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Breakthroughs in Plant Based PHB Production

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VIRTUAL

SEED
2021 SYNTHETIC BIOLOGY:
Engineering, Evolution & Design

JUNE 15-18, 2021

Safe Harbor Statement*

The statements made by Yield10 Bioscience, Inc. (the "Company," "we," "our" or "us") herein regarding the Company and its business may be forward-looking in nature and are made pursuant to the safe harbor provisions of the Private Securities Litigation Reform Act of 1995. Forward-looking statements describe the Company's future plans, projections, strategies and expectations, including statements regarding future results of operations and financial position, business strategy, prospective products and technologies, expectations related to research and development activities, timing for receiving and reporting results of field tests and likelihood of success, and objectives of the Company for the future, and are based on certain assumptions and involve a number of risks and uncertainties, many of which are beyond the control of the Company, including, but not limited to, the risks detailed in the Company's Annual Report on Form 10-K for the year ended December 31, 2020 and other reports filed by the Company with the Securities and Exchange Commission (the "SEC"). Forward-looking statements include all statements which are not historical facts and can generally be identified by terms such as anticipates, believes, could, estimates, intends, may, plans, projects, should, will, would, or the negative of those terms and similar expressions.

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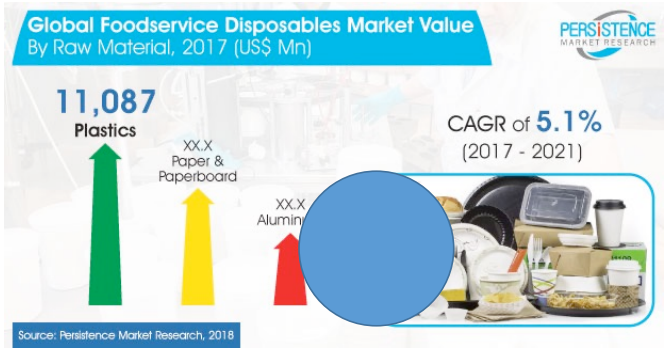
***Under the Private Securities Litigation Reform Act of 1995**

PHA Bioplastics Opportunity

Plastics: Global Production, 350 Million TPY[1], 4% Growth Rate, ~$720 Billion by 2025[2]

- Increasing demand for biodegradable or bio-sourced plastics[3]
- Low-cost crop based PHA bioplastics – target markets
  - PHA biomaterials can functionally replace over 50% of todays plastics

A. Current Materials



B. PHA Replacements[5]

Fermentation based PHA products

- **Demonstrated functionality**
- **But 3- 5x more expensive**

1. https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf
2. https://www.prnewswire.com/news-releases/plastics-market-size-worth-usd-721-14-billion-by-2025--cagr-4-0-grand-view-research-inc-300801897.html
3. www.European-bioplastics.org/market
4. https://www.persistencemarketresearch.com/market-research/foodservice-disposables
5. Yield10 corporate archives

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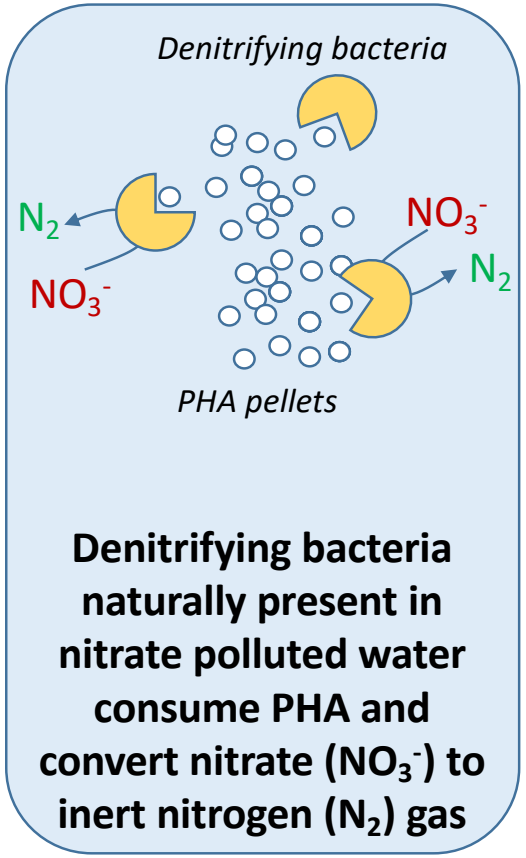
Polyhydroxyalkanoate (PHA) biomaterials

- Renewable, biodegradable class of biomaterials produced by some microorganisms as reservoir of stored carbon and energy
- Fully degradable in all biologically active environments
- Unique features of polymers will allow use in multiple applications
  - Plastics, renewable chemicals, water treatment, animal feed ingredient
- Barriers:
  - Market adoption has been severely restricted by high cost
    - *<u>Production by fermentation</u>: cost too high for most applications*

Water treatment application



Denitrifying bacteria naturally present in nitrate polluted water consume PHA and convert nitrate (NO_3^-) to inert nitrogen (N_2) gas

PHA Camelina

Mission:

Low-cost, large-scale

Carbon Negative

- Zero Waste Bioplastics -

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Why Camelina?

- Promising oilseed crop
  - seed oil levels ~ 40% of seed weight
  - does not outcross with canola
- Good platform for specialty/niche crops for high value products
- Both spring and winter varieties available
  - winter varieties, potential use as cover crop for corn and soybean acres
- Camelina producing specialty products will increase value proposition for farmers

Greenhouse grown Camelina

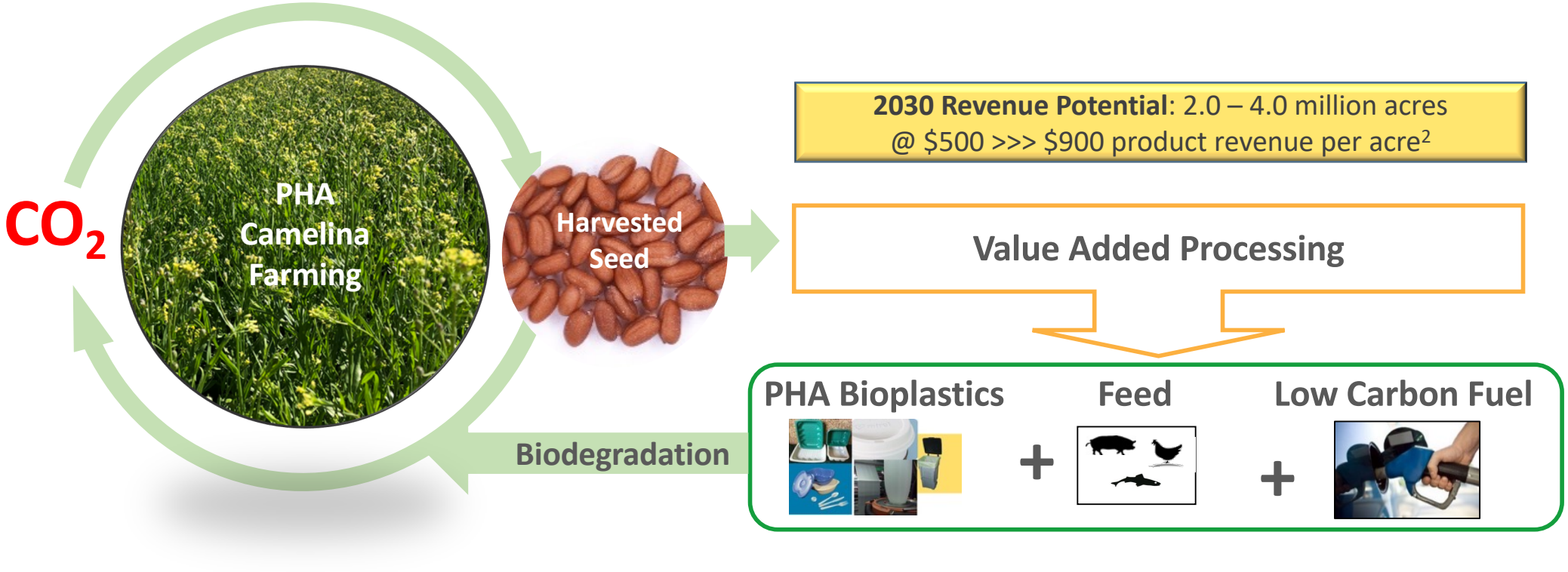
Camelina field plots at flowering

Yield10 Camelina Review: *Camelina sativa*, an oilseed at the nexus between model system and commercial crop. Malik et al., Plant Cell Rep., 2018

Goal: Carbon Negative - Zero Waste Bioplastics

Yield10 genetically programmed Camelina to produce PHA Bioplastics in the seed

Addressable Market > $200 billion[1]



[1] ~25% of plastics production, 50% of plastics used in single use packaging. [2] Estimates of market opportunity are based on industry sources as well as management's analysis, financial estimates and timelines for market introduction and adoption. >>> Technology Improvements, increased yield and oil/or PHA seed content

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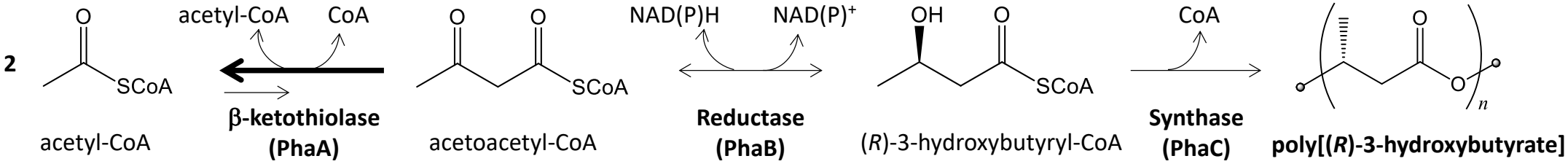
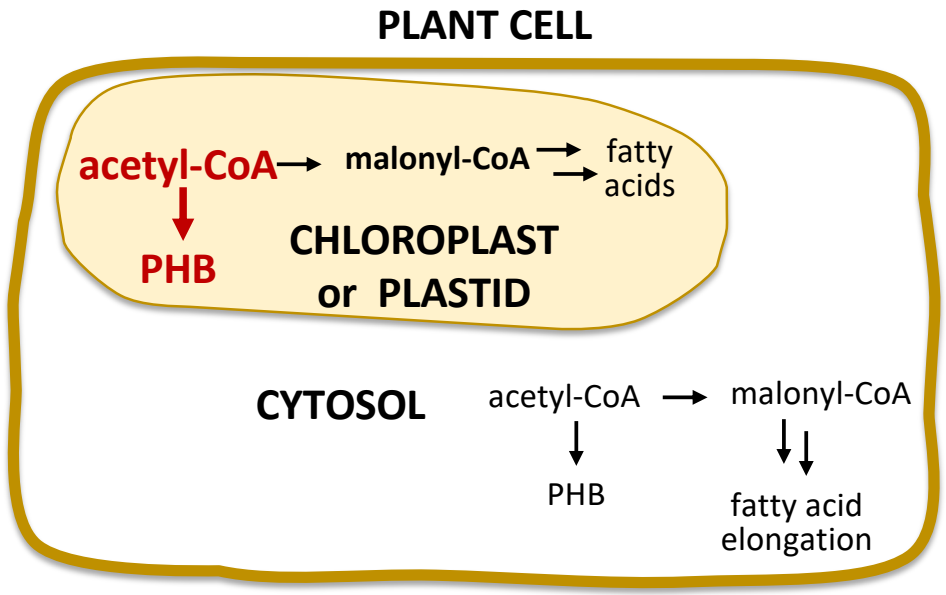
PHB Pathway – Substrate Acetyl-CoA Well Suited to Oilseeds

Bacterial PHB biosynthetic pathway



Engineering production in chloroplasts/ seed plastids has yielded high levels of PHB in plants, but often with impaired growth[1]

- Little reported success with cytosolic production (highest reported level 0.34% dry cell weight[2])

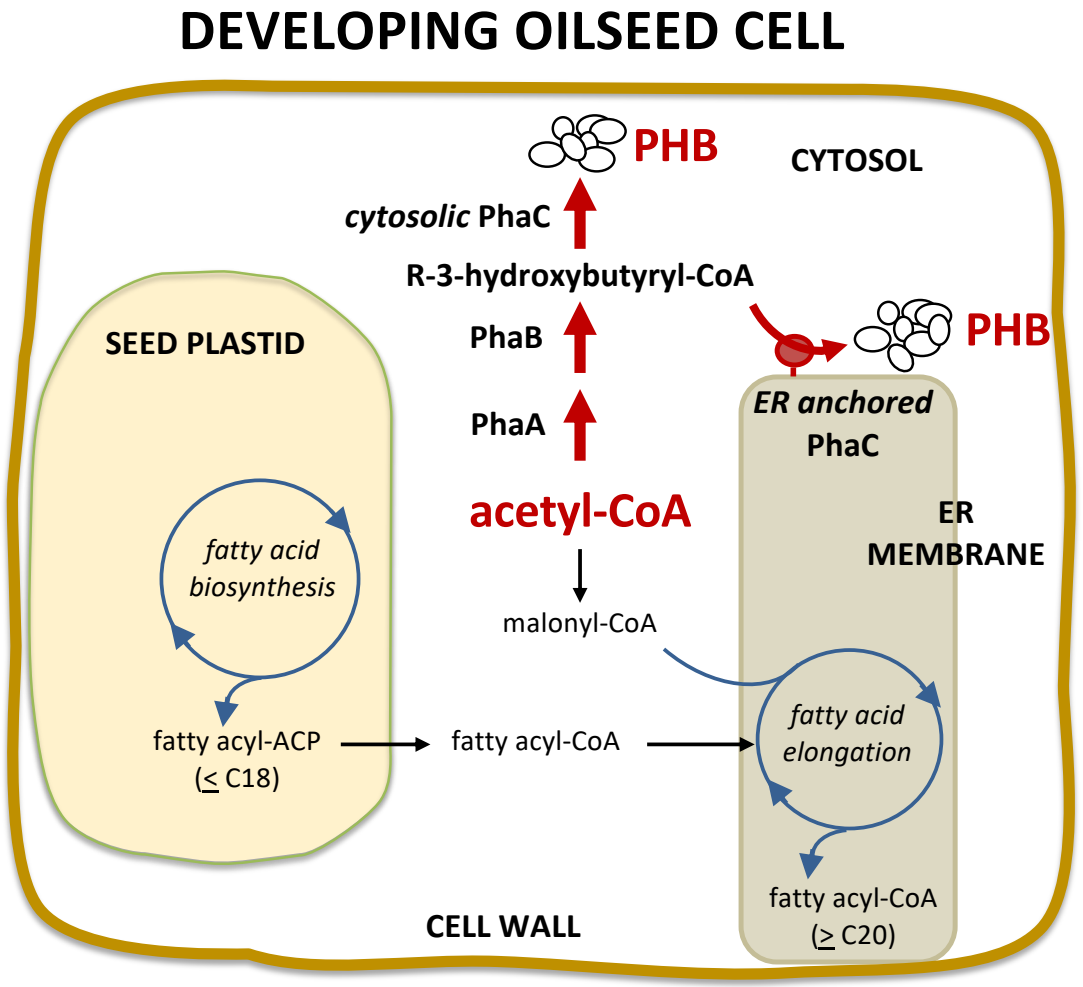


[1]**Yield10 reference for production of PHB in Camelina seed plastids, Malik et al.,** 2015, *Plant Biotechnol. J.* 13, 675.
[2]**Production in cytosol of cotton fibers, John & Keller,** 1996, *P. Natl. Acad. Sci. USA.* 93, 12768.

Production of PHB in Cytosol of Camelina Seeds

Revisit production of PHB in cytosol - Capture portion of acetyl-CoA in cytosol for production of PHB

- Two genetic constructs
  - All enzymes targeted to cytosol
  - PhaA and PhaB enzymes targeted to cytosol; PhaC anchored to the cytosolic face of the endoplasmic reticulum (ER)
- Camelina plants transformed, lines isolated



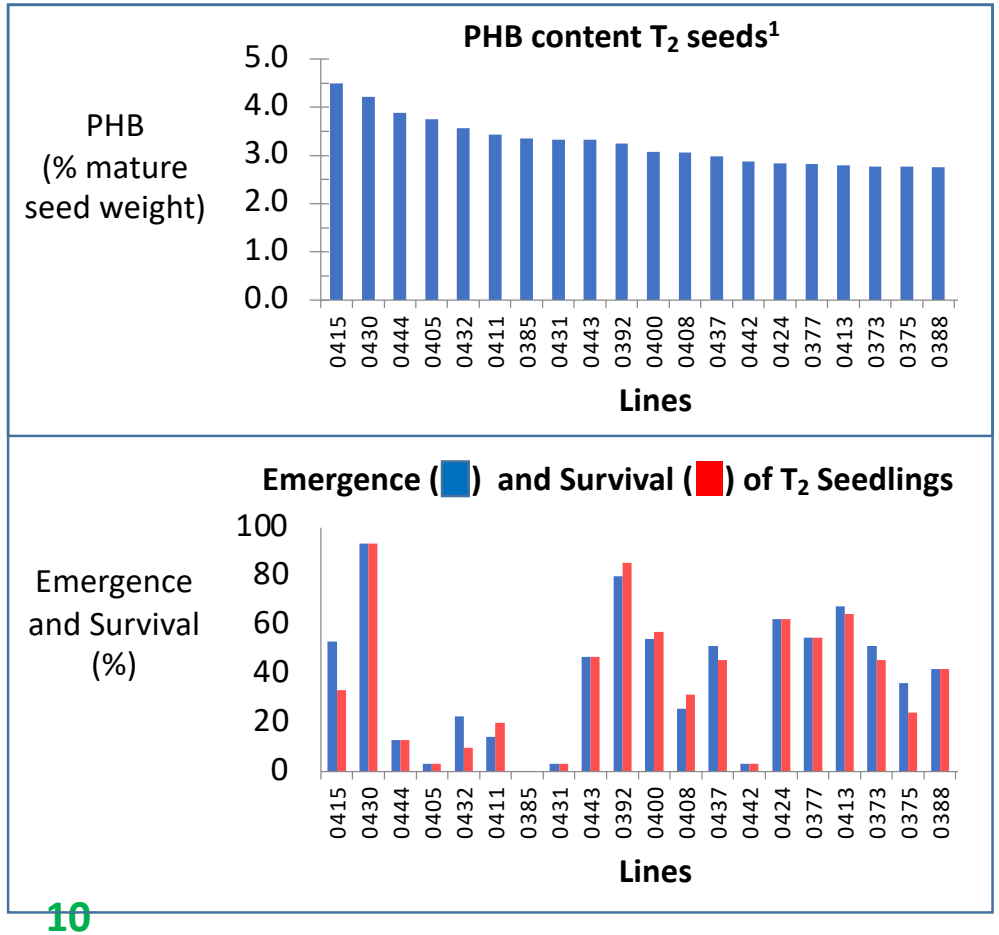
β-ketothiolase (PhaA), **reductase** (PhaB), **PHA synthase** (PhaC)

T_2 Seed PHB Content and Survival of Seedlings

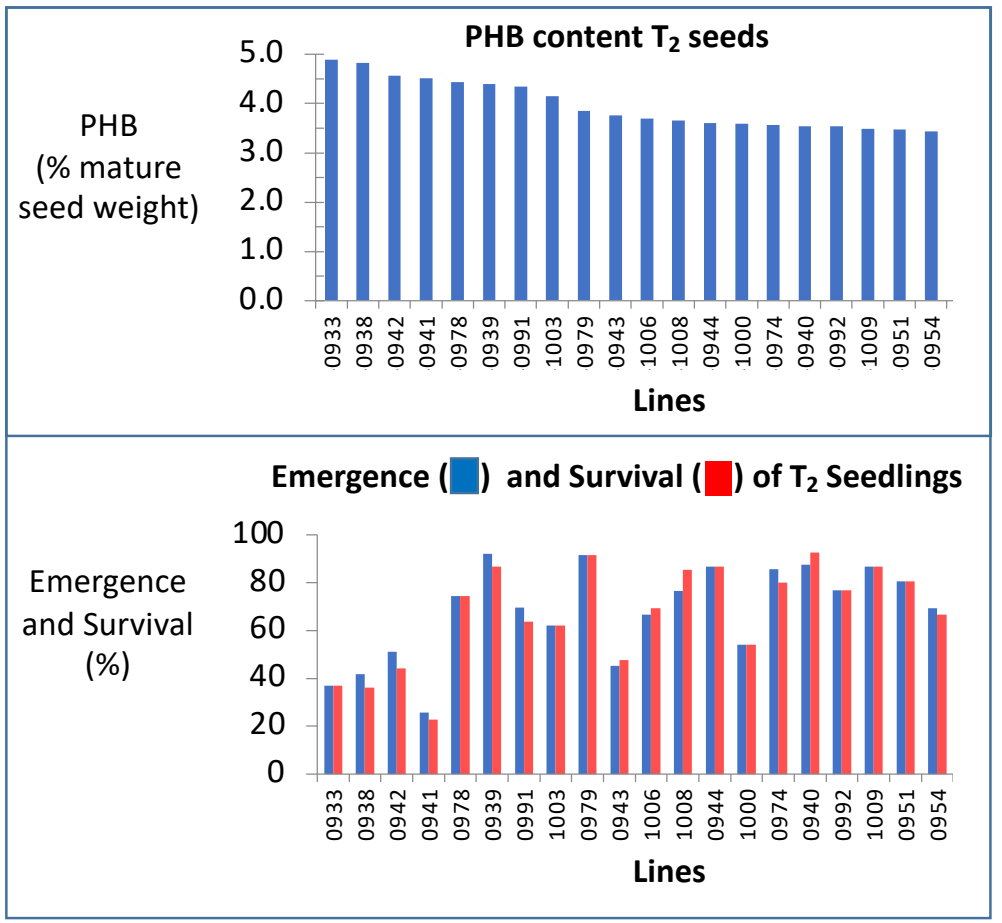
Second generation (T_2) seeds contained up to 14x reported[1] highest level of cytosolic PHB

- Some lines with good emergence and survival contained > 4% PHB (mature seed weight)

Cytosolic PHA synthase



ER anchored PHA synthase



[1]**Production in cotton fibers, 0.34% dry cell weight, John & Keller,** 1996, *P. Natl. Acad. Sci. USA.* 93, 12768.

PHB producers, healthy seedlings with narrow cotyledons

Phenotype of 7 day old seedlings

Wild-type

Cytosolic PhaC
4.5% PHB
53% emergence
33% survival

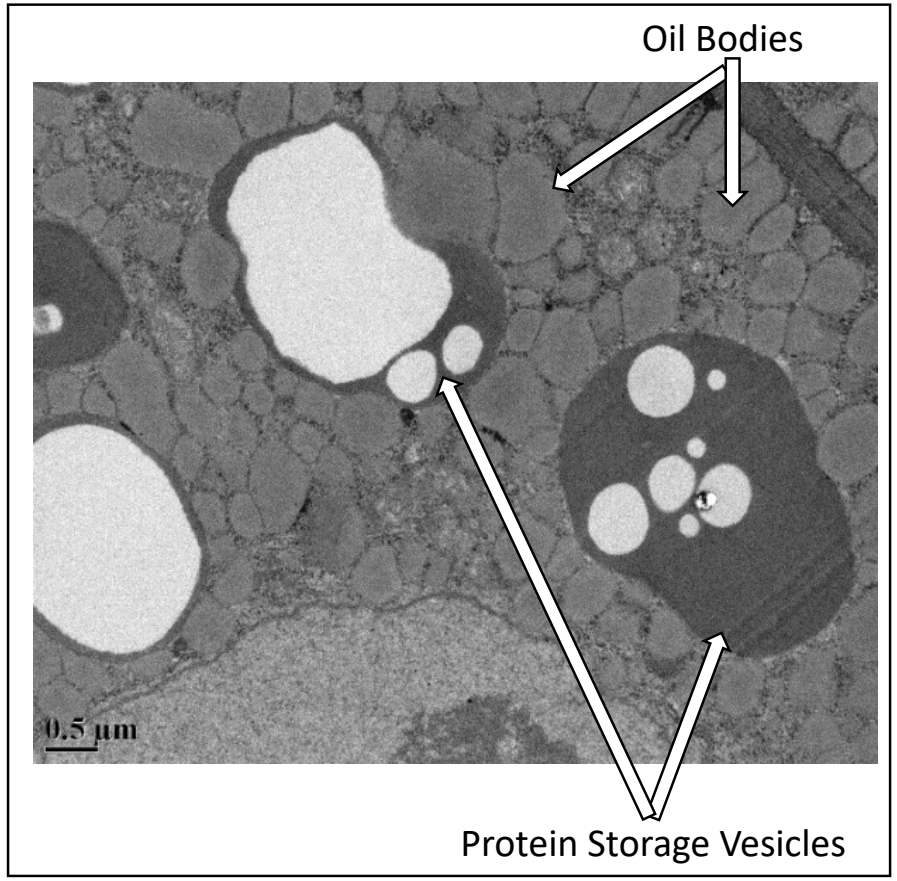
ER PhaC
4.4% PHB
92% emergence
87% survival

Pursued only ER PhaC lines in later generations. PHB production more stable in ER PhaC lines.

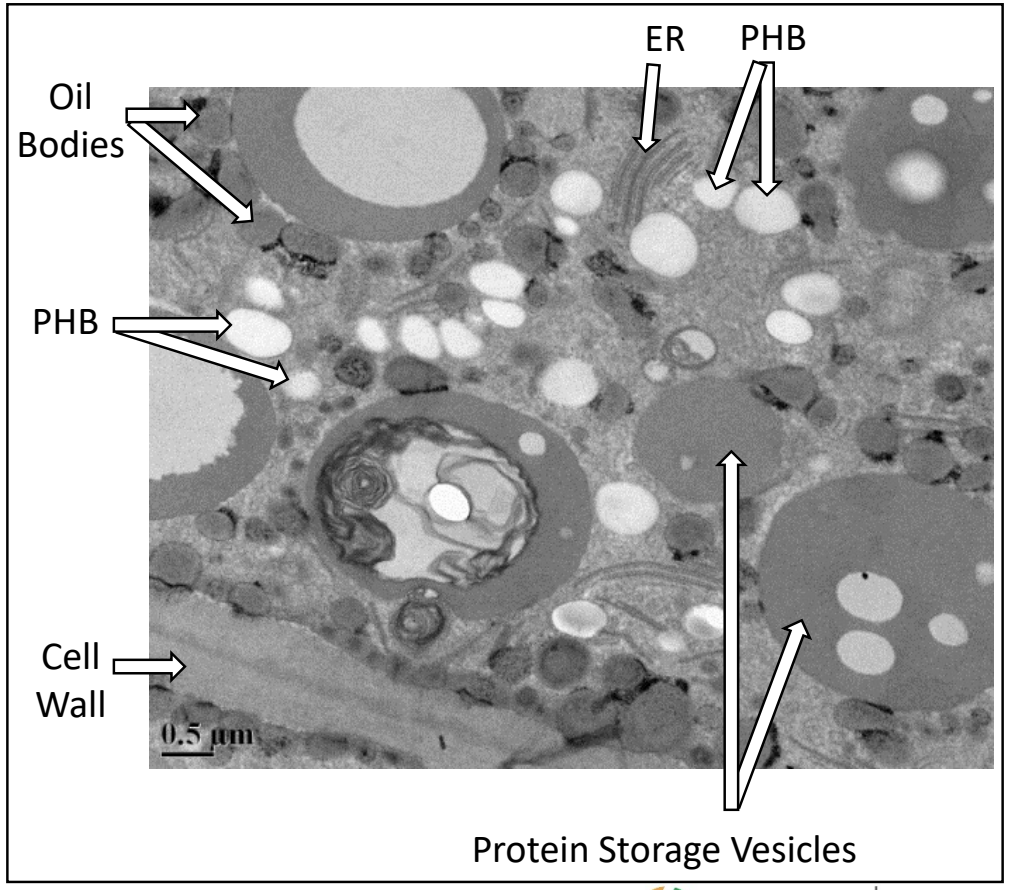
PHB Polymer Accumulates as Granules in Seed

Transmission electron microscopy (TEM) of cotyledon in imbibed seeds

Wild-type control

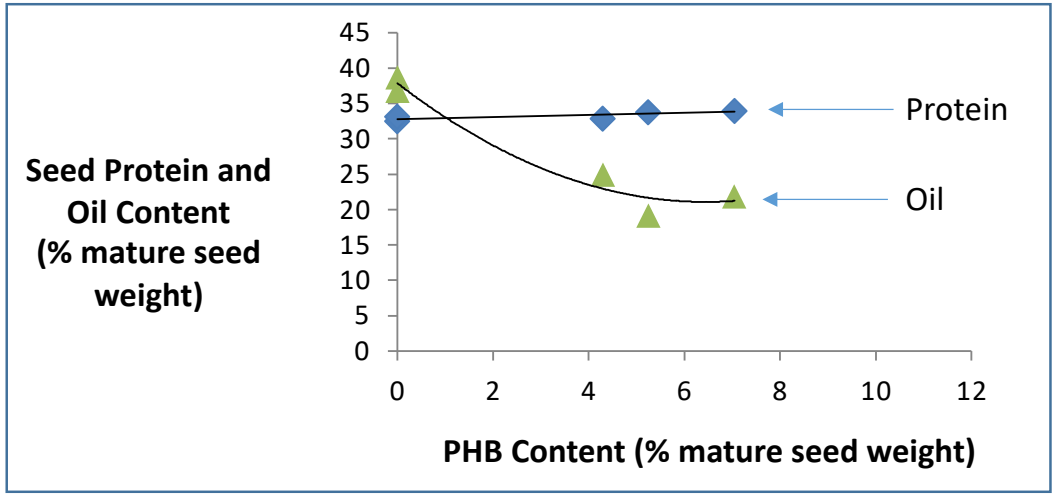


ER targeted synthase line



PHB Produced at Expense of Oil

Seed Oil and Protein Content
(from greenhouse growth of homozygous lines)



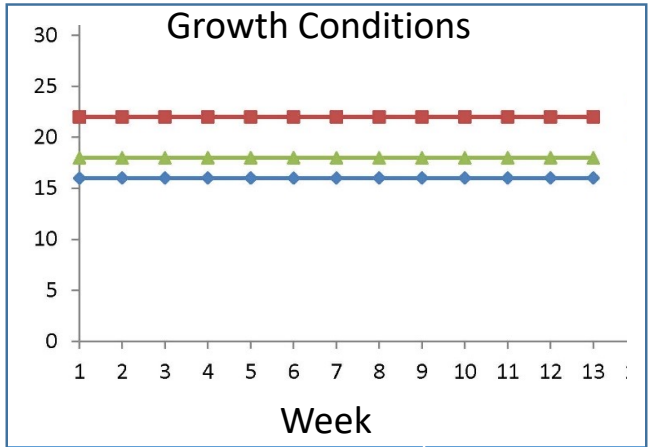
- *PHB has more value than oil*
- Looking for genes to increase carbon to seed to boost oil using GRAIN modeling platform

PHB Production in Different Growth Conditions

Lines grown in greenhouse and controlled environmental chamber programmed to simulate average spring growth conditions[1]

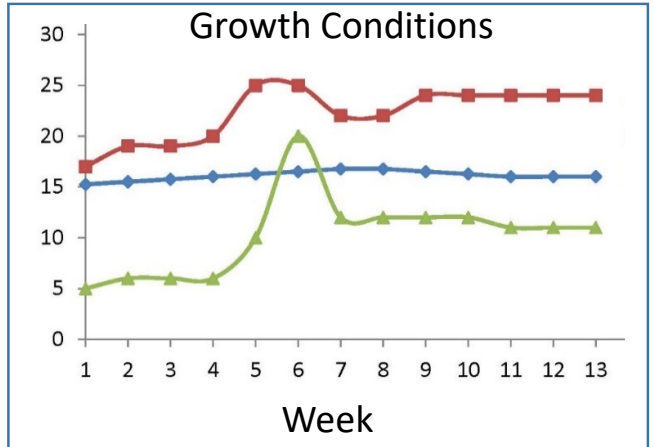
- Results for best line shown

Greenhouse



T_4 seed PHB range	3.9 - 7.1%
% survival T_3 seedlings	86
Avg T_4 seed yield (g)	8.2 ± 1.8
Number of plants	8

Controlled Environmental Chamber



T_4 seed PHB range	4.6 -10.2%
% survival T_3 seedlings	78
Avg T_4 seed yield (g)	14.7 ± 3.9
Number of plants	4[2]

Up to 10.2% PHB obtained in seeds of homozygous line

[1]Temperature settings in the controlled environmental chamber adapted from average weekly historical data between early May and late July for Saskatoon, Saskatchewan, Canada, an area suitable for Camelina growth. [2]Size of growth chamber limited number of replicates

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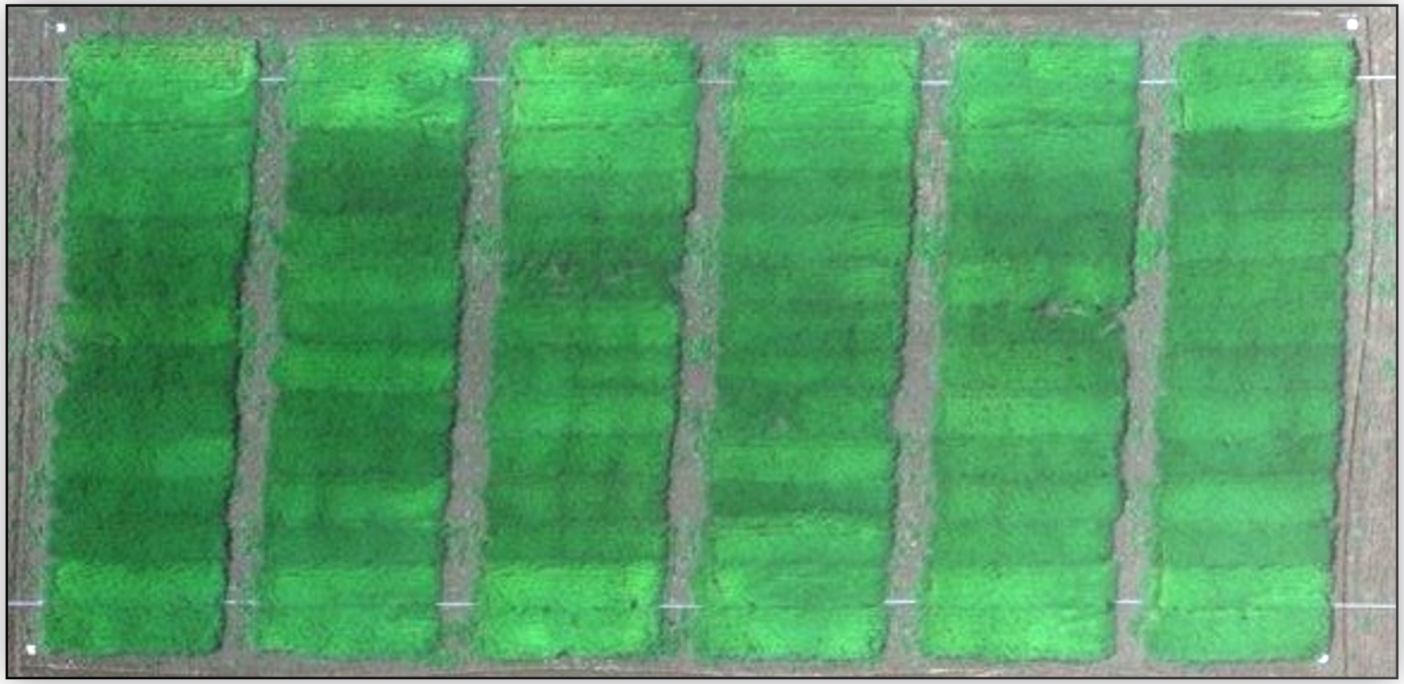
2020 PHA Field Trials

- Conducted field tests of PHA Camelina in 2020 season
  - Small replicated plots of multiple lines with ER targeted PhaC (PHA synthase)
- Proof-of-concept milestone for producing PHA in field grown Camelina
  - Up to 6% PHB produced in seeds of Camelina in the field

Drone photo of PHA Camelina replicated plots at 2020 U.S. field test site



2021 Seed Scale Up

Selected two PHA Camelina lines for further scale up in 2021

Two separate 0.2 acre plots recently planted in U.S.

- Further seed scale up
- Seed processing and product prototyping, sampling and other business development activities

PHA Development Program Status

Addressable Market

$200 billion[1]

2030 Potential Revenue

PHA — 2.0 – 4.0 million acres @ $500 >>> $900 product revenue per acre

- Developed new technology solution to produce PHA in Camelina, patent application in 2019
- Conducted field tests of PHA Camelina in 2020 season
- Proof-of-concept milestone for producing PHA in field grown Camelina achieved – up to 6% PHB in mature seed
- Selected two PHA Camelina lines for further scale up in 2021
- Elite PHA line development ongoing
  - Goal systematically increase PHA seed content to increase harvest value

PHA Camelina plants at 2020 U.S. Field Test Site

Sample PHA resin pellets produced by Metabolix

[1] *~25% of plastics production, 50% of plastics used in single use packaging.*

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QUESTIONS?

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