Water productivity of selected indigenous fruit tree crops in South Africa

Z Ntshidi[1], S Dzikiti[2], NR Ntuli[3], LN Buthelezi[3], L Wilken[2], R Du Preez[4]

1. *CSIR, Smart Places Cluster*
2. *Dept. of Horticulture, Stellenbosch University*
3. *Dept. of Botany, University of Zululand*
4. *ARC, Institute for tropical and subtropical crops*

WRC world food day dialogue
15 October 2021

INTRODUCTION

At least 20% of rural households are not food secure in South Africa

Conventional crop production is under threat from:
➢ Climate change and increasing frequency & severity of droughts;
➢ Poor soil fertility & increasing soil degradation;
➢ Rising input costs

Need for alternative crops to ensure food security.

Advantages of indigenous fruit tree crops (IFTs)
➢ Drought and disease tolerant
➢ Fruit has a high nutritional value
➢ Can thrive in nutrient poor soils
➢ Can be processed into high value products
➢ Require less skilled management.

Domestication and/or commercialization of IFTs still poor.

Marula fruit

WORKSHOP TO PRIORITIZE IFTS

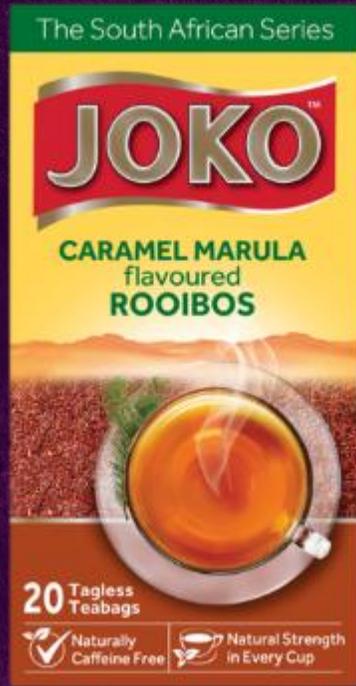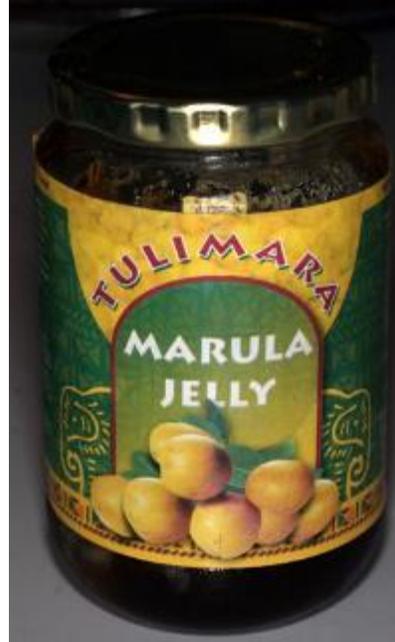- 03 October 2017, Faculty of Science Board Room at Unizulu

SPECIES DISCUSSED

SPECIES	VERNECULAR
1. Bridelia micrantha	Coastal golden leaf (E), umShange (Z), bruin stinkhout (A)
2. Dovyalis caffra	Kei apple (E), umQokolo (Z), kei-appel (A)
3. Harpephyllum caffrum	Wild plum (E), umGwenya (Z), Wildepruim (A)
4. Rhoicissus temontosa	Forest grape (E), isiNwazi (Z), Bosc...
5. Syzygium cordatum	Waterberry (E), umDoni (Z), Water...
6. Carissa macrocarpa	Big num num (E), umThungulu (Z), ...
7. Ficus sur	Broom cluster (E), umKhiwane (Z), ...
8. Lannea discolor	Tree grape (E), isiGanganyane (Z), ...
9. Sclerocarya birrea	Marula (E), umGanu (Z), Maroela (...
10. Vangueria infausta	Wild medler (E), umViyo (Z), Wilde...
11. Adansonia digitata	Baobab (E), isiMuhu (Z), kremetar...
12. Pappea capensis	Jackel plum (E), umVuna (Z), Dopp...
13. Podocarpus falcatus	Yellowwood (E), umSonti (Z), Outn...
14. Strychnos spinosa	Monkey orange (E), umHlalakonts...
15. Ximenia caffra	Large sourplum (E), umThunduluk...
16. Cordia caffra	Septee tree (E), iLalanyathi (Z), Septeeboom (A)
17. Parinari curatellifolia	Mabola plum (E), umKhuna (Z), Bosappel (A)
18. Phoenix reclinata	Wild date plum (E), iSundu (Z), Wilde-dadelboom (A)
19. Trichilia dregeana	Forest mahogany (E), umKhuhlu (Z), Rooiessenhout (A)
20. Ziziphus mucronata	Buffalo thorn (E), isiLahla (Z), Blinkblaar-wag-n-bietjie (A)

- *Inhambanella henriquesii* (Milkpear)

- *Englerophytum magalismontanum* (Stemfruit)

- *Garcinia livingstonei* (African Mangosteen)i

- *Kigelia africana* (Sausage tree)

- *Manilkara discolor* (Forest Milkberry)

- *Berchemia zeyheri* (Red Ivory)

- *Vitellariopsis dispar* (Tugela Bush-milkwood)

- *Pittosporum viridiflorum* (Cheesewood / Mkhwakhwa)

- *Dialium schlechteri* (Zulu Podberry)

SELECTED SPECIES

- > 30 different IFT species in RSA

- High domestication/commercialization potential
- Selection criteria
  - ➤ Ease of propagation or regeneration
  - ➤ Yield quality & quantity
  - ➤ Value added products & markets etc.
  - ➤ Resistance to pests, diseases droughts.

- Top ranked species
  - ❑ *S. birrea* (Marula/ umGanu)
  - ❑ *S. spinosa* (Monkey orange)
  - ❑ Dovyalis caffra (Kei apple/ umQokolo)
  - ❑ Garcinia livingstonei (Mangosteen/umPhimbi
  - ❑ Vangueria infausta (Wild meddler/ umViyo)
  - ❑ Berchemia zeyheri (red ivorywood)

LIQUI FRUIT
100% MARULA MANIA
FRUIT JUICE BLEND
grape/pear, marula & other fruit

Olkerii Farm
Taste of Africa
MARULA
JAM

MARULA OIL
CERTIFIED ORGANIC

MARULA OIL
CERTIFIED ORGANIC

MARULA OIL
CERTIFIED ORGANIC

MARULA OIL
CERTIFIED ORGANIC

aQuellé
MARULA

TULIMARA
MARULA
JELLY

The South African Series
JOKO
CARAMEL MARULA
flavoured
ROOIBOS
20 Tagless Teabags
Naturally Caffeine Free
Natural Strength in Every Cup

PORTIA M
PURE LUXURY FOR YOUR SKIN
Marula Skin Oil
Recommended For:
• Scars
• Stretch marks
• Uneven skin tone
• Dehydrated skin
Rich in omega 3,6 and 9 fatty acids for amazing skin hydration

Clover
Stp UP
MARULA FRUIT
LIMITED EDITION
MARULA

BARKER AND QUIN
Marula
TONIC WATER
4 x 200 ml BOTTLES

TRESemmé
USED BY PROFESSIONALS
NEW
EXPERT
WITH MARULA OIL
KERATIN SMOOTH
5 BENEFITS 1 SYSTEM
CONDITIONER
750 mL

AMARULA
CREAM
& MARULA FRUIT

STUDY APPROACH

YEAR	DURATION	SPECIES	COMMENT
	Jan		- Contracts
	Apr		- Reviews& stakeholder engage.
2017	Aug		- Site search
	Dec		- Equipment installation
	Jan		
	Apr		
2018	Aug		
	Dec		
	Jan		
	Apr		
2019	Aug		
	Dec		
	Jan		
	Apr		
2020	Aug		
	Dec		
	Jan		
2021	Apr		
	Aug		
	Dec		

S. Birrea & S. Spinosa — 1, 2 — KwaZulu-Natal

S. Birrea & Dovyalis — 3 — Mpumalanga

Dovyalis & V. infausta — 4 — KwaZulu-Natal

AIMS & OBJECTIVES

A. AIM

To quantify the water use and water productivity of selected indigenous fruit tree (IFT) species

Marula – S. birrea   **Monkey orange – S. spinosa**

- Bonamanzi Game Reserve near Hluhluwe, Northern Zululand

AIMS & OBJECTIVES

B. SPECIFIC OBJECTIVES

i.   To quantify the water use patterns of *S. spinosa* and *S. birrea* trees and to establish how this is affected by environmental factors;

ii. To study the yield attributes of the two species over 2 years;

iii. To estimate the water productivity (i.e. kg of fruit per m3 of water consumed) and to compare with that of exotic fruit trees.

MATERIALS & METHODS

I. STUDY SITE
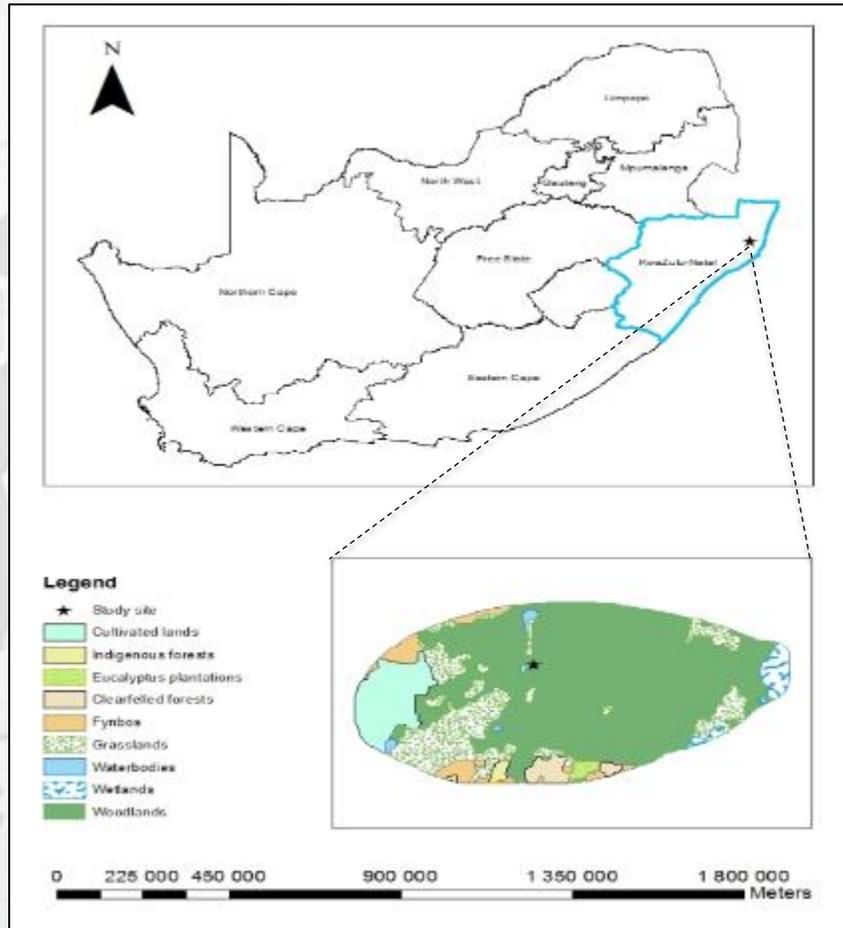
- Bonamanzi Game reserve (KZN)

- Data collection: Jan 2018 – Jan 2020

- Alternate bearing

CLIMATE & SOIL MEASUREMENTS

Automatic weather station

CS616 soil moisture probes

- Deep sandy soils

- Soil water content sensors @ 15, 60, 120 cm

- Recorded hourly

- Tmax, Tmin, Rhmax, Rhmin, Radiation, rainfall etc.

TREE WATER USE MEASUREMENTS

- Heat ratio sap flow method, 2 trees/species
- Collected at hourly intervals throughout the study period

TREE & SOIL ATTRIBUTES

INSTRUMENTED TREES

SPECIES	DBH (cm)	LAI	HEIGHT (m)	Tree density (trees / ha
MARULA	19.4	0.9	8	48
STRYCHNOS	16.2	1.6	6	37

SOIL PROPERTIES

Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Fine sand (%)	Medium sand (%)	Course sand (%)	Stone (%)	Classifi cation	Water holding capacity		
									10 kPa (%)	100 kPa (%)	mm/ m
15	7	2	91	50.2	34.0	6.8	0	Sa	18.6	8.2	104.6
40	7	2	91	48.6	34.0	8.4	0	Sa	18.5	8.3	102.5
60	9	0	91	55.7	30.0	5.3	0	Sa	19.8	8.5	113.6

FRUIT GROWTH RATE

- Hourly using DEX 100 & DEX 70 dendrometers connected to data loggers

STRYCHNOS

Dendrometer

MARULA

Dendrometer

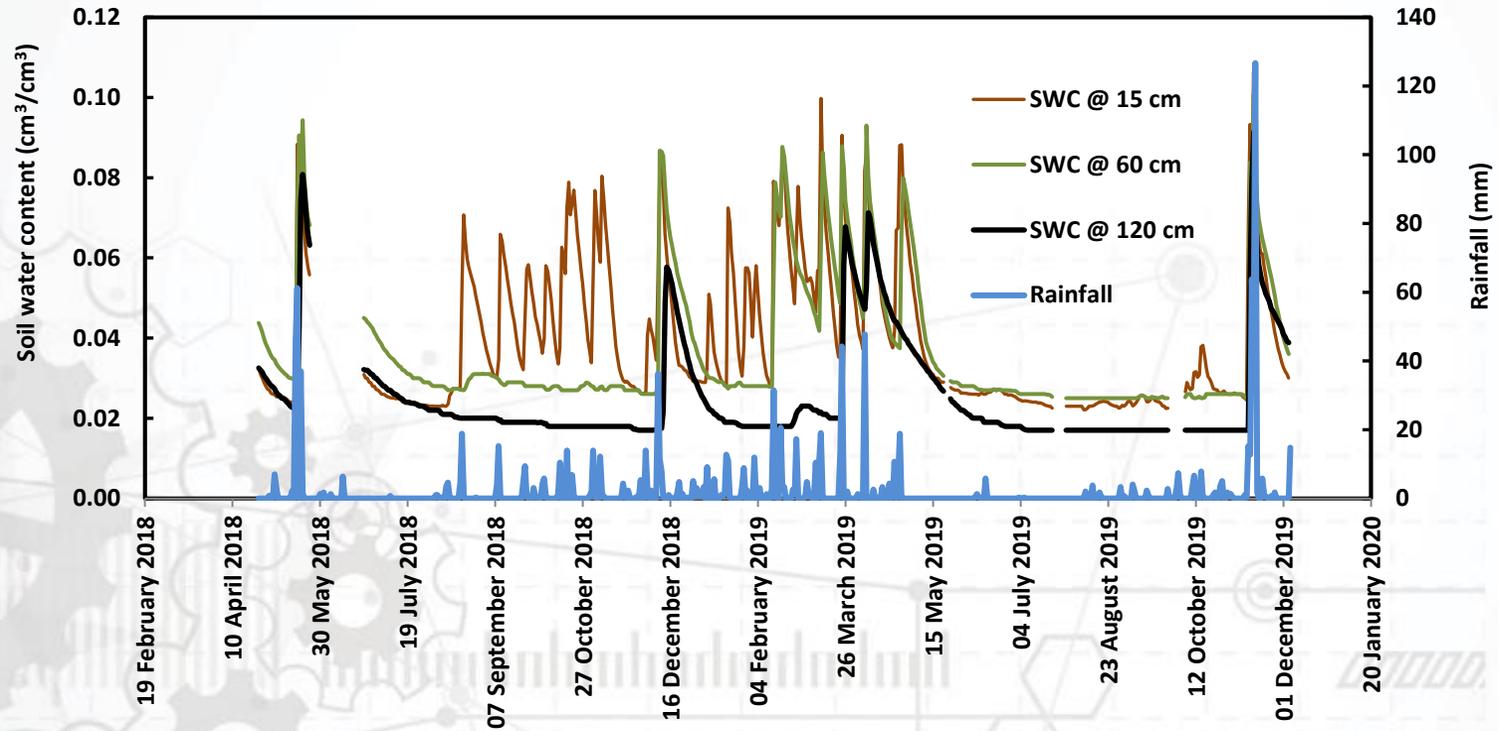# RESULTS: MICROCLIMATE

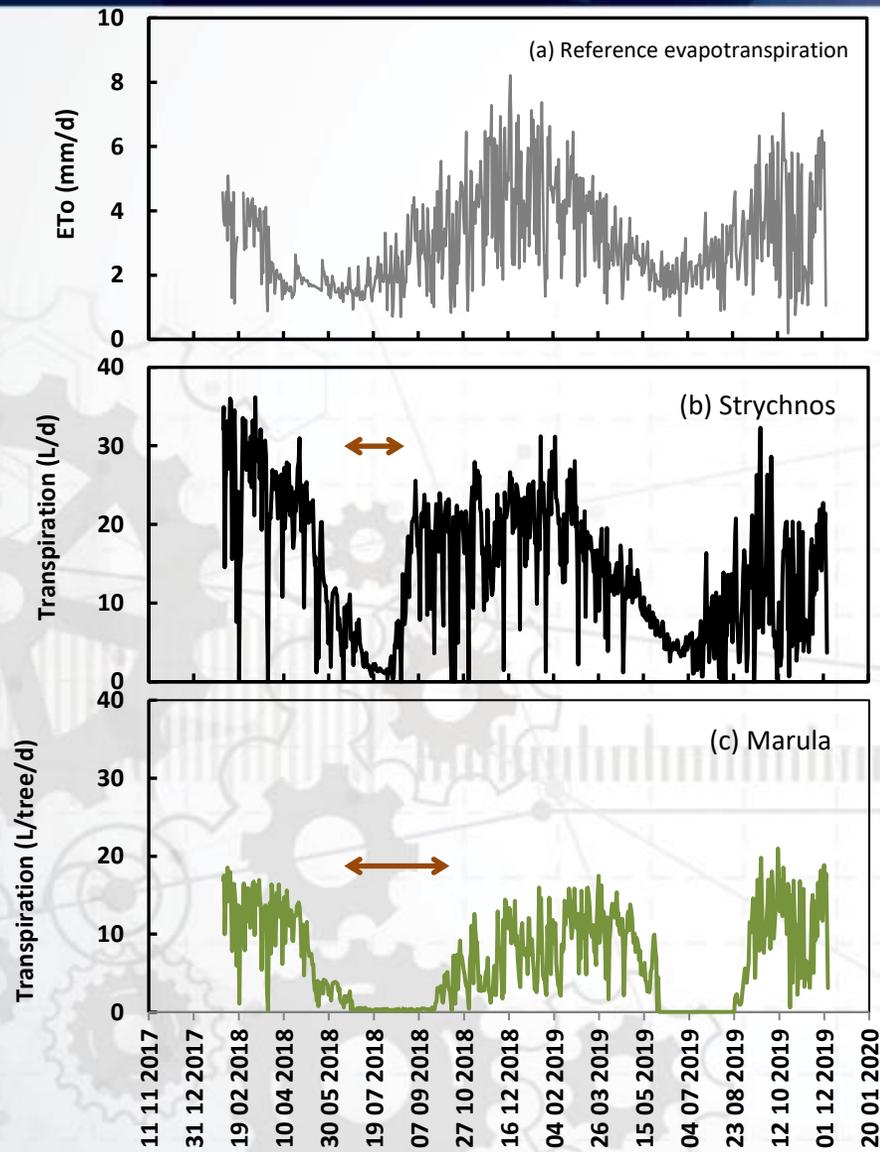(a) Solar radiation

(b) Air temp

(c) ETo & rainfall
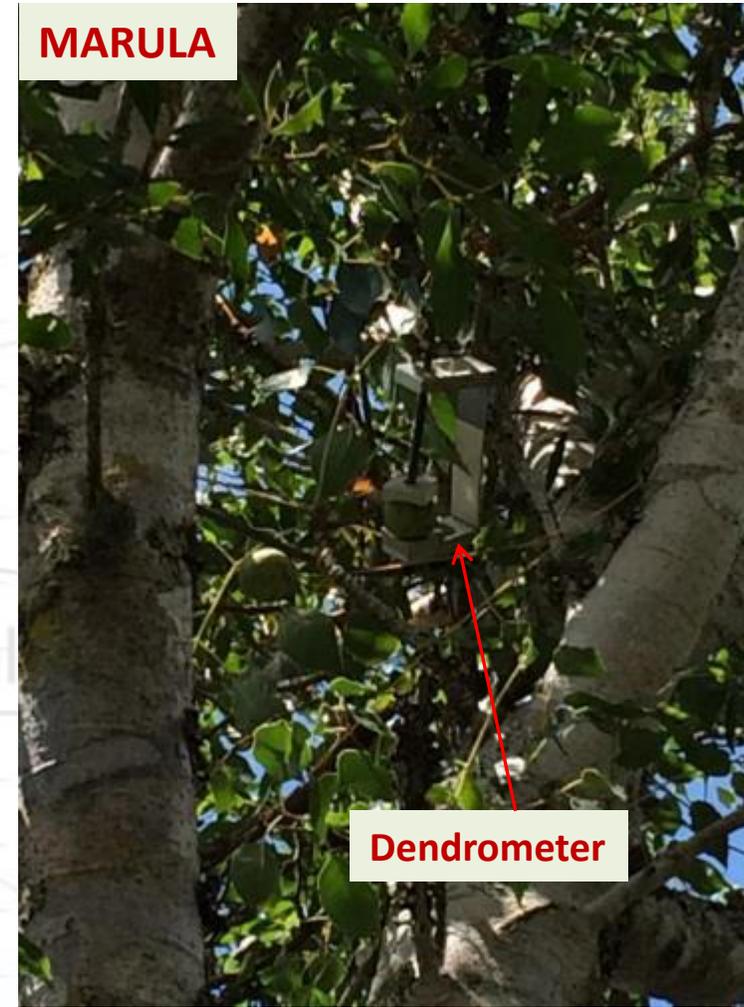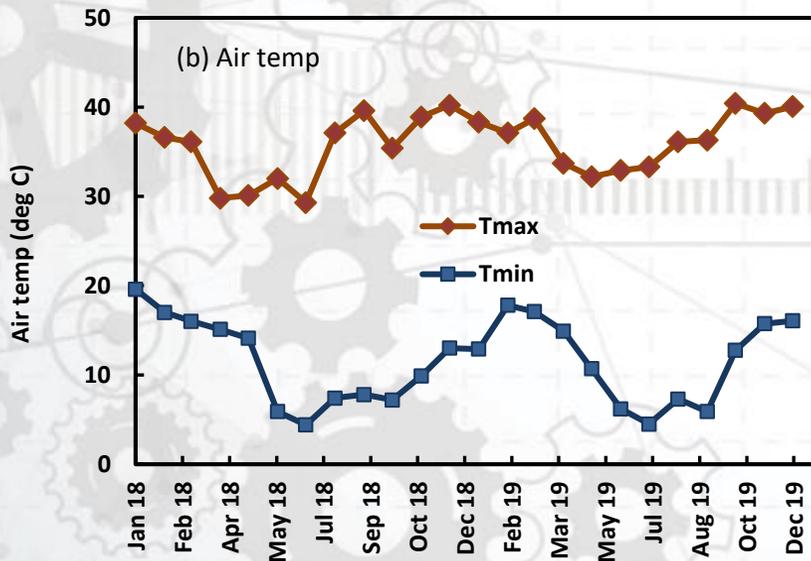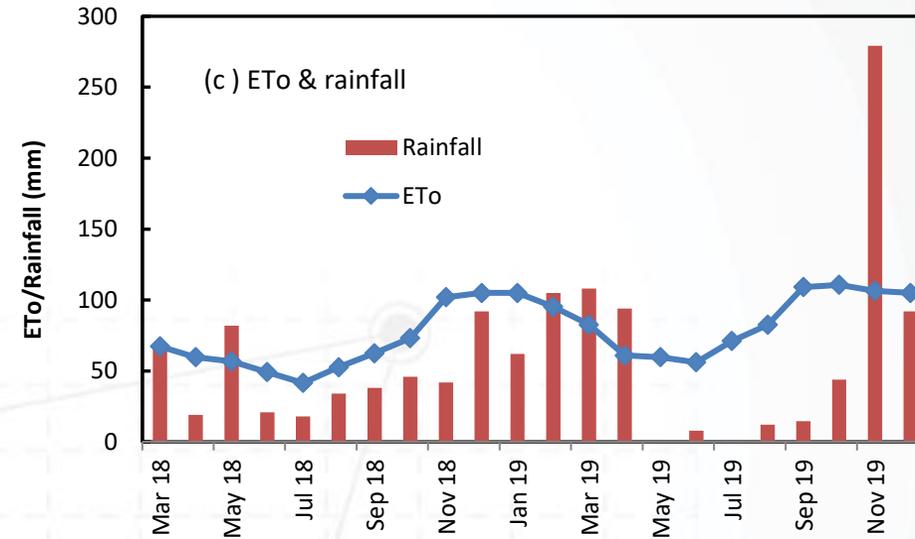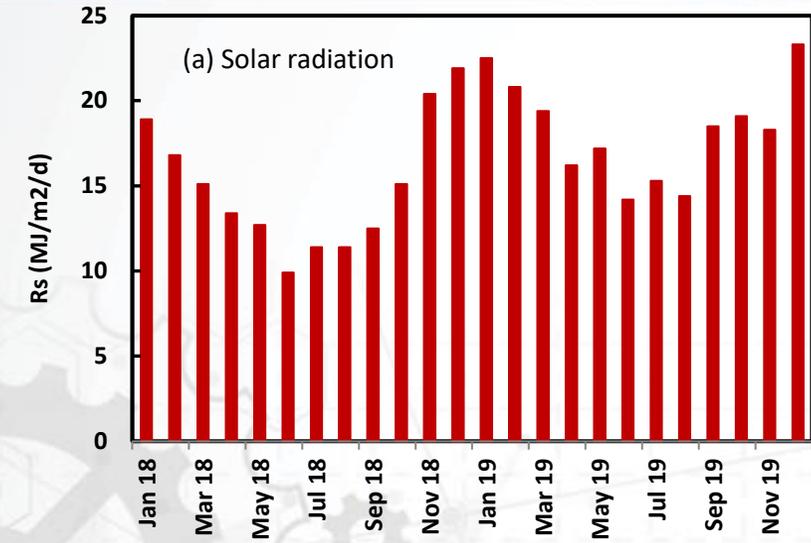
- Total rainfall ~ 723 mm (average of 2 years)
- Total ETo ~ 938 mm (average of 2 years)

RESULTS: SOIL WATER DYNAMICS

- A few storms infiltrated up to the 120 cm depth

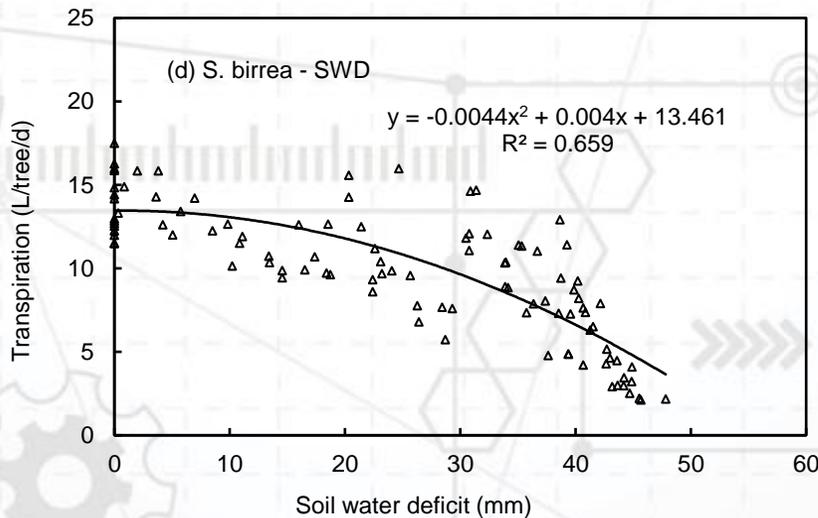# RESULTS: TREE TRANSPIRATION

(a) Reference evapotranspiration
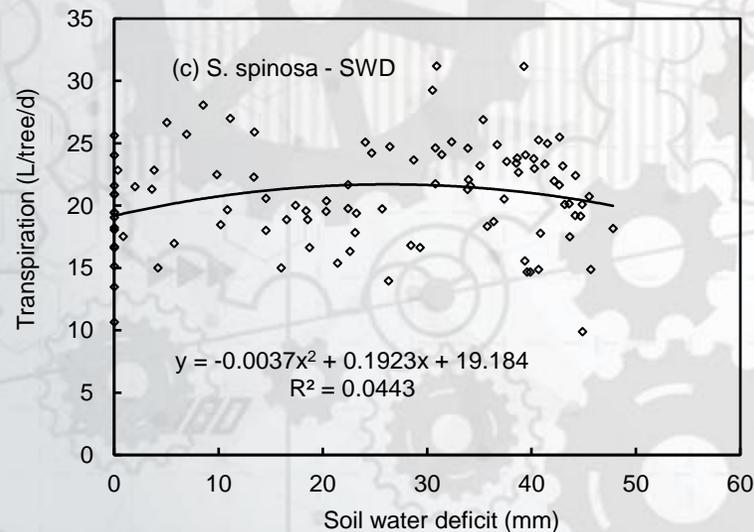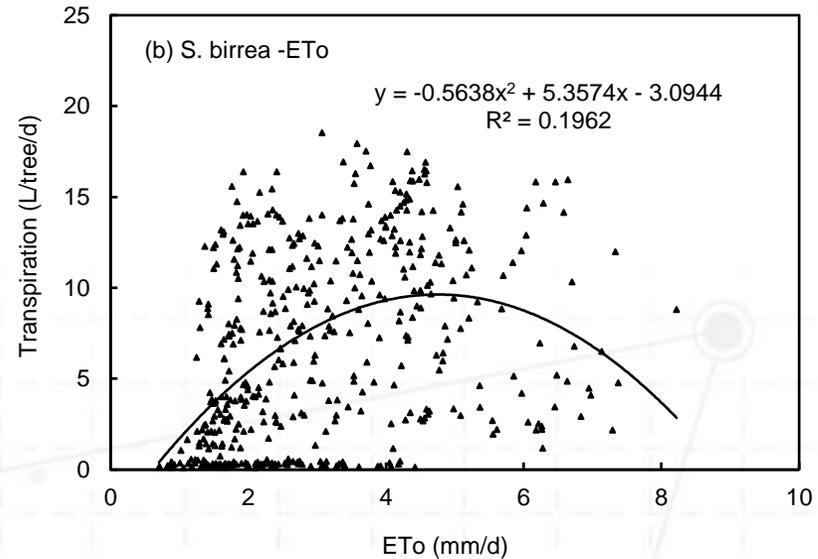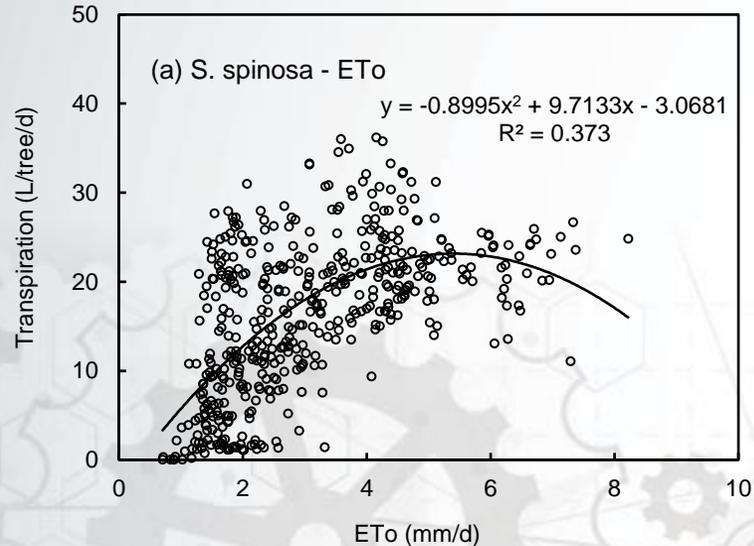
(b) Strychnos

(c) Marula

- Daily transpiration of marula was ~ 50% that of Strychnos

- Difference in daily water use reflects differences in canopy size

- Marula has a longer dormancy period which reduces its total water use

RESULTS: WATER USE DRIVERS

(a) S. spinosa - ETo

$y = -0.8995x^2 + 9.7133x - 3.0681$
$R^2 = 0.373$

(b) S. birrea -ETo

$y = -0.5638x^2 + 5.3574x - 3.0944$
$R^2 = 0.1962$

(c) S. spinosa - SWD

$y = -0.0037x^2 + 0.1923x + 19.184$
$R^2 = 0.0443$

(d) S. birrea - SWD

$y = -0.0044x^2 + 0.004x + 13.461$
$R^2 = 0.659$

S. spinosa transpiration was correlated to the atmospheric evaporative demand ($R^2 = 0.37$). But the water use was poorly correlated to the soil water deficit ($R^2 < 0.10$)

The atmospheric evaporative demand explained less than 20% of the variation in *S. birrea* transpiration ($R^2 = 0.19$) while the soil water deficit in the rootzone explained more than 65% of this variation ($R^2 = 0.66$)

RESULTS: FRUIT GROWTH RATE
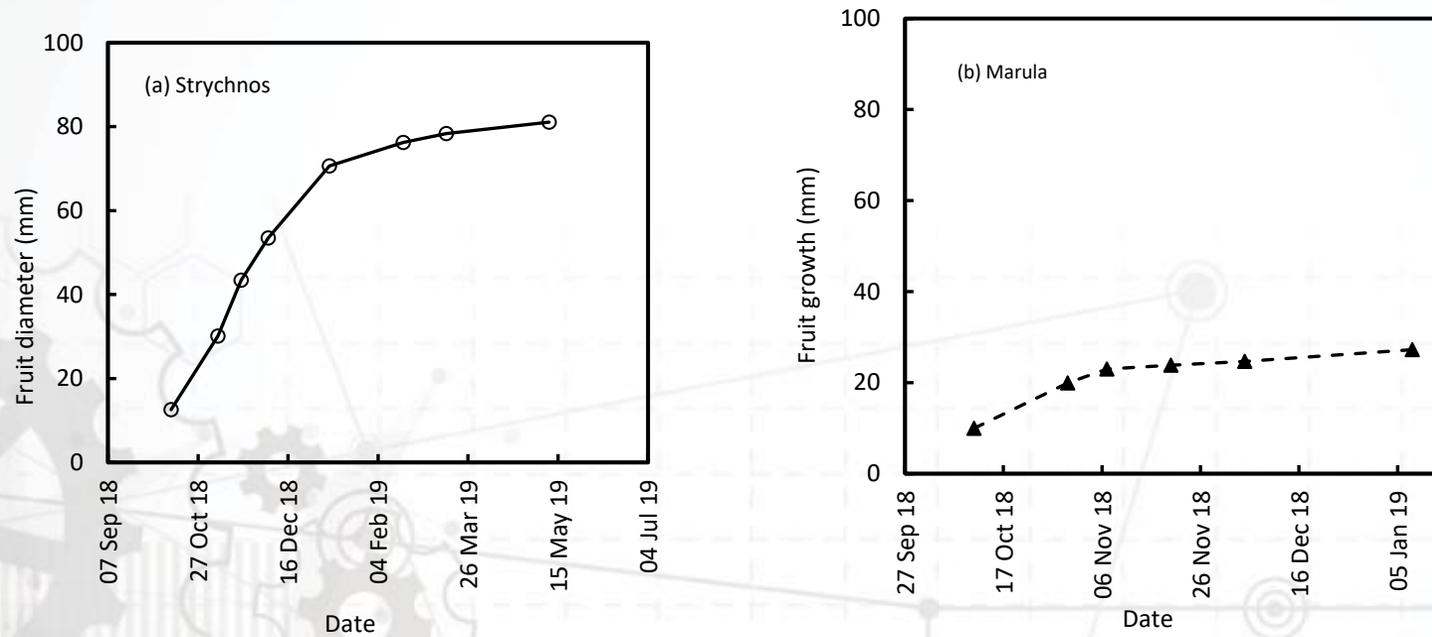
- For Strychnos, rapid growth continues up to about Feb

- For Marula growth curve flattens in November – December.

RESULTS: WATER PRODUCTIVITY

VARIABLE	STRYCHNOS	MARULA
Daily maximum transpiration (L/tree/d)	36	19
Annual total transpiration (L/tree/y)	6061	2160
Average no of fruit per tree	56	128
Average fruit mass (g)	276	16
Average yield (kg fresh mass per tree)	15.2	4.3
Water productivity (kg/m3)	*2.5*	*1.99*

Water productivity of exotic species:
1) Citrus : 4.4 - 6.1 kg/m3 (Gush et al., 2017)
2) Apple : 4 - 18 kg/m3 (Gush & Taylor, 2014; Dzikiti et al., 2018)
3) Plums : 5.97 kg/m3 (Dzikiti & Schachtschneider, 2015)
4) Peach : 3.5 kg/m3   (Dzikiti & Schachtschneider, 2015)

CONCLUSIONS

❖ Differences in daily water use between Marula and Strychnos are strongly related to canopy size;

❖ Seasonal total water use of Marula is much lower because of a longer dormancy period;

❖ Strychnos water use was more correlated to environmental variables than soil water deficit, while this was vice versa for marula

❖ The water productivity of the IFTs studied here are much lower than that of exotic species. Marula yield at the KZN site is very low

❖ Water productivity of the indigenous fruit trees may be increased if they are managed (e.g. irrigation, fertigation etc.)

ACKNOWLEDGEMENTS

END