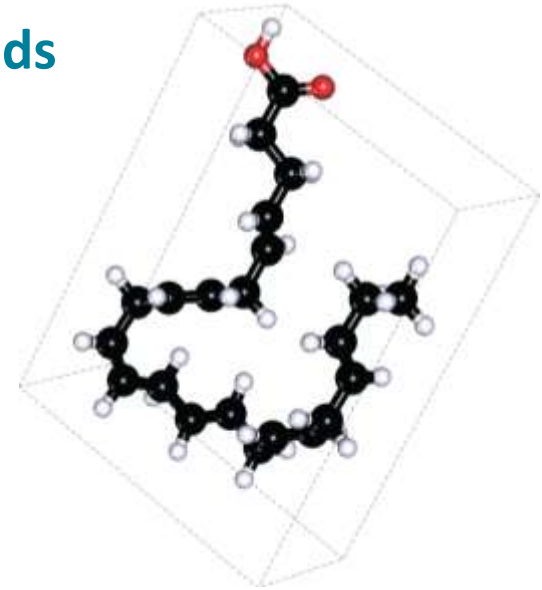
DHA production in *Camelina*, *Brassica juncea* and canola seed

James Petrie | CSIRO

ARAB 18, Barossa Valley, 2014

Why DHA?

The importance of long-chain omega-3 fatty acids



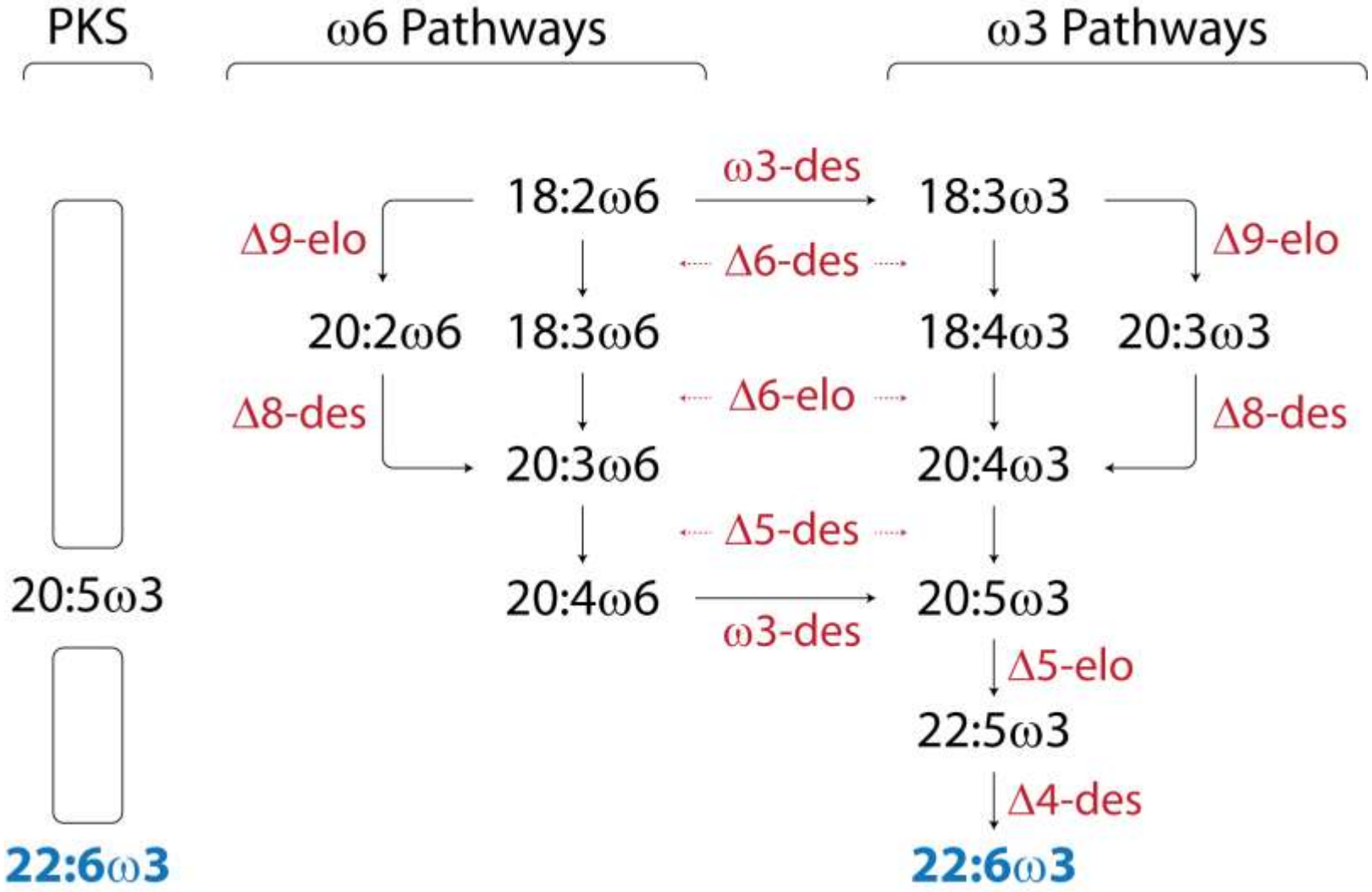
- **Marine: long-chain EPA and DHA**
  - Strong health benefits
  - Microalgal primary production

- **Plants: short-chain ALA and SDA**
  - Limited health benefits
  - Low conversion to DHA

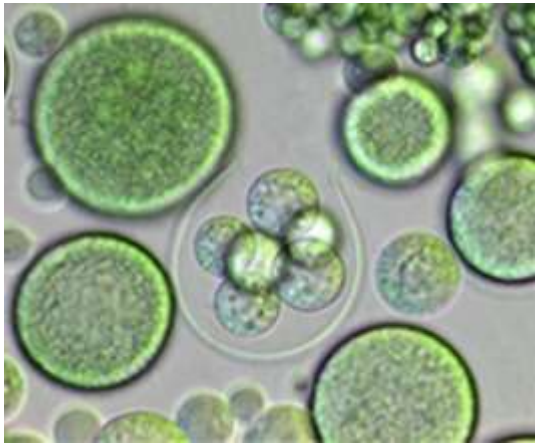
Why DHA?

- Growing demand for EPA and DHA for nutritional and pharmaceutical uses
- Wild fish stocks are finite, algae are expensive to grow
- Aquaculture is growing rapidly but requires omega-3 feed (~60% global fish oil is used in aquaculture)

DHA biosynthesis: you need some genes



Making a new omega-3 production platform



Microalgae
(EPA and DHA
primary producers)

GENES

Canola

Going to the source: algal culture collection

Australian National Algae Culture Collection

18:1, OA

Δ12-des ↓ 18:2, LA — *Lachancea kluyveri* PLoS One 7:e49165

ω3-des ↓ 18:3, ALA — *Pichia pastoris* Yeast 25:21-27 (not CSIRO)

Δ6-des ↓ 18:4, SDA — *Micromonas pusilla* Metab Eng. 12:233-240

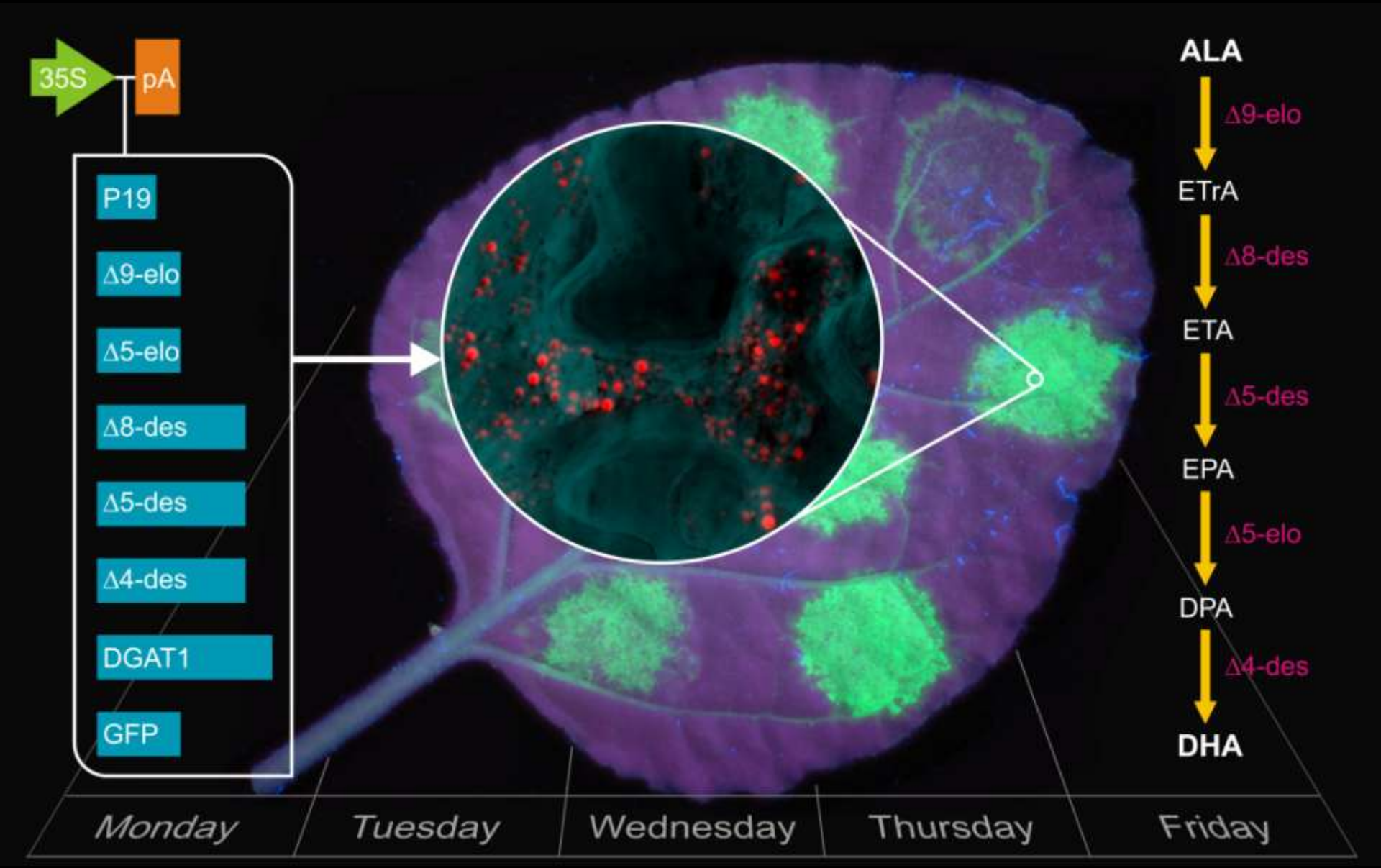
Δ6-elo ↓ 20:4, ETA — *Pyramimonas cordata* Marine Biotechnol. 4:430-438

Δ5-des ↓ 20:5, EPA — *Pavlova salina* Phytochem. 6:785-796

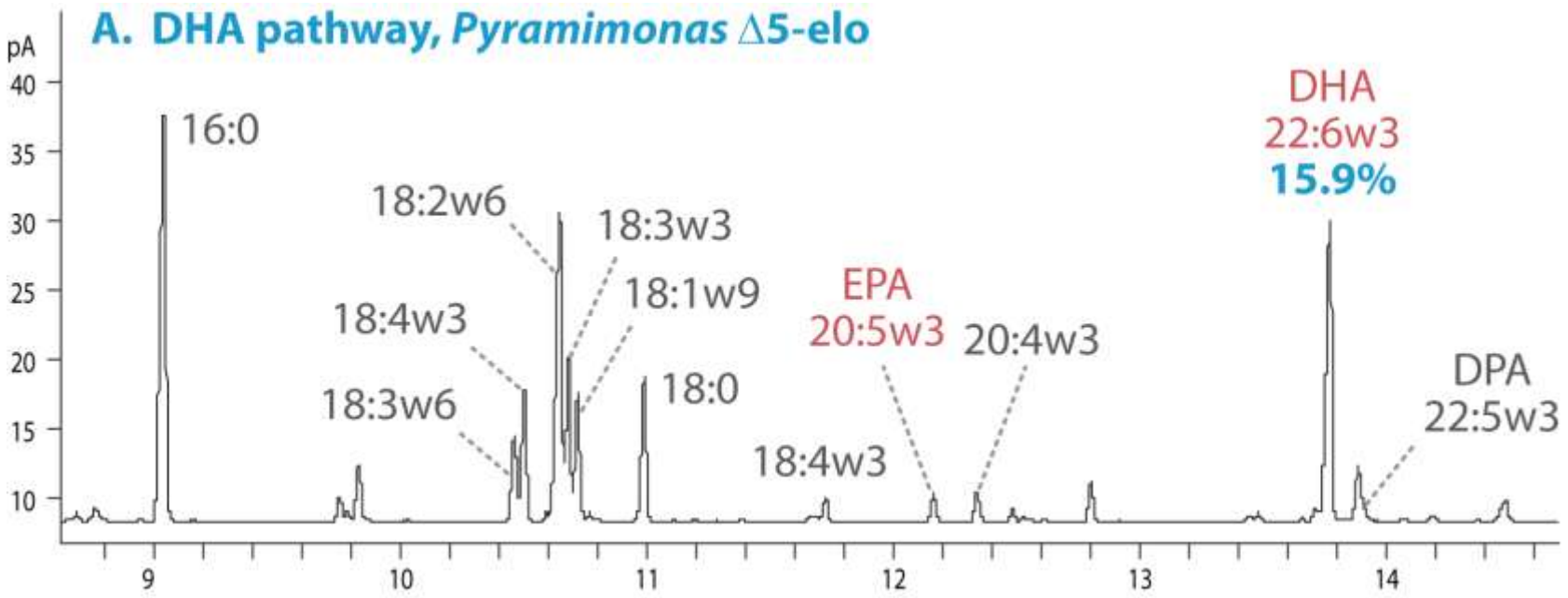
Δ5-elo ↓ 22:5, DPA — *Pyramimonas cordata* Marine Biotechnol. 4:430-438

Δ4-des ↓ 22:6, DHA — *Pavlova salina* Phytochem. 6:785-796

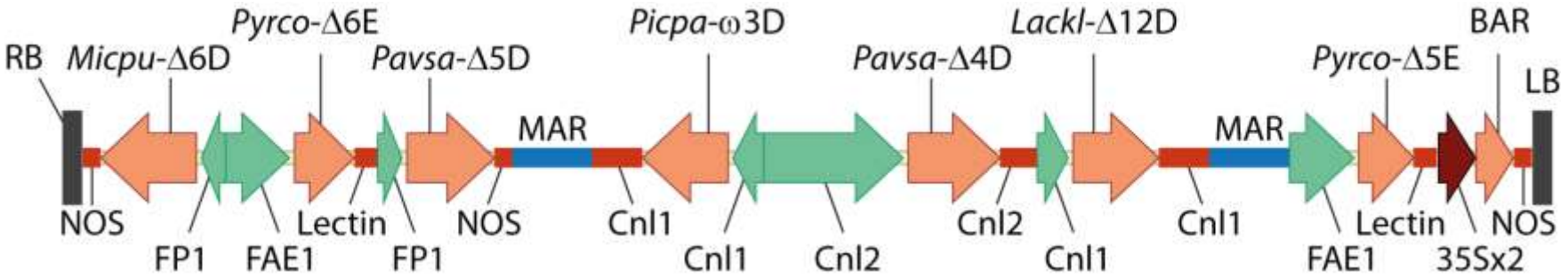
Finding the right combination: benth testing



Testing gene combinations in leaf



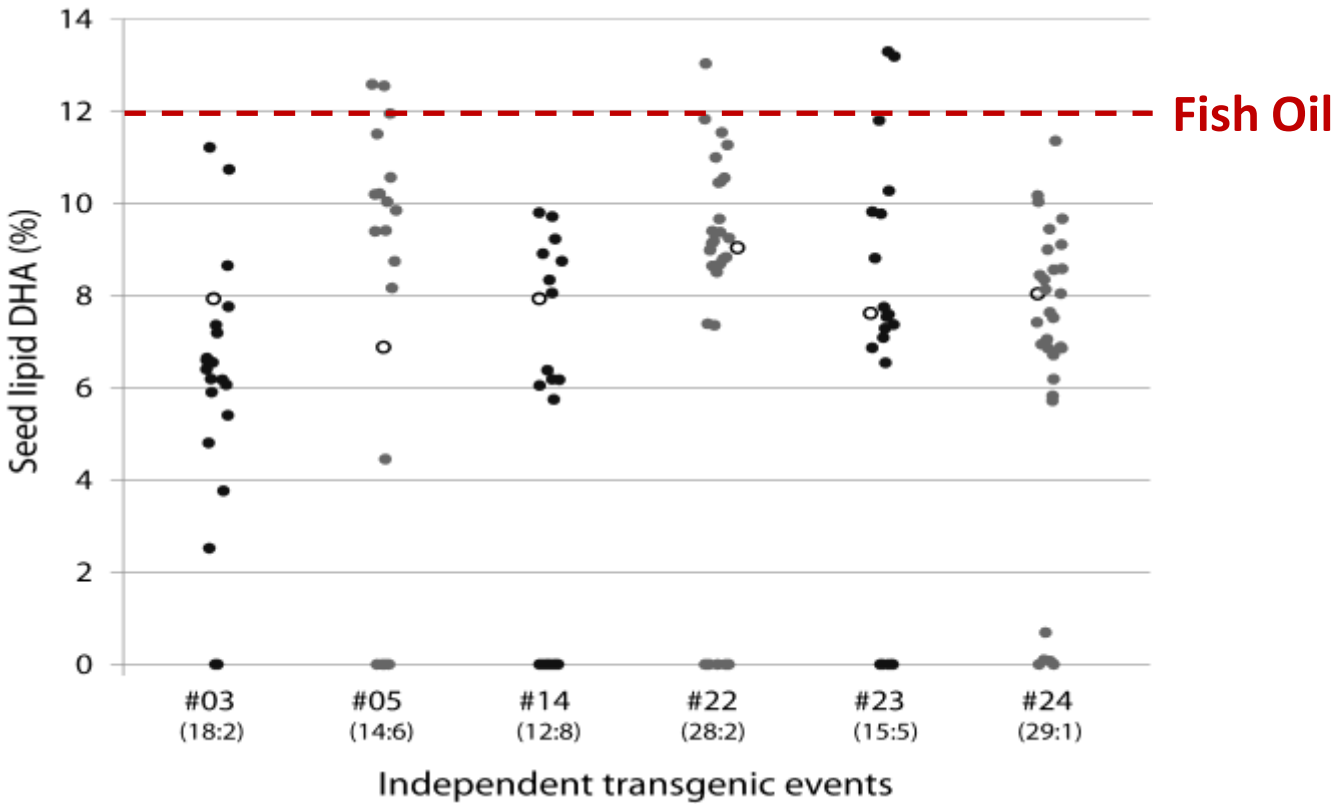
Stable, multi-gene construct design



Elements

- FP1: *B. napus* truncated napin
- FAE1: *A. thaliana* Fatty Acid Elongase 1
- Cnl1, Cnl2: *L. usitatissimum* conlinins
- MAR: Matrix attachment regions from *Nicotiana tabacum*
- TMV transcriptional leader as 5’ UTRs

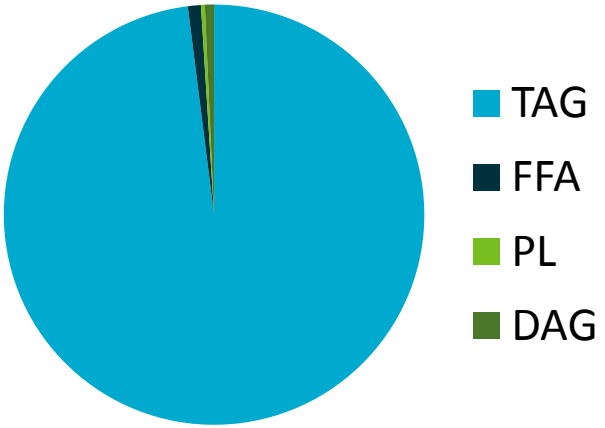
DHA production in Camelina seed (T2 seed)



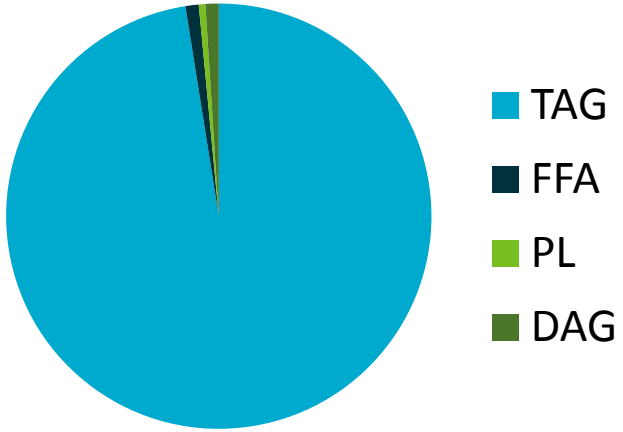
Pooled T5 seed profile

ALA	SDA	ARA	EPA	DPA	DHA
26.1	**2.8**	0.03	**2.5**	**1.3**	**12.5**

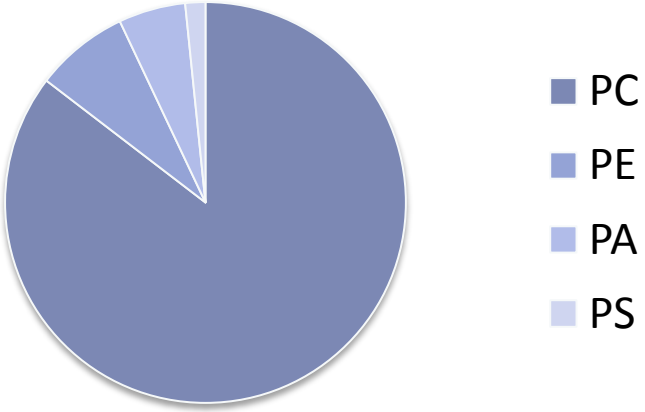
Lipid class composition:
Control seed



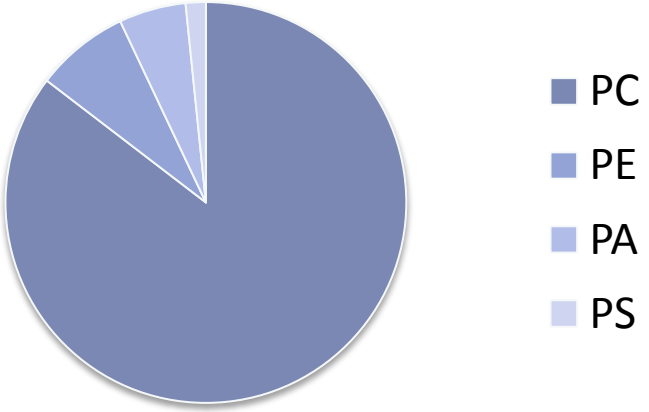
Lipid class composition:
DHA seed



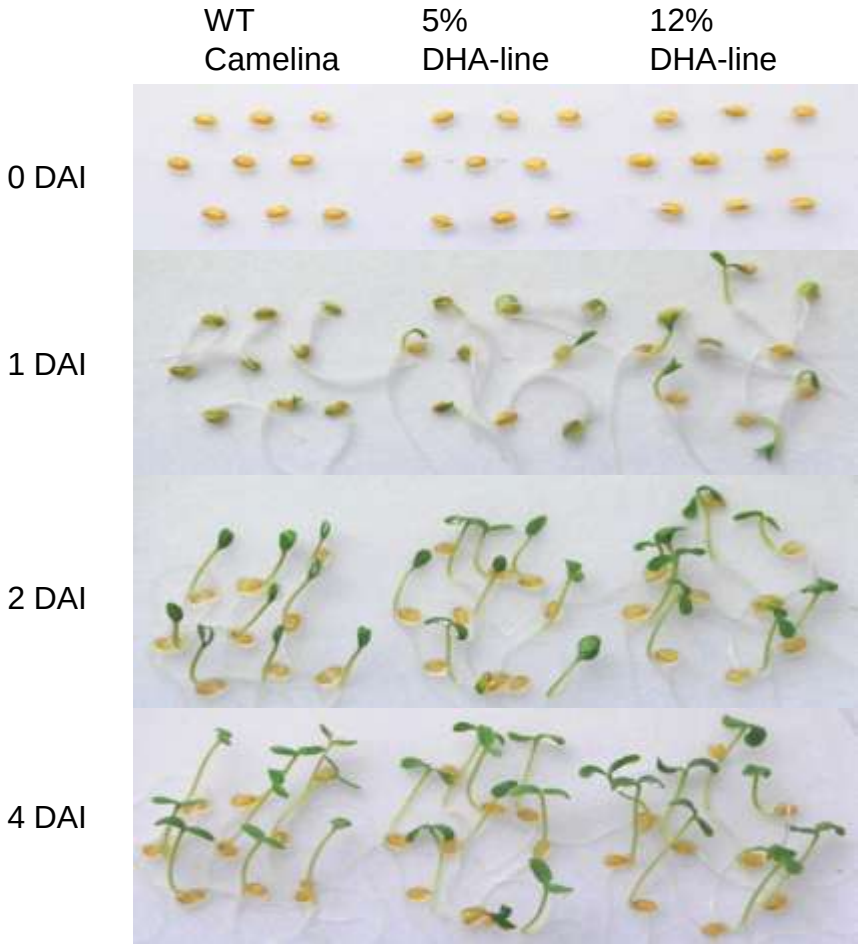
PL class composition:
Control seed



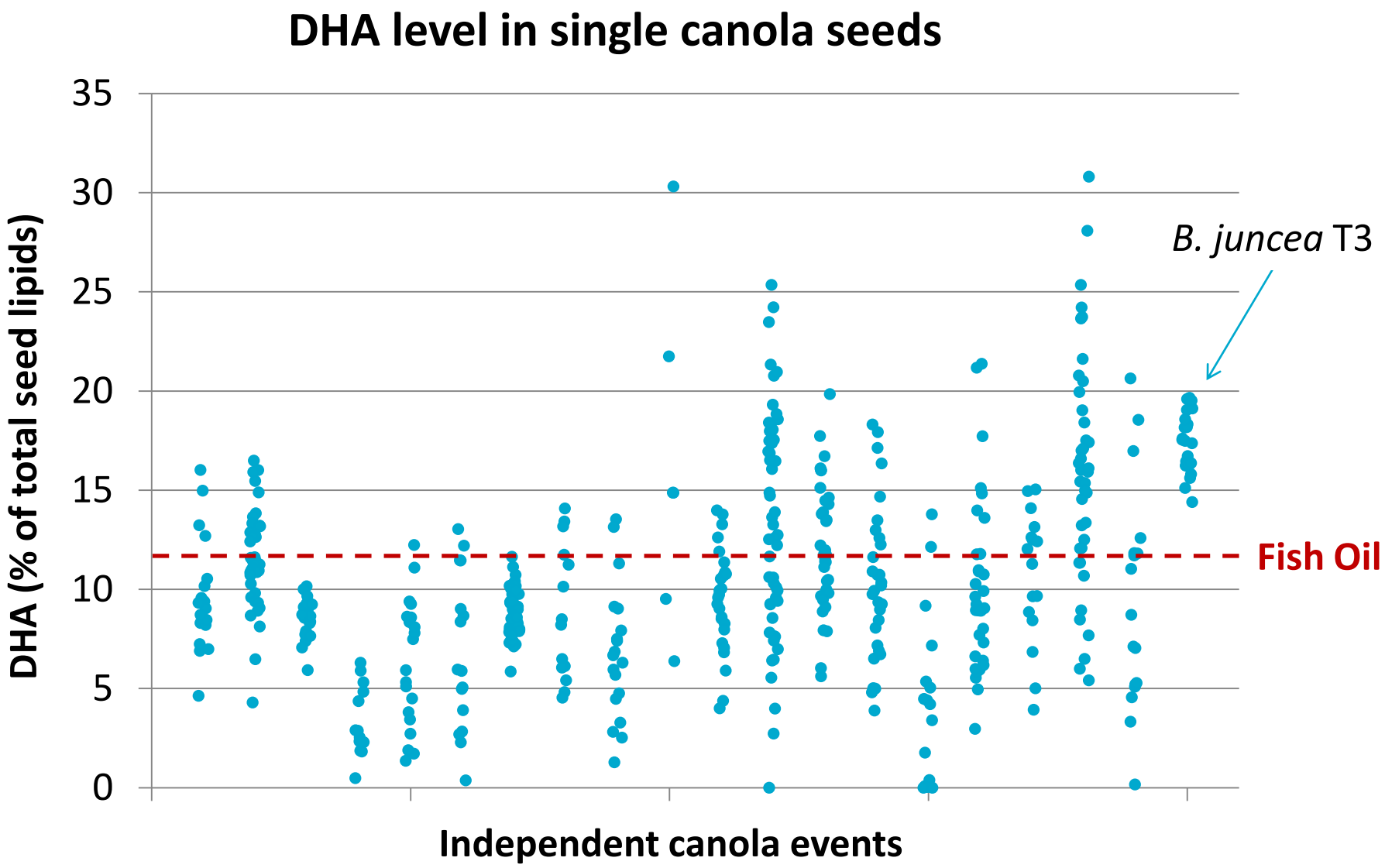
PL class composition:
DHA seed



Normal germination of DHA Camelina seed



Does it work in canola?



Field trials in Horsham

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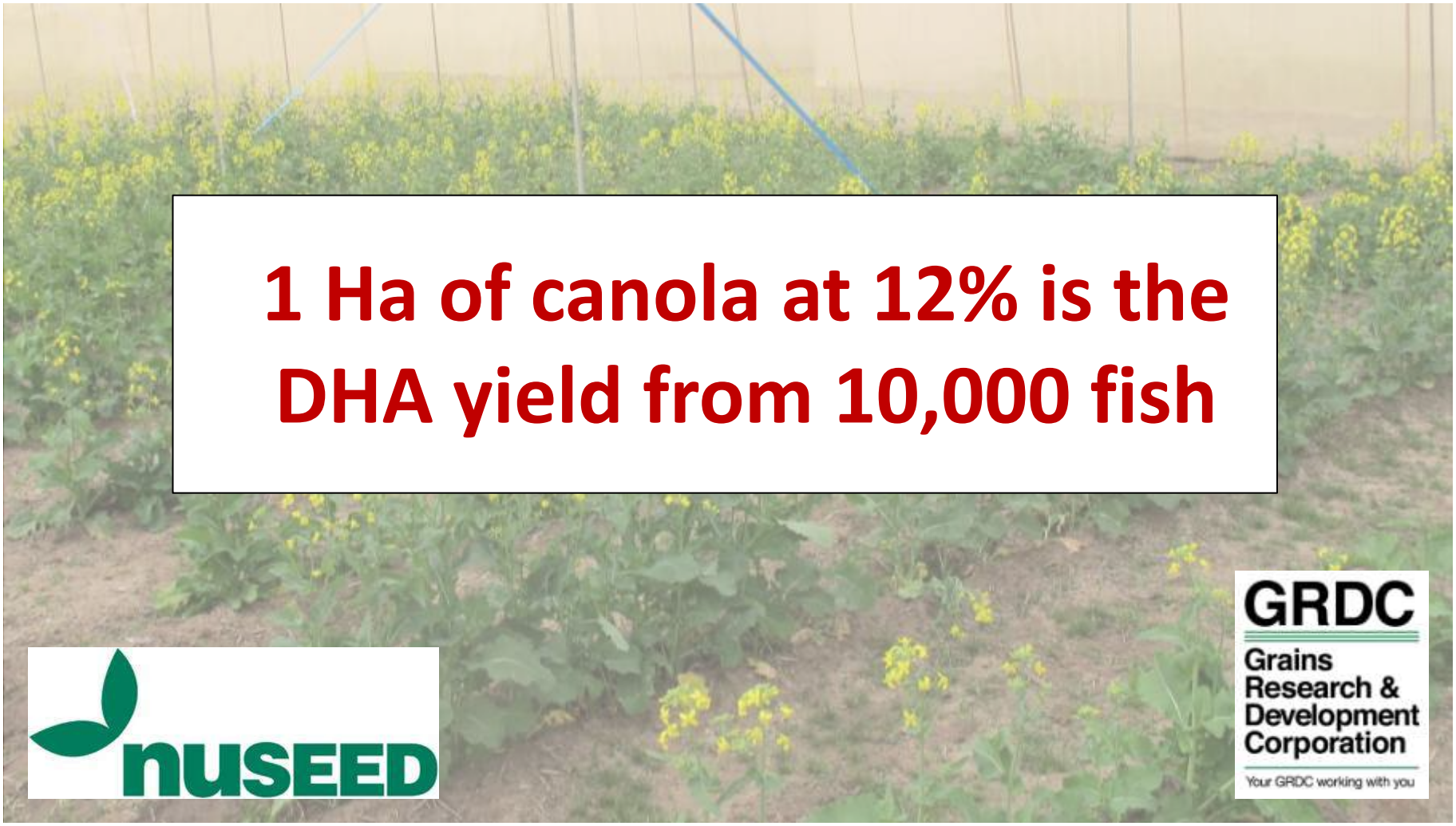

Thank you

CSIRO Omega-3 Team