

Nitrate availability prior to waterlogging drives canola biomass resilience but increases fertilizer-mediated Mn uptake

Haochen Zhao

Tasmanian Institute of Agriculture,
University of Tasmania

UNIVERSITY of TASMANIA

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Waterlogging a global issues on specific soil

Heavy rainfall \uparrow \rightarrow waterlogging

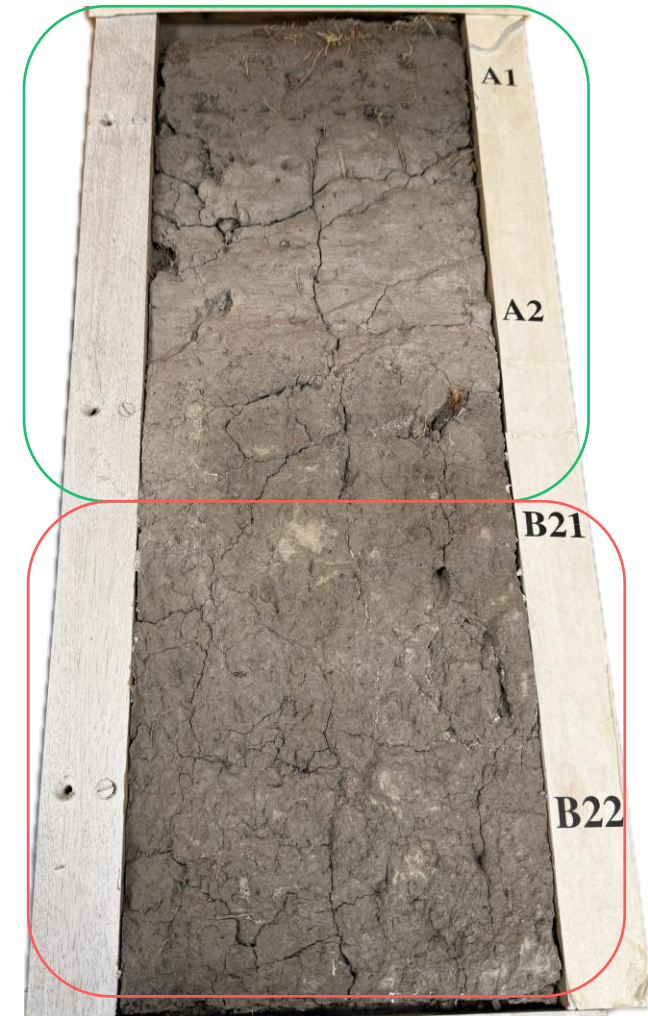
Textural contrast + subsoil permeability \downarrow \rightarrow waterlogging

Common in VIC, SA and WA

Canola expansion \uparrow \rightarrow more vulnerable

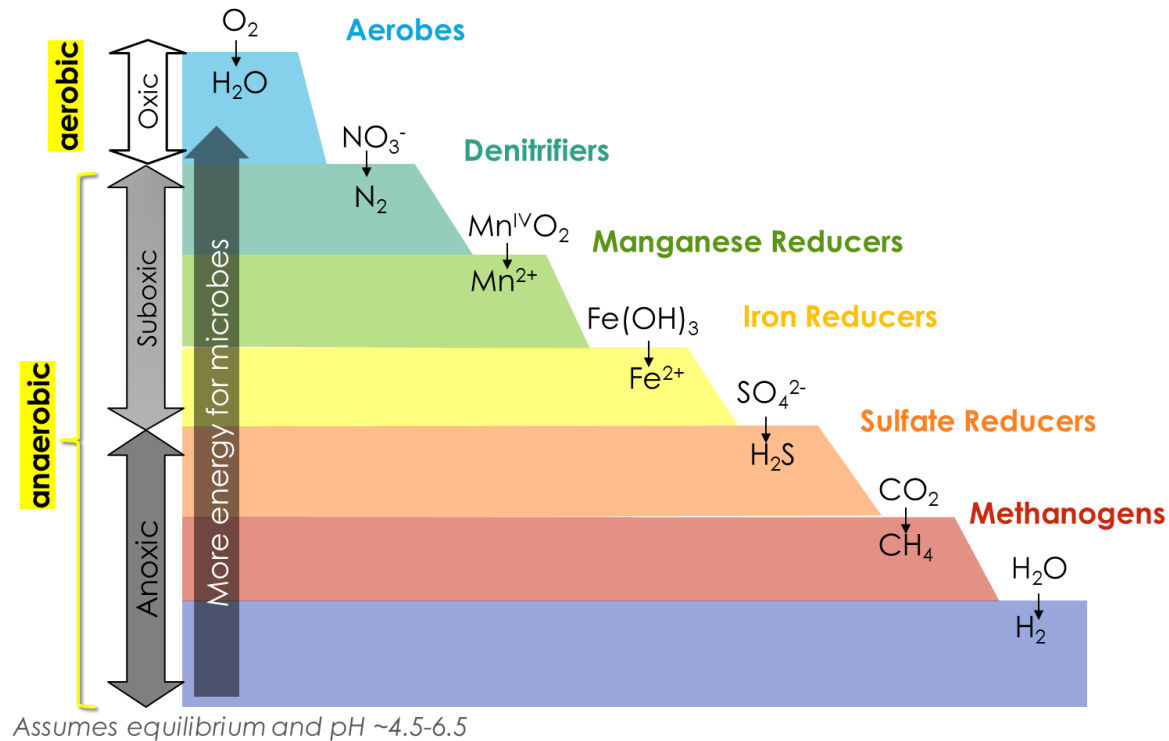
Waterlogging \rightarrow 20% - 70% yield \downarrow

Soil horizons



Texture contrast soil (sandy topsoil on clayey subsoils) Cressy, TAS

Waterlogging effects on soil Eh, metal mobilisation and nitrogen dynamics



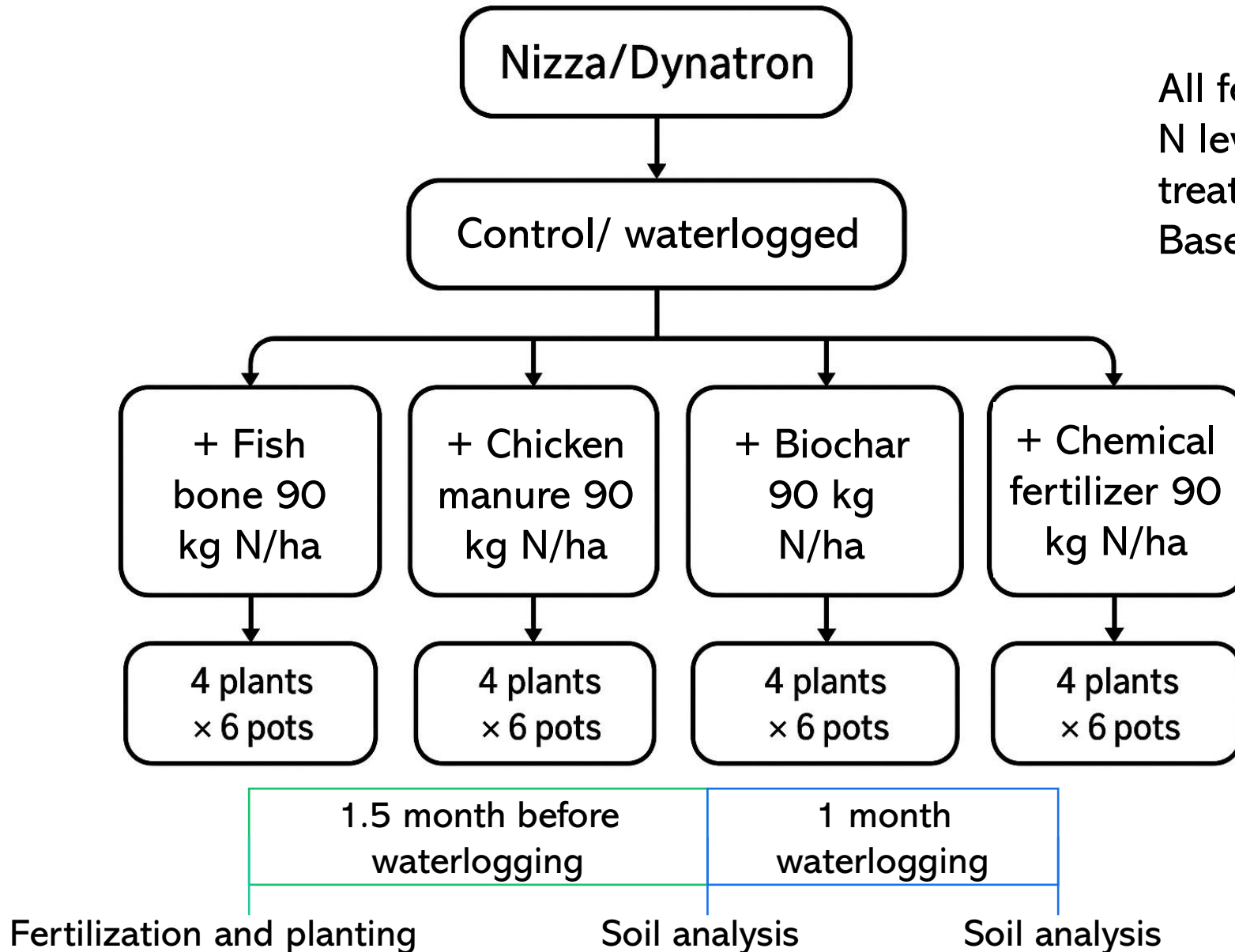
- Waterlogging $Eh \downarrow \rightarrow$ reduced conditions
- Dissolution $\rightarrow Mn(IV) \rightarrow Mn^{2+} \uparrow$ and $Fe(III) \rightarrow Fe^{2+} \uparrow$
- Nitrification $\downarrow \rightarrow$ denitrification $\uparrow \rightarrow NO_3^-$ - N depletion $\rightarrow NH_4^+$ -N relative accumulation
- Denitrification $\rightarrow N_2O \rightarrow N_2$



Chemical vs organic fertilizer

- Chemical N fertilizers (ammonium nitrate, urea) → NO_3^- -N ↑
- Organic fertilizers limit short-term NO_3^- -N
- Organic amendments/fertilizers → NH_4^+ -N or organic forms

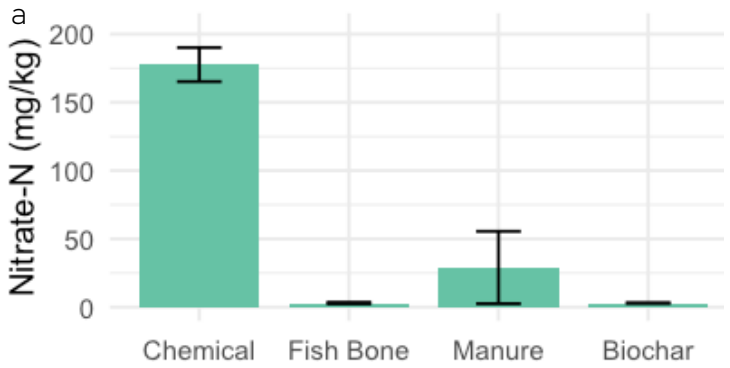
Experiment design



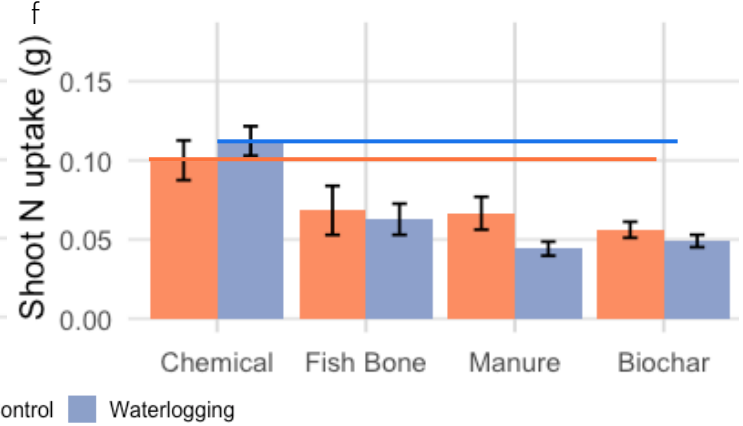
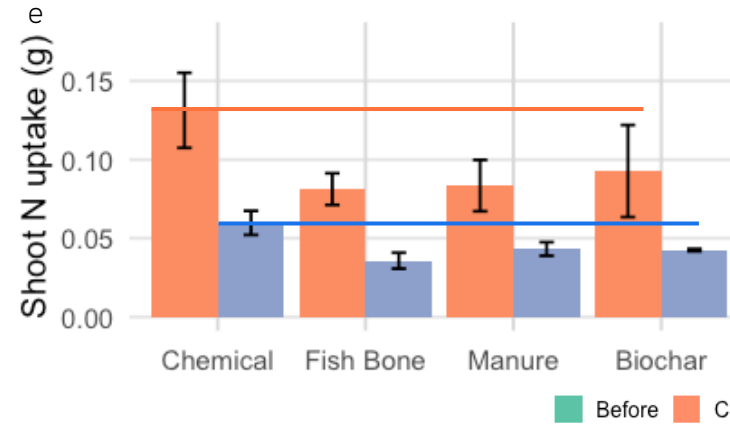
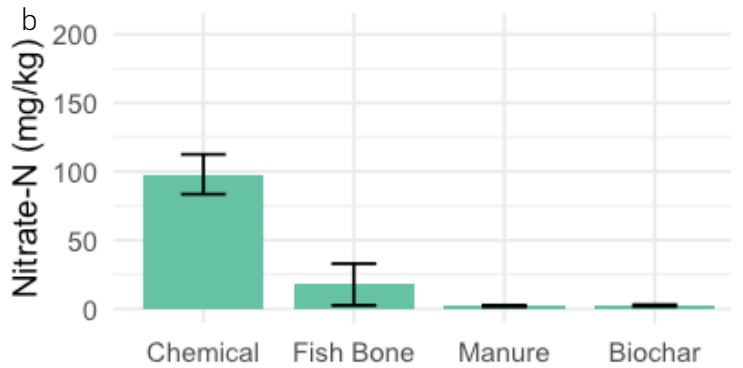
All fertilization have same N level of 150 kg N/ha all treatment have 60 kg N/ha Base.

Chemical fertilizer created higher pre-WL NO_3^- -N than organic fertilizer/amendments

Dynatron



Nizza

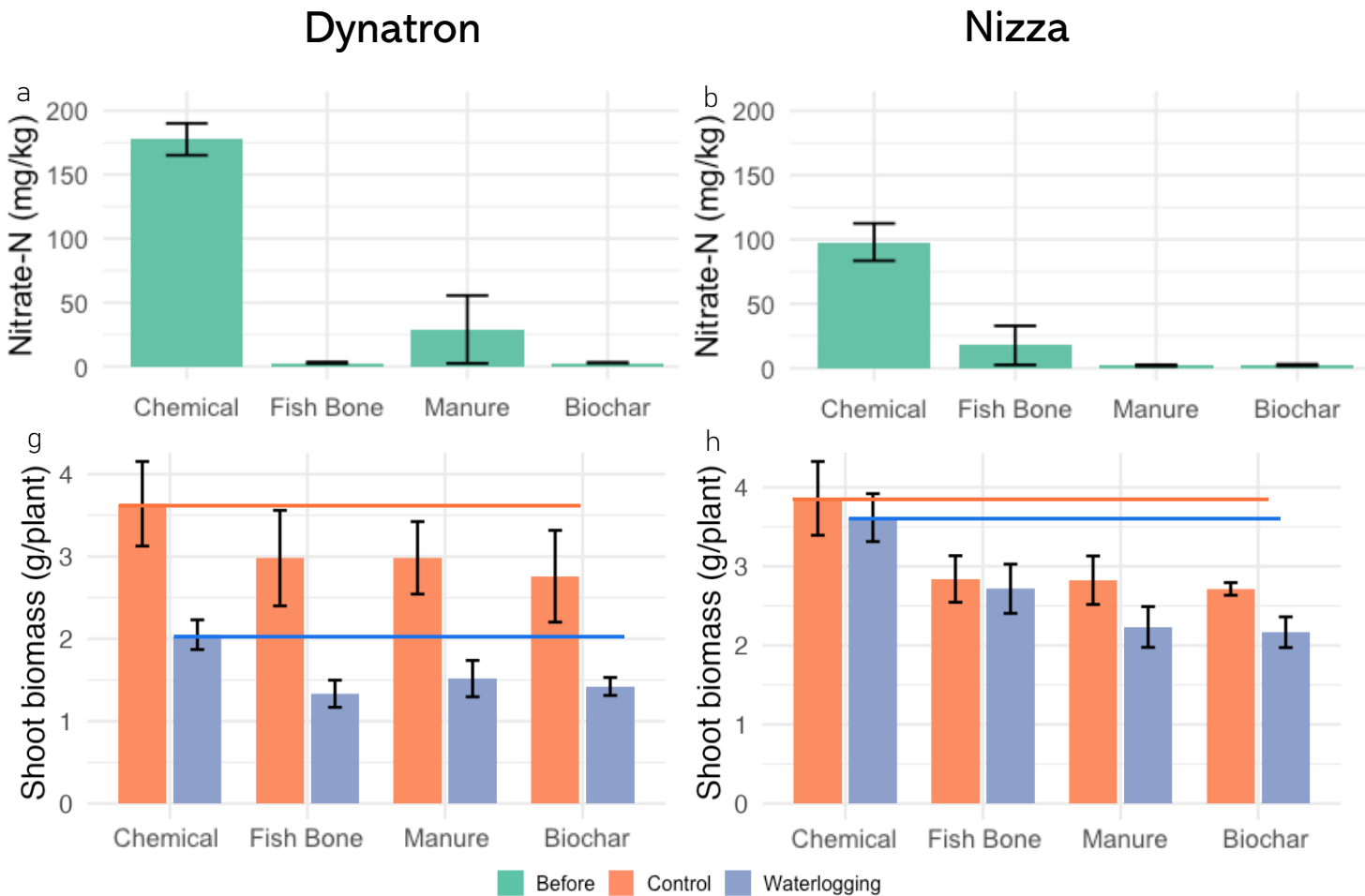


Legend: Before (green), Control (orange), Waterlogging (blue)

- NO_3^- only ~1–5% of total N.
- Only Base increased shoot N by 38–67% (D) and 79–154% (N) under WL.

Compact letter displays reflect Tukey's HSD/Welch's t-tests rankings lowercase = before waterlogging/control, uppercase = waterlogged.

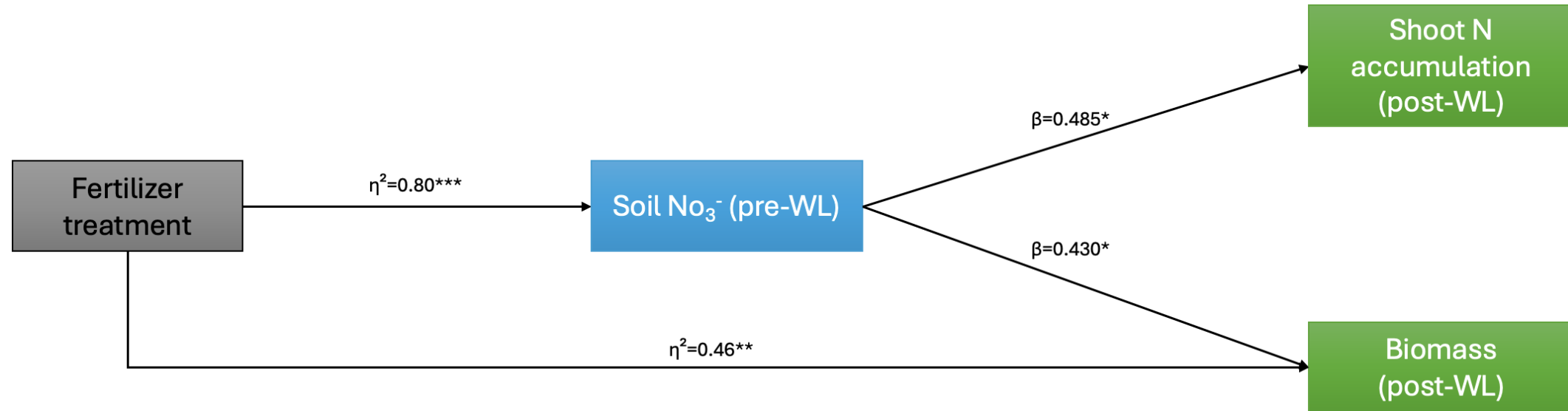
Chemical fertilizer produced higher biomass than organic fertilizer/amendments



• Only base → biomass↑ under WL (15–40% D; 10–20% N)

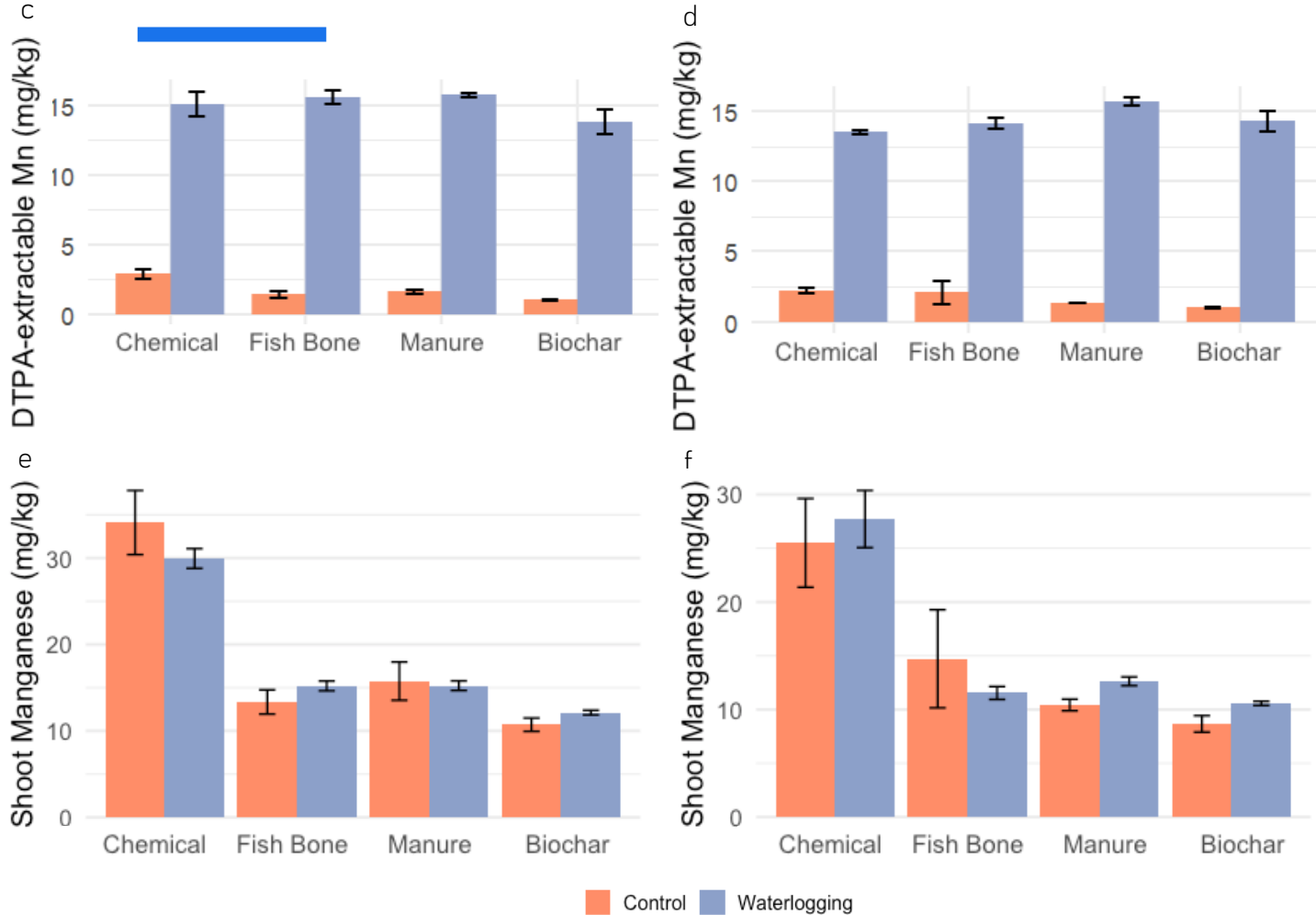
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Chemical fertilizer enhanced pre-WL soil NO_3^- -N drives shoot N and biomass under waterlogging.



- Model explained ~80% of soil NO_3^- -N
- 18–24% of plant trait variance
- Fertilizer \rightarrow biomass ($\eta^2 = 0.46$)
- Key driver: pre-WL soil NO_3^- -N

Soil-Plant decoupling of Mn under waterlogging



- Waterlogging → soil Mn ↑ 5–8 times

- Chemical fertilizer ↑ shoot Mn by 13–20

mg/kg vs organic amendments.

- $\eta^2 = 0.41-0.81$

- Soil Mn raise \neq proportional shoot Mn uptake

Compact letter displays reflect Tukey's HSD/Welch's t-tests rankings lowercase = control, uppercase = waterlogged.



Conclusion

- Chemical fertilization → pre-WL NO_3^- -N → shoot N uptake ↑ and biomass ↑
- Chemical fertilization → Mn uptake ↑
- Management implications:** Before waterlogging NO_3^- -N → canola resilience under prolonged waterlogging.
- Mn risk

Limitation: 1. Short-term pot experiment 2. Lack of long-term assessment



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Questions?

- Haochen.zhao@utas.edu.au