose 2	DCMU Glucose 1	DCMU Glucose 2

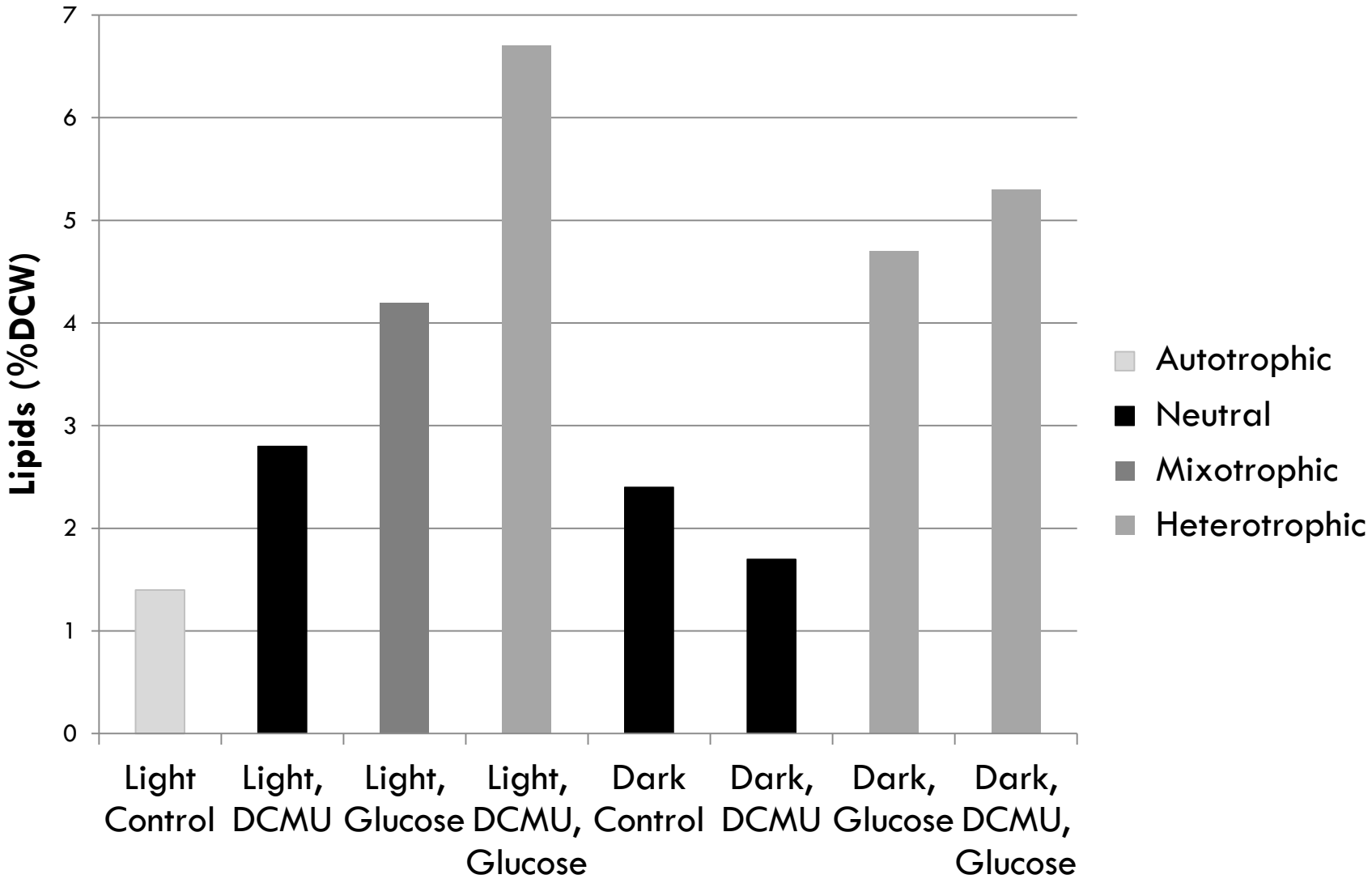
Growth Curves for Each Condition



Carbon Consumption in Different Growth Conditions



Lipid Analysis of Each Condition



Summary of Experimental Results

Growth Condition	Growth Rate (Day^{-1})	R^2 (unitless)	Carbon Consumption (%)	Lipid Yield (% DCW)	Lipid Normalized Production Weight ($Days^{-1}$)
Light Control	0.0578	0.955	-	1.4	0.081
Light, DCMU	0.0468	0.829	99.2	2.8	0.131
Light, Glucose	0.2124	0.897	90.8	4.2	0.893
Light, DCMU, Glucose	0.1473	0.925	86.0	6.7	0.987
Dark Control	-0.0070	1.000	-	2.4	0.017
Dark, DCMU	-0.0005	1.000	97.2	1.7	0.001
Dark, Glucose	0.1216	0.885	81.7	4.7	0.572
Dark, DCMU, Glucose	0.0725	0.9092	85.9	5.3	0.384

Conclusions

- Heterotrophic conditions showed highest lipid yields and second-highest growth rates
- Mixotrophic condition showed the highest growth rate overall
- Results support idea of DCMU being used as additional source of carbon
- Heterotrophic growth conditions were shown to provide an effective environment for lipid production and growth of C. *vulgaris*

ALGAE-DERIVED BIOFUELS: COMPARATIVE ALGAL YIELD OF AUTOTROPHIC, HETEROTROPHIC, AND MIXOTROPHIC GROWTH CONDITIONS

Andrea McFarland
mcfarl39@students.rowan.edu

Kassandra Grimes
grimes34@students.rowan.edu

Rowan University

2012 MAREA
Breinigsville, PA