Influence of the photothermal quotient in the critical period on yield potential of Canola

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Benchmarking Canola Potential Yield

under best practice water and climate are the only factors limiting yield

Water limited yield potential (W_{yp}) = 15 kg/ha/mm seasonal water supply
(best managed hybrids, evaporation > 60mm)
(adapted French and Schulz 1984, *Kirkegaard 2015)

CROPPING

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LOFTY GOAL: Brill Ag's Rohan Brill, Wallendbeen, NSW, hopes the three-year project striving for hyper yielding canola in high rainfall areas will help growers in their quest to grow 5t/ha crops.

Growers & researchers not routinely achieving yields greater than 5t/ha despite water supply exceeding >400mm

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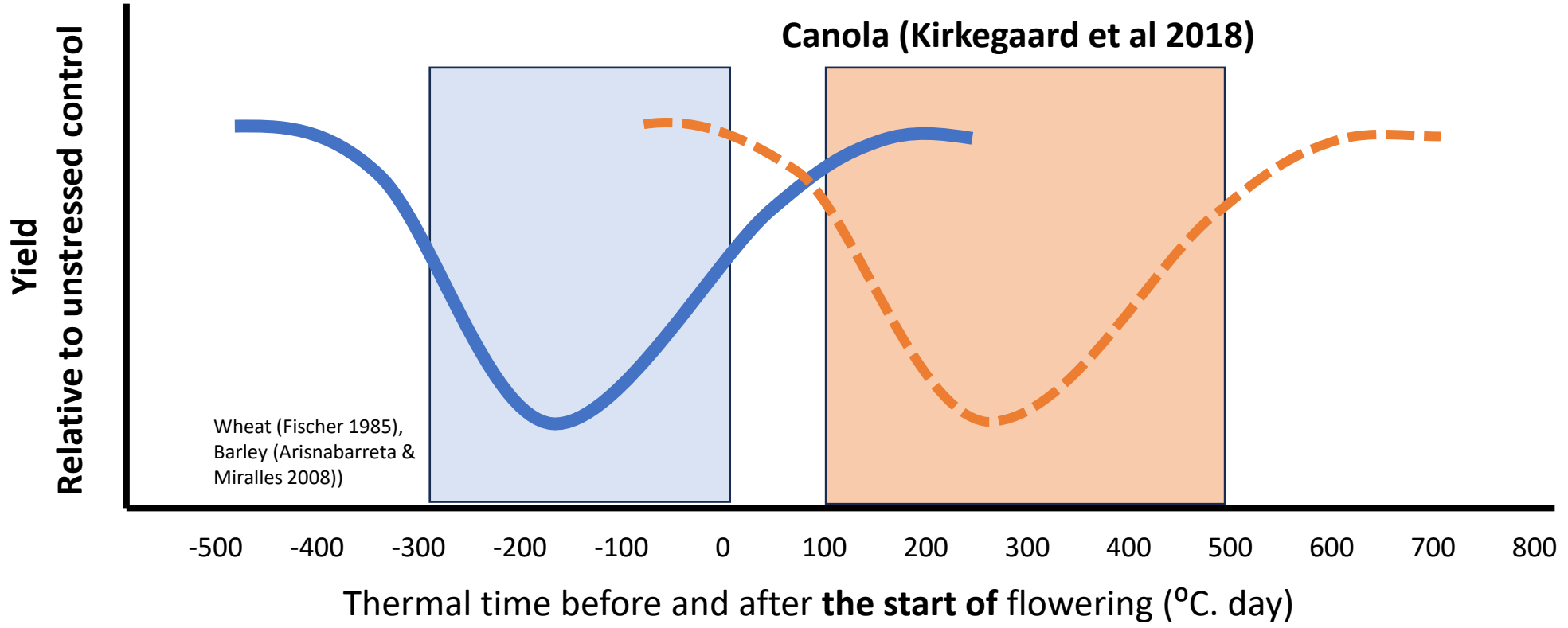
Let’s focus on critical periods – crop yield is not always causally linked to crop life cycle length*

Dual focus on reducing stress (frost, heat, moisture) ie Optimal flowering Periods (Lilley et al 2019) and maximising growth in the critical period (*Slafer et al 2023)

Grain number (yield potential) is defined in a species-specific critical period and is proportional to;

- the rate of growth in the critical period;
- the duration of the critical period,
- reproductive allocation

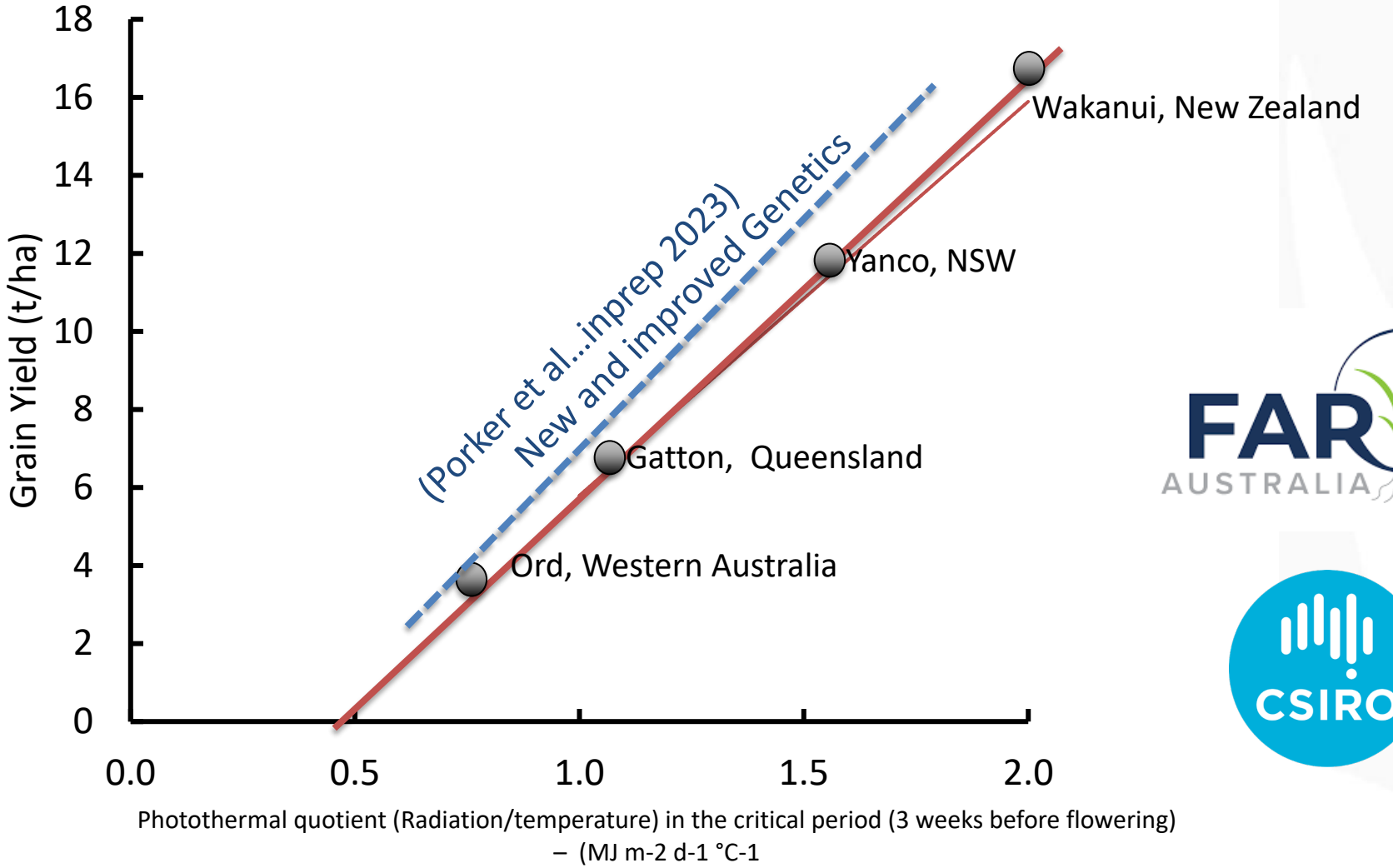
(Slafer et al 2023)



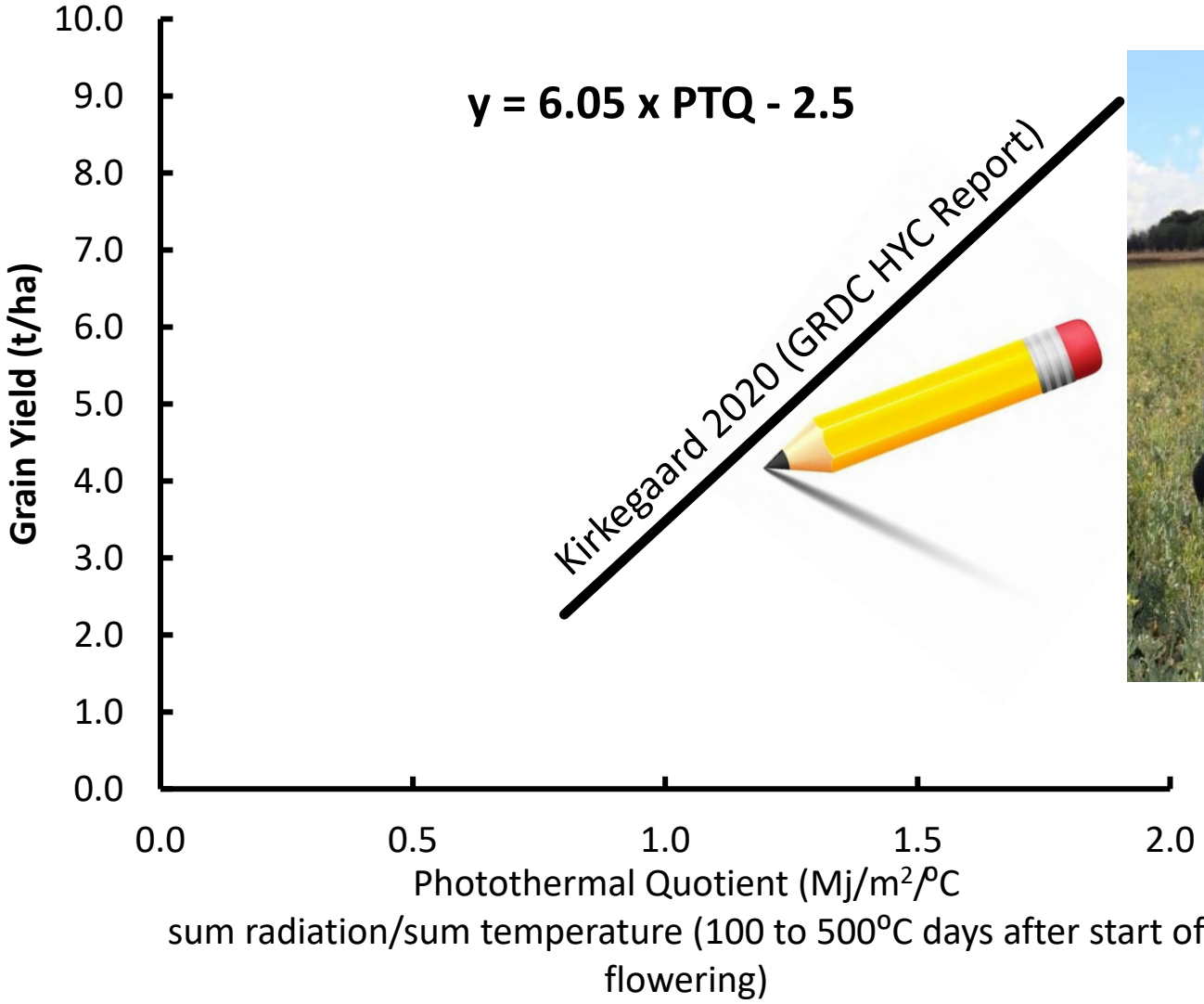
Solar radiation and temperature (PTQ - Photothermal Quotient) in the critical period sets yield potential when water is non limiting in Wheat in absence of other stress (Rawson 1988)

High PTQ = High yield potential

- High light energy maximises photosynthesis
- Cool temperatures slow development and increases phase length



The proposed relationship between potential yield and PTQ in the critical period for canola based on 60% of wheat.



Glucose equivalents

(Penning de Vries et al., 1974)
(Hocking et al., 1997)

Comparative yields

- *60% (Holland et al., 1999)*
- *WUE equations*
- *50% of wheat in non-water limited environments (GRDC Hyper-yielding 2020 – 22)*

How do the world record holders and best managed ‘non water limited’ trials stack up?

GRDC Hyper-yielding crops
2020 – 2022 (3.8 – 6.8t/ha)

Optimised Canola Profitability 2016 – 2018 (3.8 – 5.6t/ha)

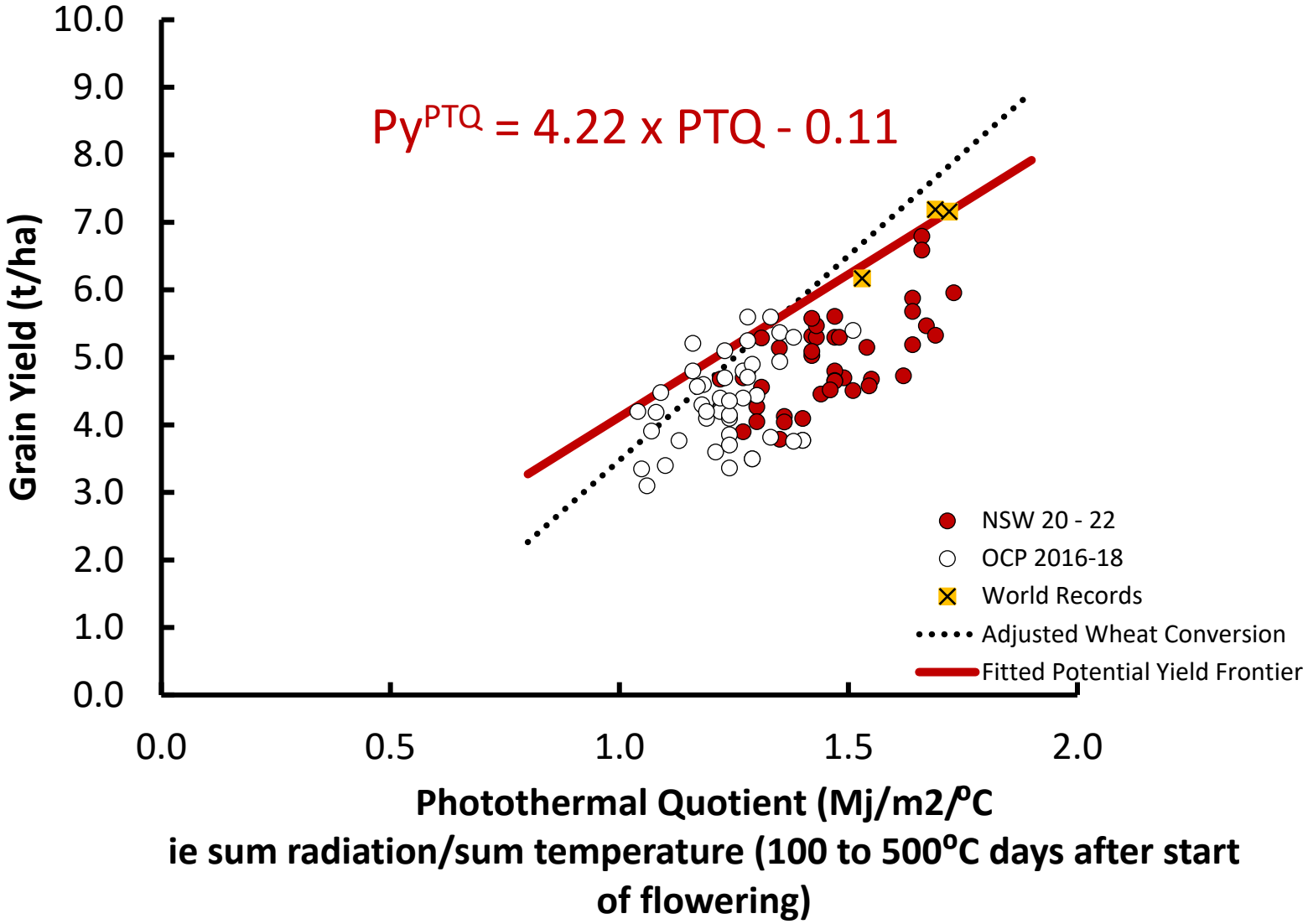
Other data….

Richard Budd, Kent UK 2018 7.19t/ha*

Michael Nicolls 2016
Sisters Creek, TAS 6.14 t/ha

Peter Brooks
Princess Pastoral Co.
Oberon NSW
7.16t/ha

PTQ is a robust estimation of potential yield from high yielding Australian experiments (n= 122, >30 environments)



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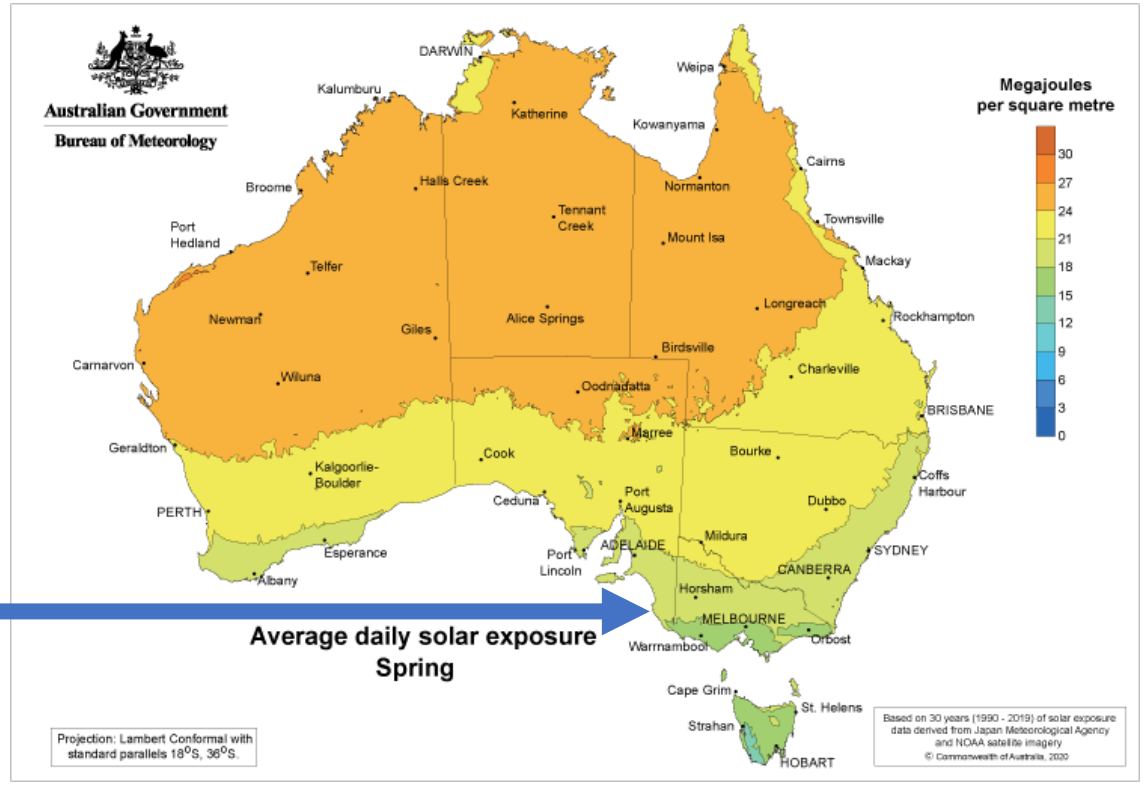
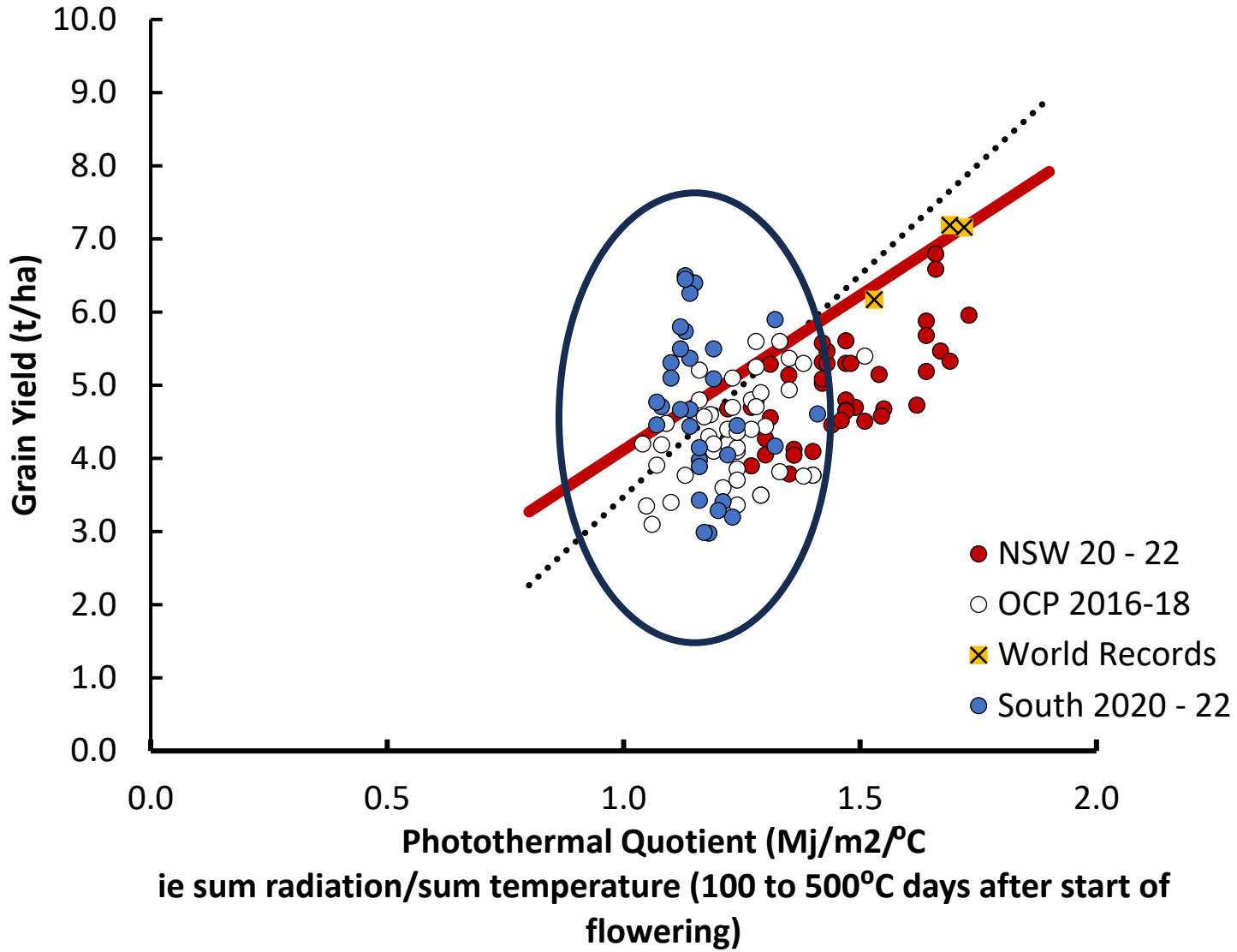
Strange things happen when you move south

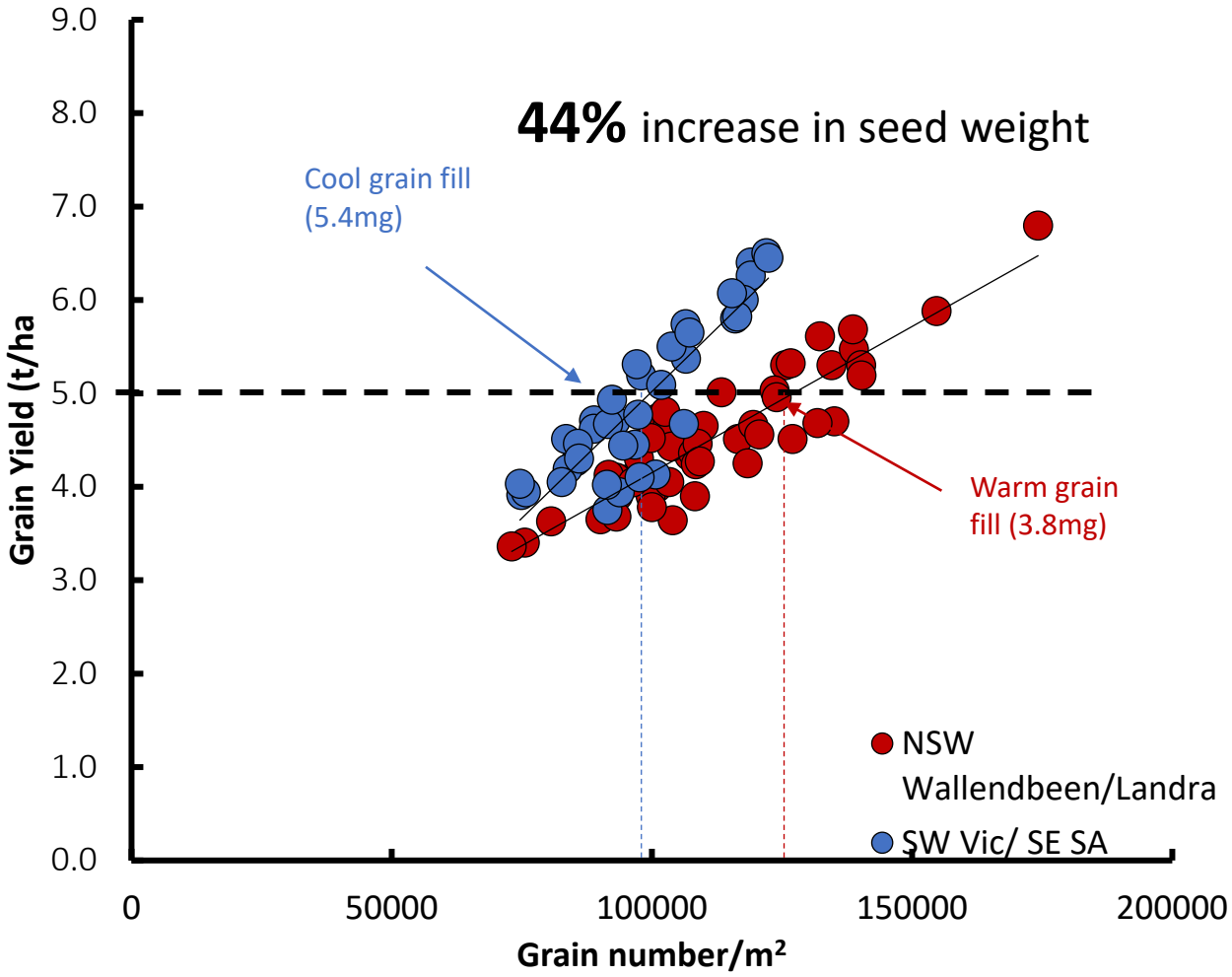
Lower spring solar radiation, and lower PTQ in critical period despite lower temperatures



Higher yields were being achieved in the southern high rainfall zones despite low PTQ



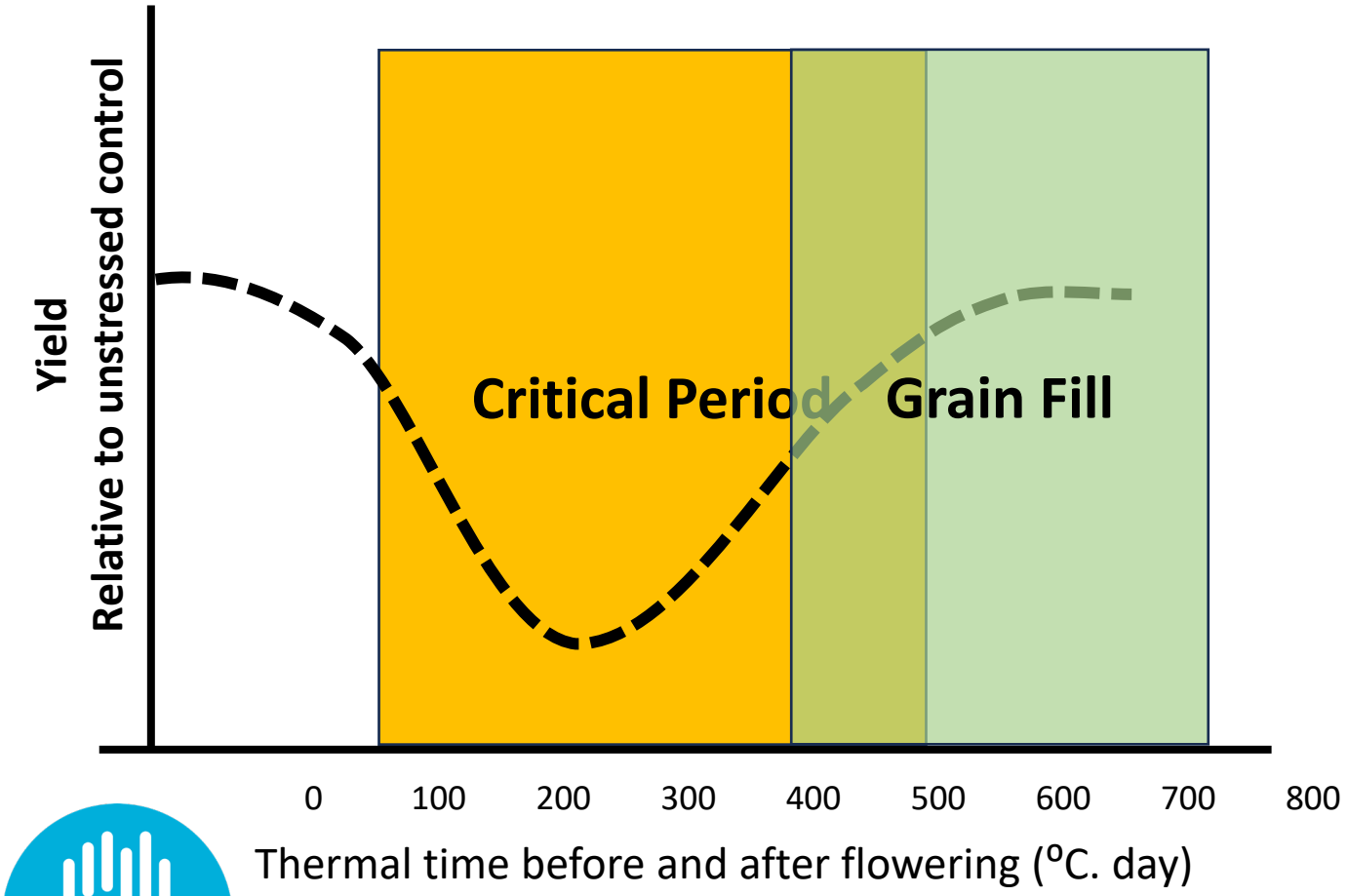
Canola can compensate for low grain number (from low PTQ in the critical period) in favourable grain filling environments

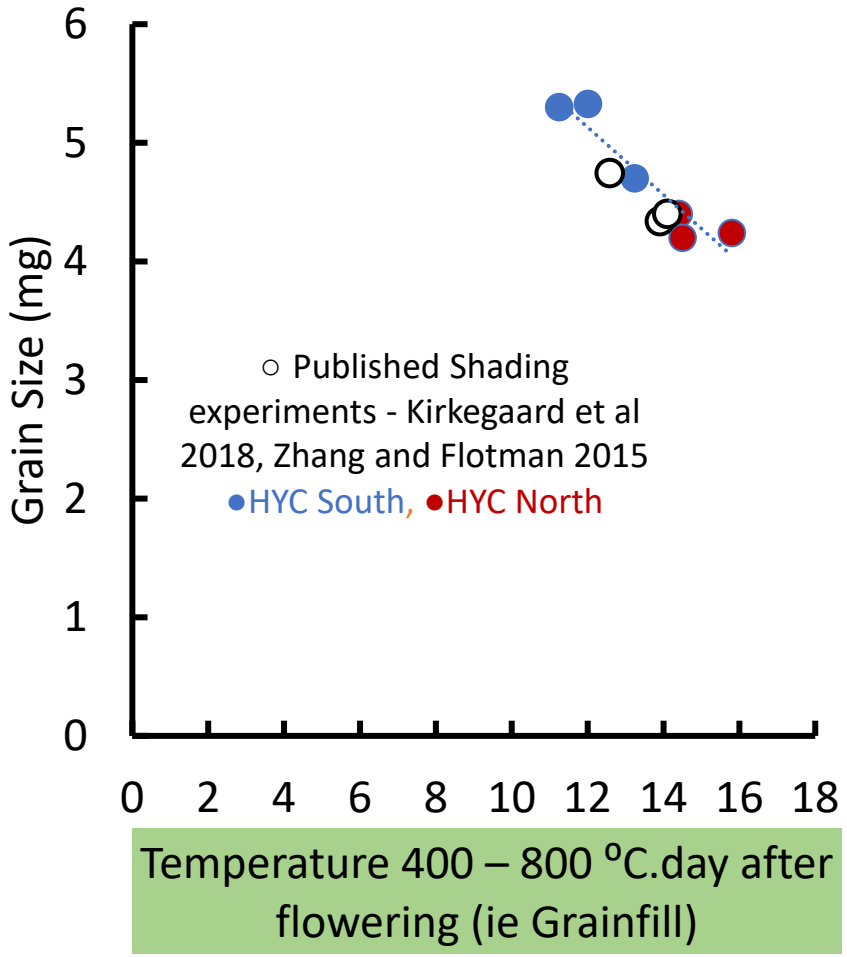


Shading experiments that reduced grain number had a - **3%, 29%, or 61**% increase in seed weight

Zhang and Flottmann (2015), Kirkegaard et al. (2018) and Labra et al. (2017),

Temperatures (VPD and water?) during grain-fill influences capacity to compensate for lower grain number from low PTQ during critical period?





Summary

- PTQ in the critical period is a reliable estimate of yield potential in most non water limiting environments
- Canola can compensate for low grain number from lower PTQ in milder environments (mechanisms?)- high source/sink relationships post flowering
- No apparent trade-off between GN and GW in some environments = avenue for raising yield frontier.
- Increasing yield frontier will require new focus on efficiencies in critical period and post critical period

Thank you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- Pre 2016 (JK data) Did not include n =
- OCP 2016 (Wet Season), Leeton and Finley Irrigation 2018 n =
- NSW DATA HYC Wallendbeen, Gnarwarre, WA, Landra, Millicent, (2020 – 2022) n =
- Southern HRZ Data (2020 – 22 Millicent SA, 2020 – 22 Gnarwarre Vic, Cummins 2022) n=
- Commercial world record crops

Low temperatures and high solar radiation (sunnier or longer days) = High PTQ