Evaluating super high oleic acid (SHO) safflower in sodic and saline soils

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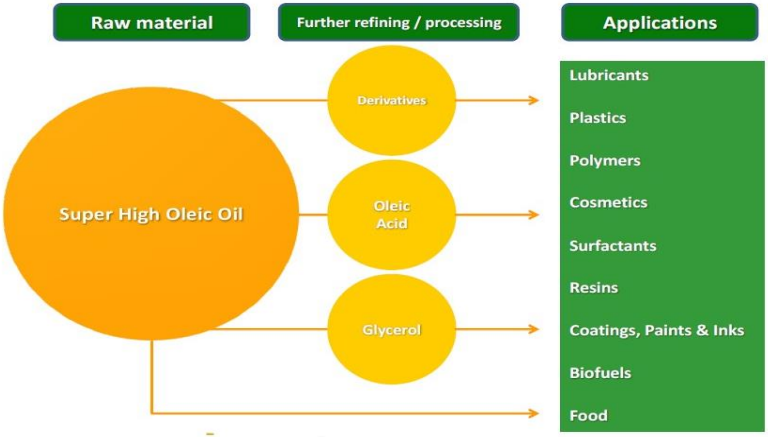
What is safflower?

- Safflower has been grown for oilseed in Australia since the 1950's
- Thistle-like plant can be sown in either winter or spring
- Deep tap root system to access subsoil water and generate biopores
- Rotational break crop for soil disease benefits
- Machinery requirements for safflower production are similar to cereal production
- Sowing area gradually declined as the safflower varieties at the time had poor disease tolerance and low oilseed production levels

Source: http://geisseler.ucdavis.edu/Guidelines/Safflower.html

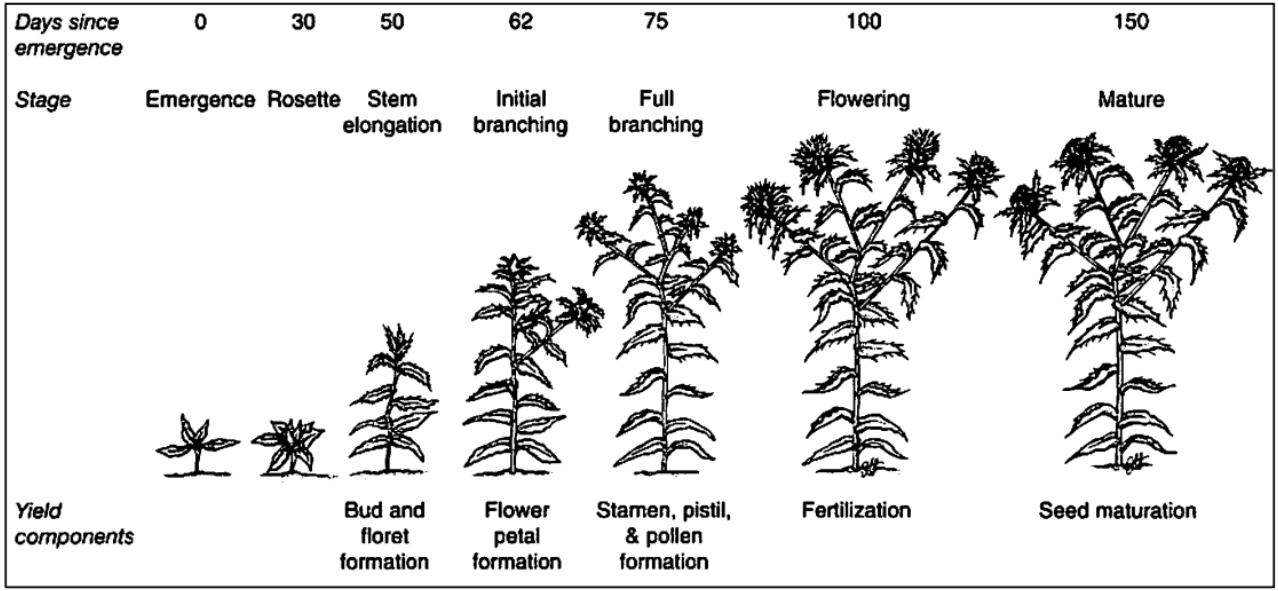
What is SHO safflower?

- Super high oleic acid (SHO) safflower cultivar (E40-R) with oil containing 92% oleic acid
- Developed by CSIRO and GRDC and licensed to GO Resources
    - Gene silencing of two safflower lipid biosynthetic genes, *FAD2.2* and *FATB* to develop plants that have over 92% oleic acid levels
- Super high oleic oil is a raw material for the production of bio-lubricants, bioplastics, cosmetics and pharmaceuticals
- Oleic acid has desirable thermal properties as an ***alternative plant-based, high grade, reusable, and biodegradable biofuel***
- First commercial planting was in 2019



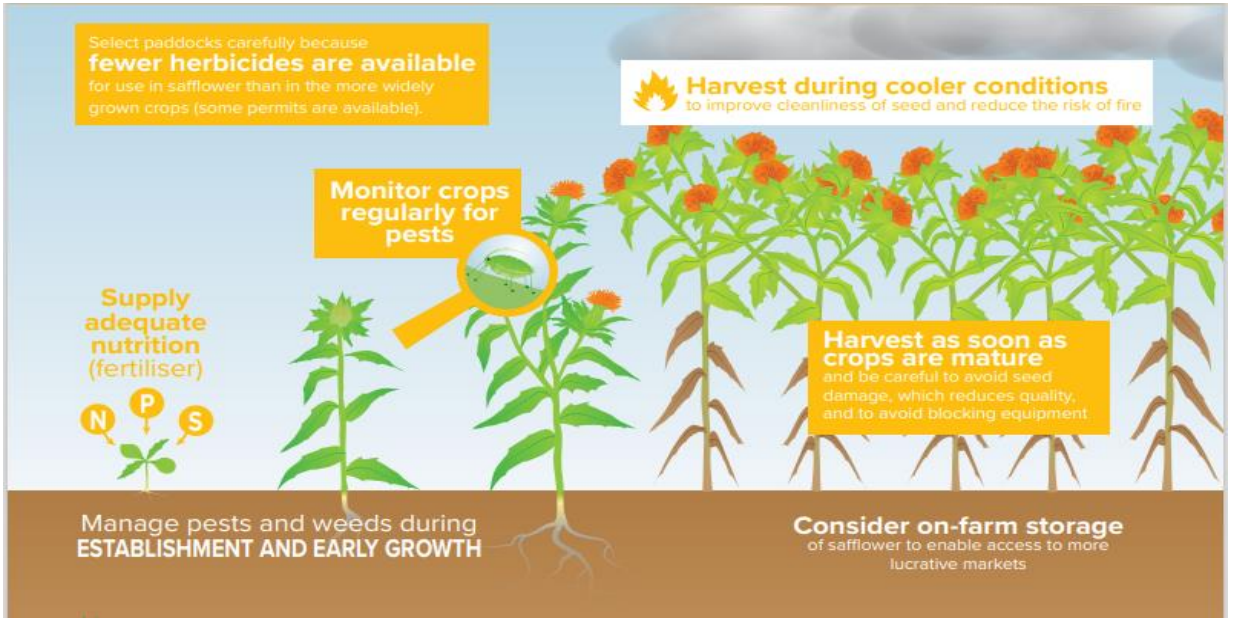
Growth stages of safflower

~26-31 weeks from emergence to harvest maturity



Stages of Safflower Development (Kaffka and Kearney 1998 UC ANR Publ. 21565)

Key considerations for growing safflower



- 20-30 kg N/ha at sowing, 12-20 kg P/ha for low P soils
- Pests: birds, aphids, cutworm, moths/caterpillars, redlegged earth mites, blue oat mite, thrips
- Weeds: broadleaf control of weeds is difficult with limited herbicides.
- Diseases: Phytophthora root rot, Alternaria blight, some rusts and leaf spot, grey mould
- Sowing: June-July in SA but suggesting earlier may be suitable (30-40 plants/m^2 , 2-5 cm depth)
- Yield: 1-1.5 t/ha but increasing with new breeding efforts (2-3 t/ha under irrigation)

GRDC GrowNotes 'Safflowers'

SAGIT Project S-UA921

Evaluating super high oleic acid safflower in sodic and saline soils

Project Aims:

1. To evaluate and demonstrate the role of safflower (including SHO lines) in saline soils

2. To conduct a pilot experiment to determine the level of tolerance of safflower lines to sodic soils

SA Grain Industry Blueprint

→ Generate a tenfold increase in the production of specialty oils in SA, such as safflower, hemp and linseed (from about 2,000 tonnes to 20,000 tonnes)

→ Support the development of other non-canola, high-value or niche oilseeds

SAGIT

Government of South Australia
Department of Primary Industries and Regions

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Aim 1: To evaluate and demonstrate the role of safflower (including SHO lines) in saline soils

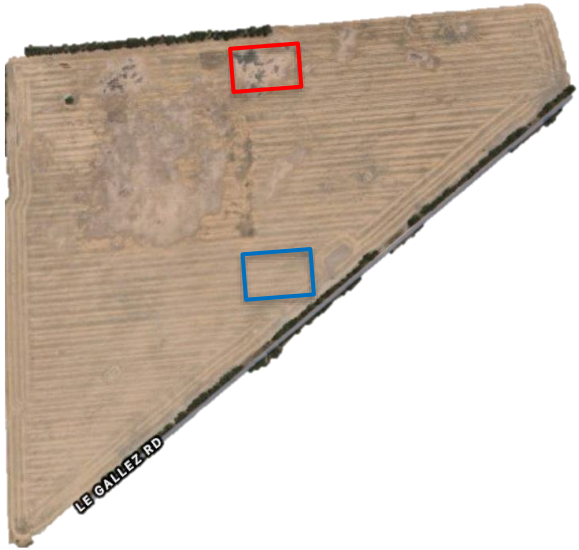
Field trials conducted at Coomandook, SA

2021
- Sown 1st of June 2021

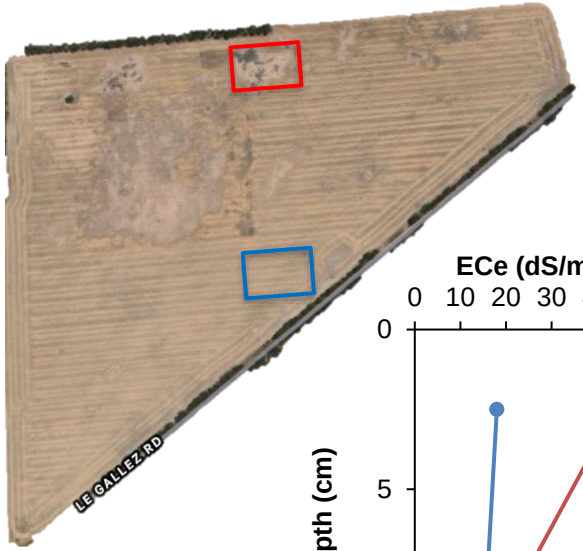
2022
- Sown 16th of June 2022 (shortly after rain event)

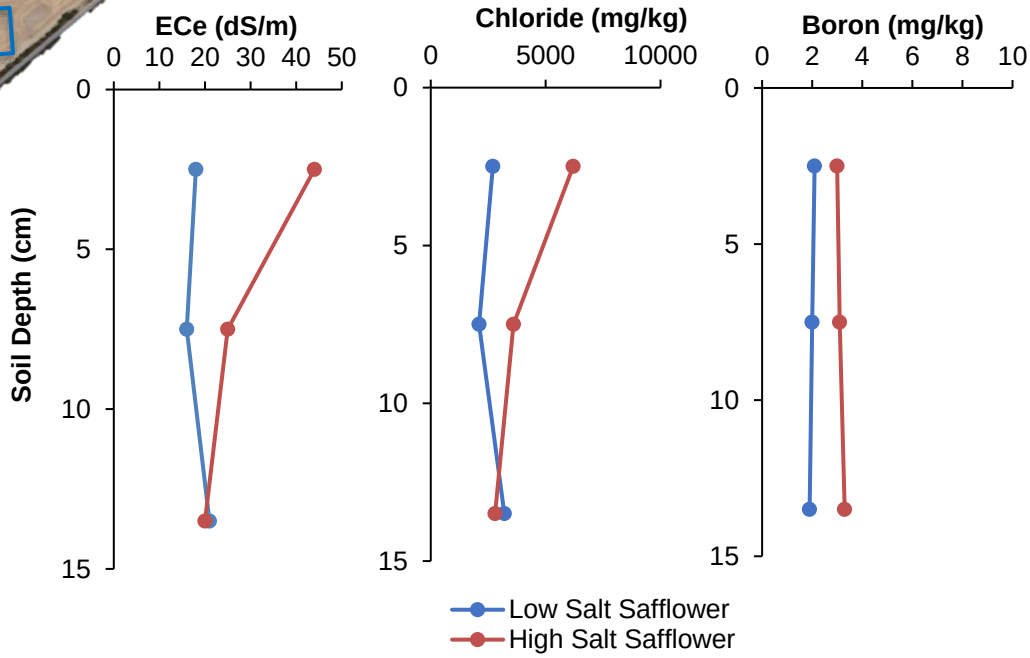
Design
- 4 reps in low salt, 3 reps in high salt site
- 10 safflower lines (low salt)
- 7 safflower lines (high salt)

Measurements
- Soil site characterisation
- Establishment and early vigour
- Leaf nutrient concentrations
- Shoot biomass
- Grain yield
- Oil quality (underway)

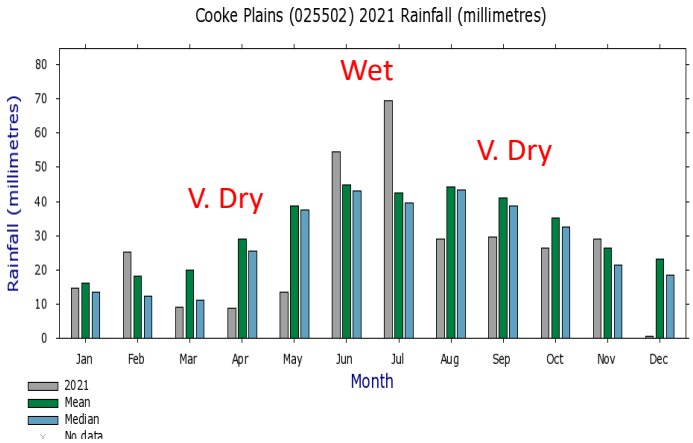


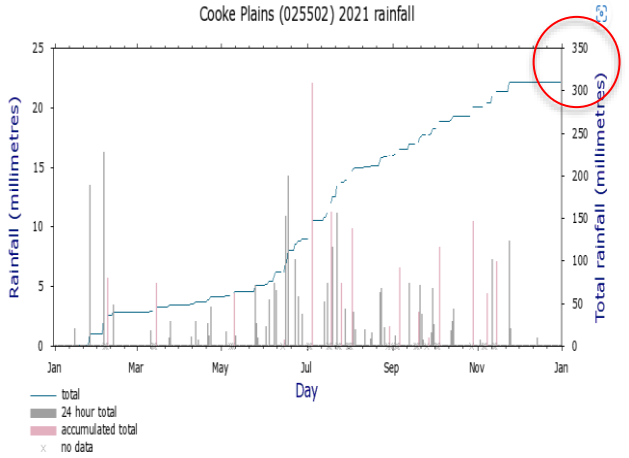
Soil salinity an issue at both low and high salinity sites

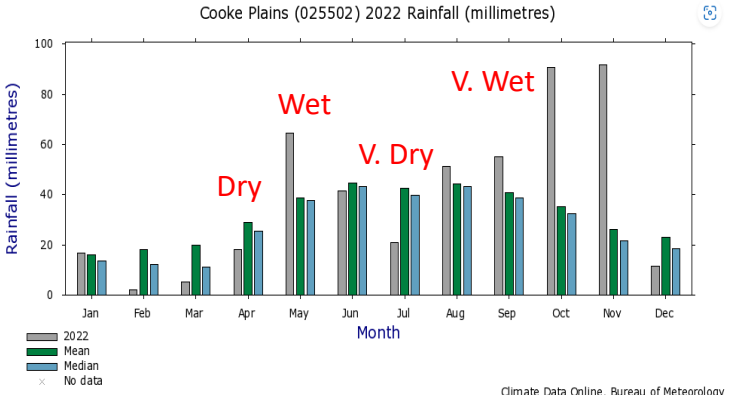




Two very different growing seasons in 2021 and 2022







Note: Data may not have completed quality control

Product Code: IDCJAC0009

Climate Data Online, Bureau of Meteorology
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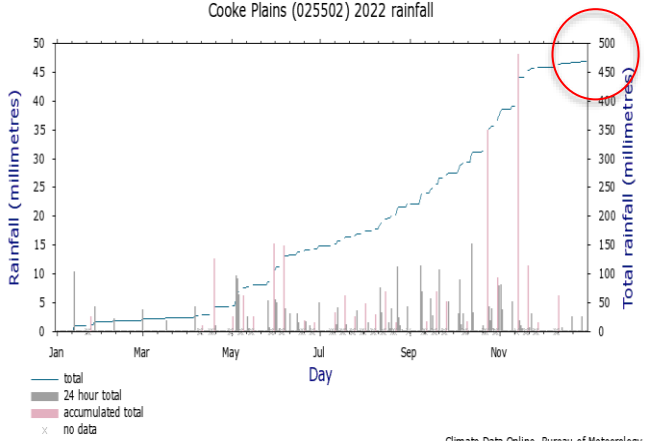


2021 = Safflower does not always grow well in saline soils

Low salt safflower trial
Coomandook SA, 2021

High salt safflower trial
Coomandook SA, 2021

→ Need to be careful to have sufficient soil moisture for safflower in saline soils

2022 = Safflower can grow well in saline soils*

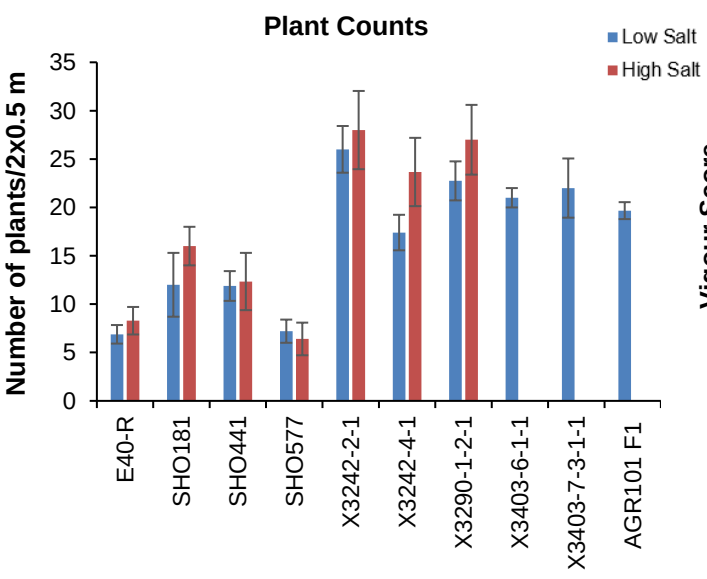
*with sufficient soil moisture

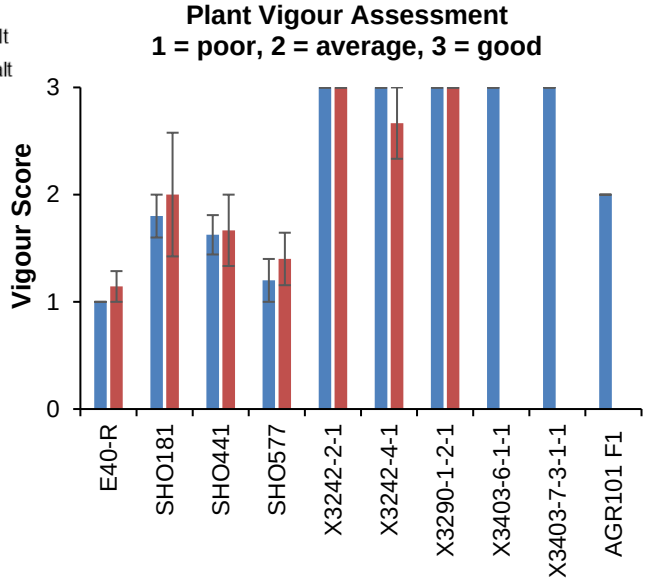
*choose the variety carefully

Low salt and high salt safflower trial
Coomandook SA, 2022

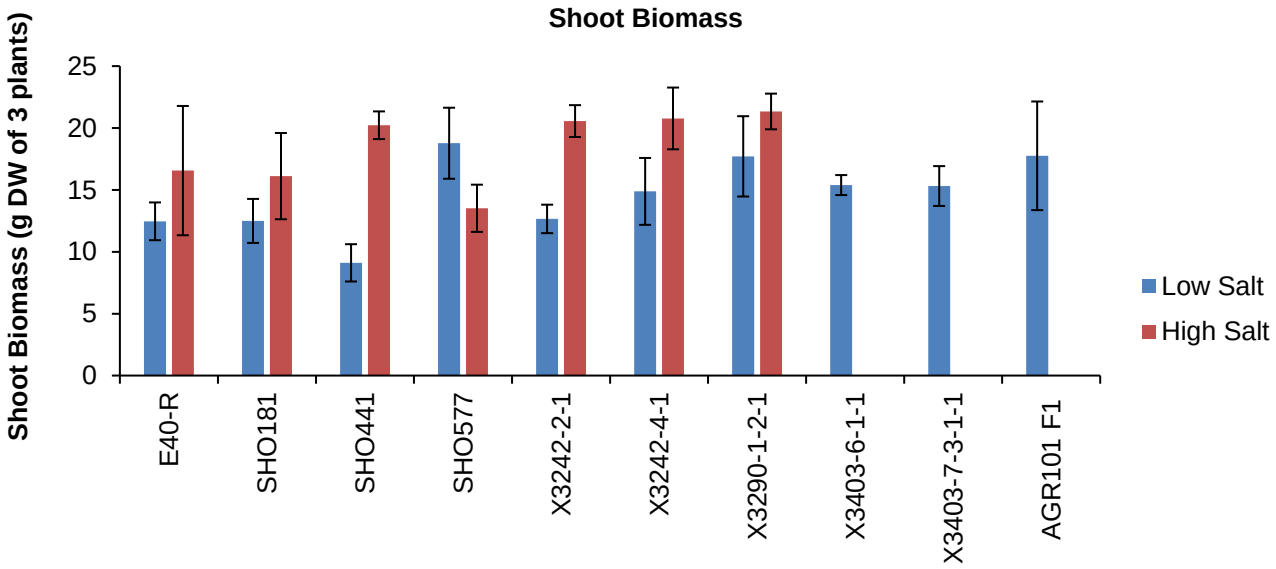
Early vigour differences among SHO safflower lines

High salt safflower trial
Coomandook SA, 2022



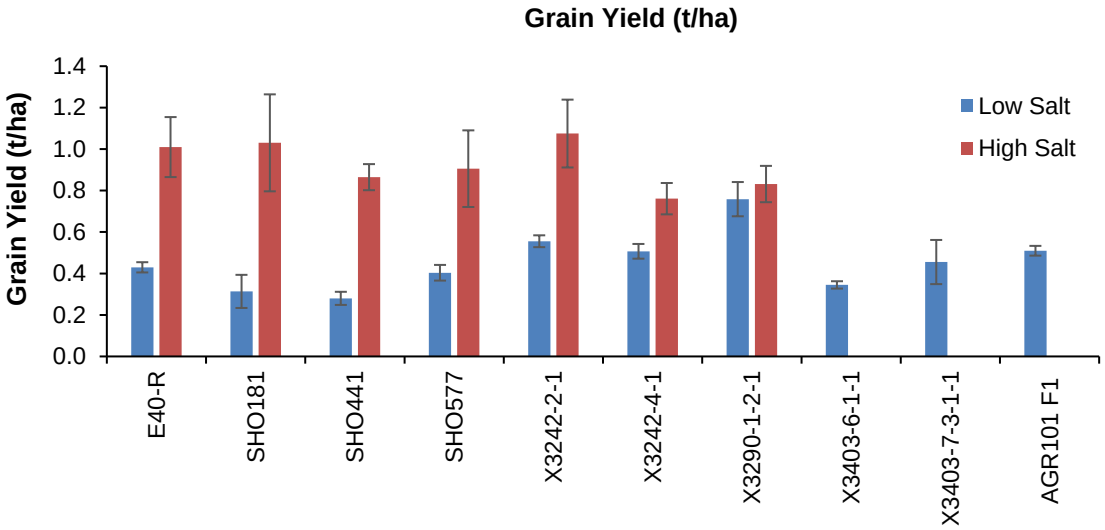


High salt site had higher biomass – legacy nutrients



Shoot biomass samples collected on the 13th of September 2022

High salt site had higher yields (~1t/ha) – legacy nutrients



Aim 2: A pilot experiment to determine the level of tolerance of safflower lines to sodic soils

Lines
- 8× SHO safflower lines
- 1× canola
- 1× wheat

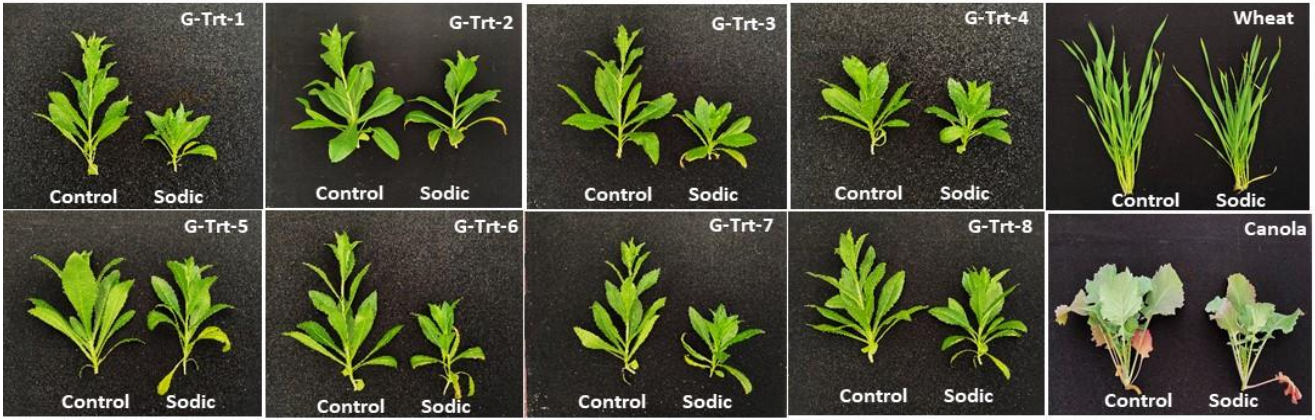
Replicates
- 6 replicate pots per treatment
- 120 pots (1 kg each)

Soils (amended field soil)
- Non-sodic (control) (unamended)
- Alkaline, sodic soil
  → high sodium, boron, aluminium, pH

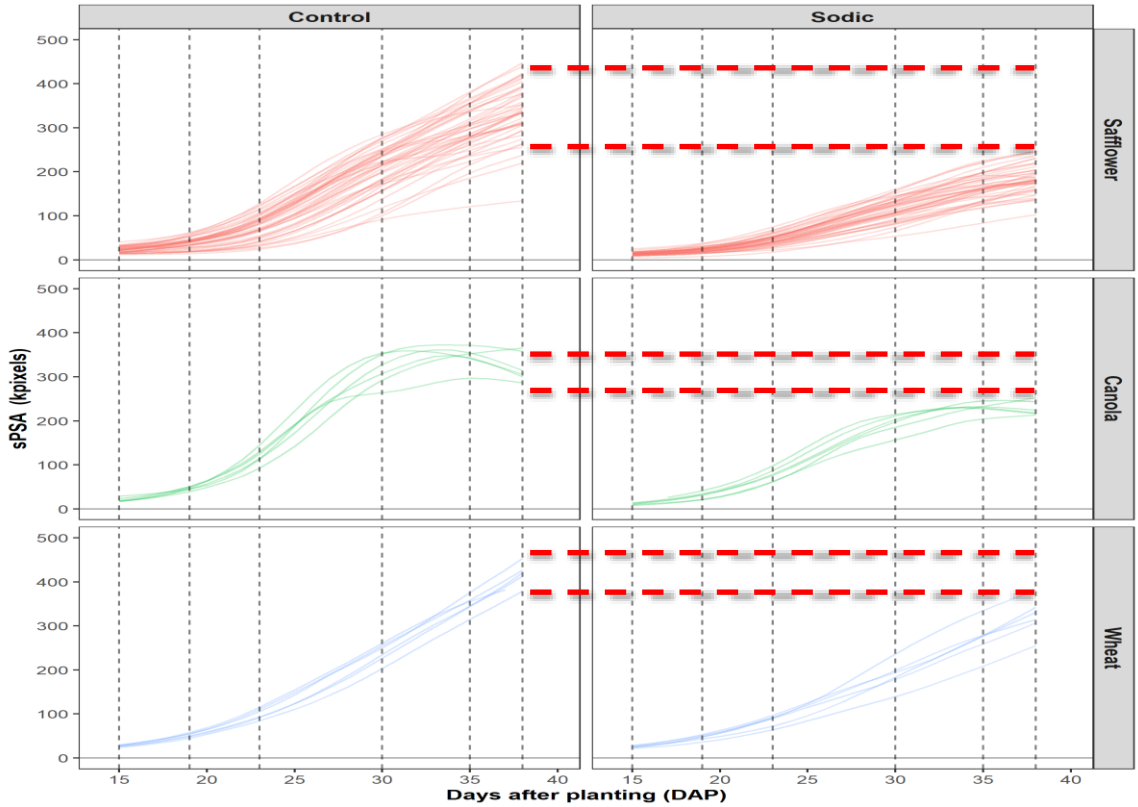
Measurements (38 days after planting)
- Shoot growth rates
- Water use
- Shoot nutrient concentrations

Soil Property	Soil Treatment	
	Control	Sodic
pH (1:5, soil:water)	9.30	**10.30**
pH ($CaCl_2$)	8.54	**9.02**
Calcium (%)	79.38	66.75
Magnesium (%)	12.65	8.55
Potassium (%)	2.23	1.85
Sodium (%)	5.75	**22.85**
Chloride (mg/kg)	122.5	96.00
$EC_{1:5}$ (soil:water) (dS/m)	0.19	**0.54**
Boron (mg/kg)	1.28	**12.25**
Aluminium (cmol/kg)	<0.02	<0.02

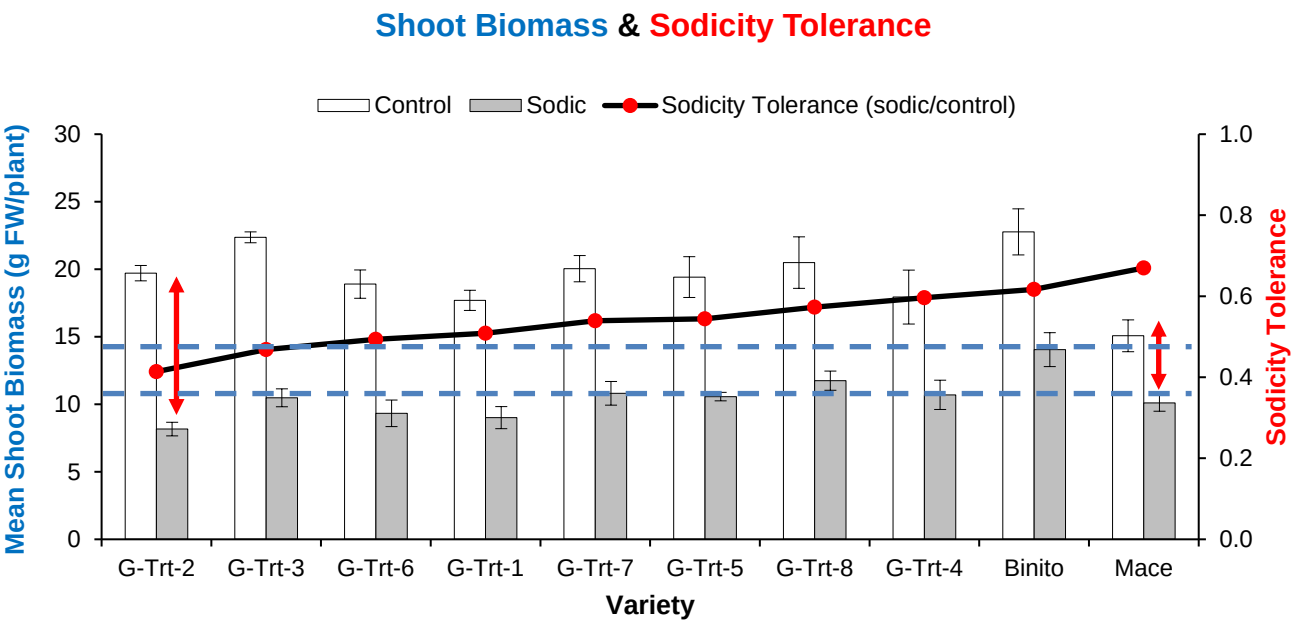
Lots of variation in growth between the different safflower varieties



Growth of safflower was reduced by sodicity compared to control



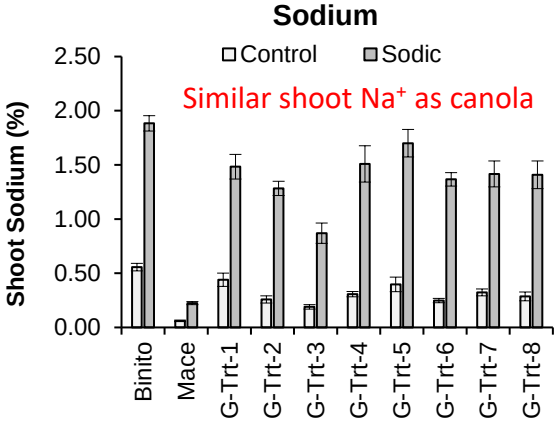
‘Sodicity tolerance’ of safflower is not higher than canola or wheat

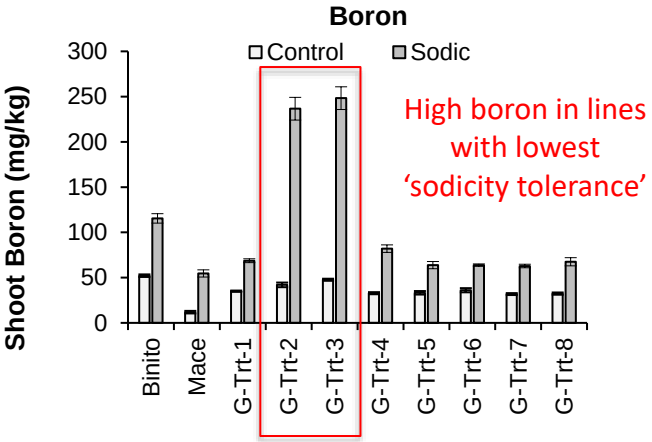


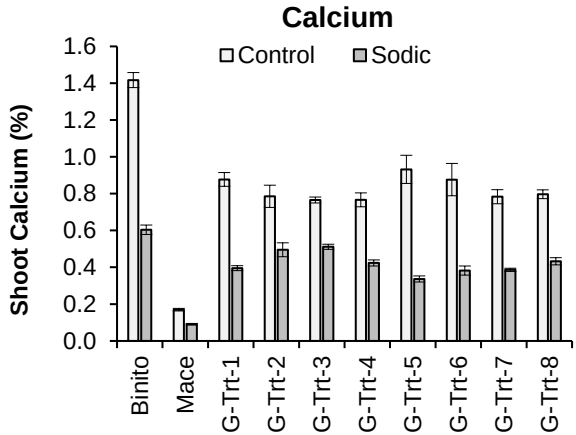
Ranked in order of ‘sodicity tolerance’

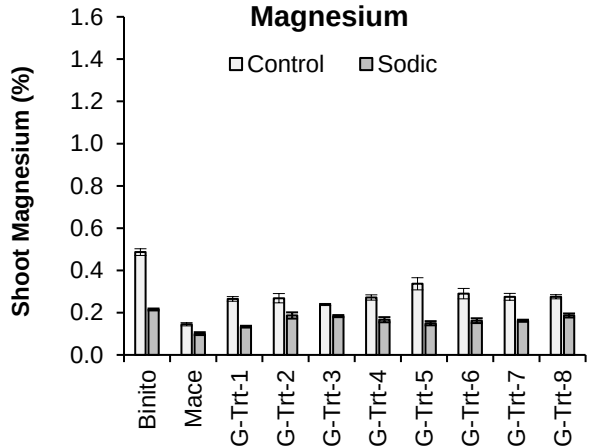
Safflower sodicity tolerance ranged from 41-60% and was less than both canola (62%) & wheat (67%)

Plant breeding can still improve the sodicity tolerance of safflower









Key Messages

- SHO safflower germinated, produced biomass and grain yield in both the low and high salinity (2022 results)
  - → **care** is needed as a failed safflower crop will occur if inadequate soil moisture occurs at seeding into saline soil (2021 results)
  - → Need to replicate findings
- Current commercially available line of the SHO safflower (E40-R) had variable shoot biomass in the high salinity site in 2022, yielded 1 t/ha
  - → Need to replicate findings
- Variation amongst the SHO safflower lines
  - → Advanced breeding lines look promising for saline soils with strong early vigour and high biomass production

Acknowledgements

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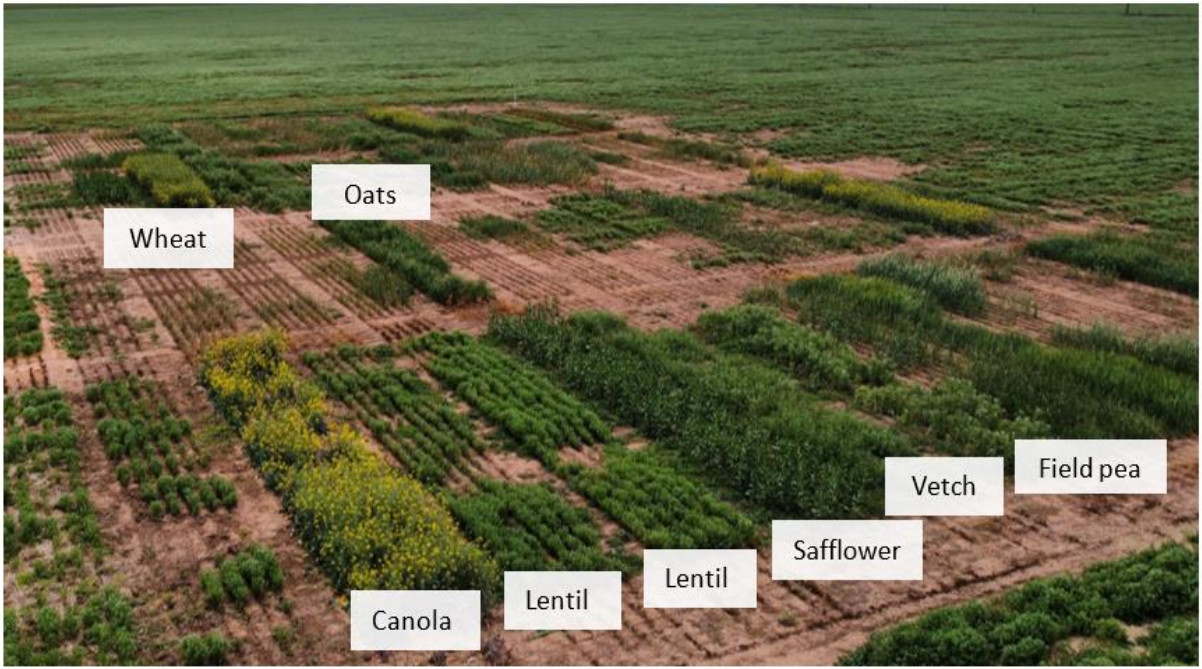

Crop type and variety treatments in the salinity management trial at Tickera, SA 23rd September 2022

Australian Government's Future Drought project: 'Building resilience to drought with landscape scale remediation of saline land' funded to Mallee Sustainable Farming under the Soils and Landscape grants program.

	Active constituent	Group	Example trade names*
Pre-emergent	Ethyl dipropylthiocarbamate	E	EPTAM®
	Pendimethalin	D	Stomp 330EC®, Rifle ®, Fist®, Conquest Charger 330 EC®
	Tri-allate	J	Avadex Xtra®, Avamix Elite®, Approve®
	Trifluralin	D	Treflan 480®, TriflurX®, Trilogy®, Snare®
Post-emergent	Diclofop-methyl	A	Conquest®, Rhino®, Diklofop 375®
	Propaquizafop	A	Correct®, Shogun®
	Metsulfuron methyl	B	Ally® (Varieties Saffola, Sironaria and Sirothora only)