

# Regulated Deficit Irrigation (RDI) to enhance fruit quality

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Twin Towers, Sunshine Coast

# Introduction

- Major export markets for Australia are in Asia
- Asians prefer sweeter fruit
- A techniques is required to enhance sugar levels
- RDI can be used to increase sugar content of fruit

## How it can be done?

- Previous research/sweetness/manipulation of tree physiology through irrigation
- RDI technique can be applied during specific stages
- Adoption of the RDI technique requires:
  - suitable irrigation scheduling
  - understanding the phenological stages
  - investigation of negative effects on fruit

# Establishment of RDI trial at Dareton

## Varieties:

M7 (early)

Washington navel (mid)

Lane Late (late)

## Rootstocks:

*Poncirus trifoliata* (Tri22)

Troyer citrange

Volkameriana:

Swingle citrumelo

Citrus macrophylla

Replicates: 6      Total trees: 540

Tree spacing:      tree to tree = 5 m  
                            row to row = 3 m

Tree density: 666 trees/ha

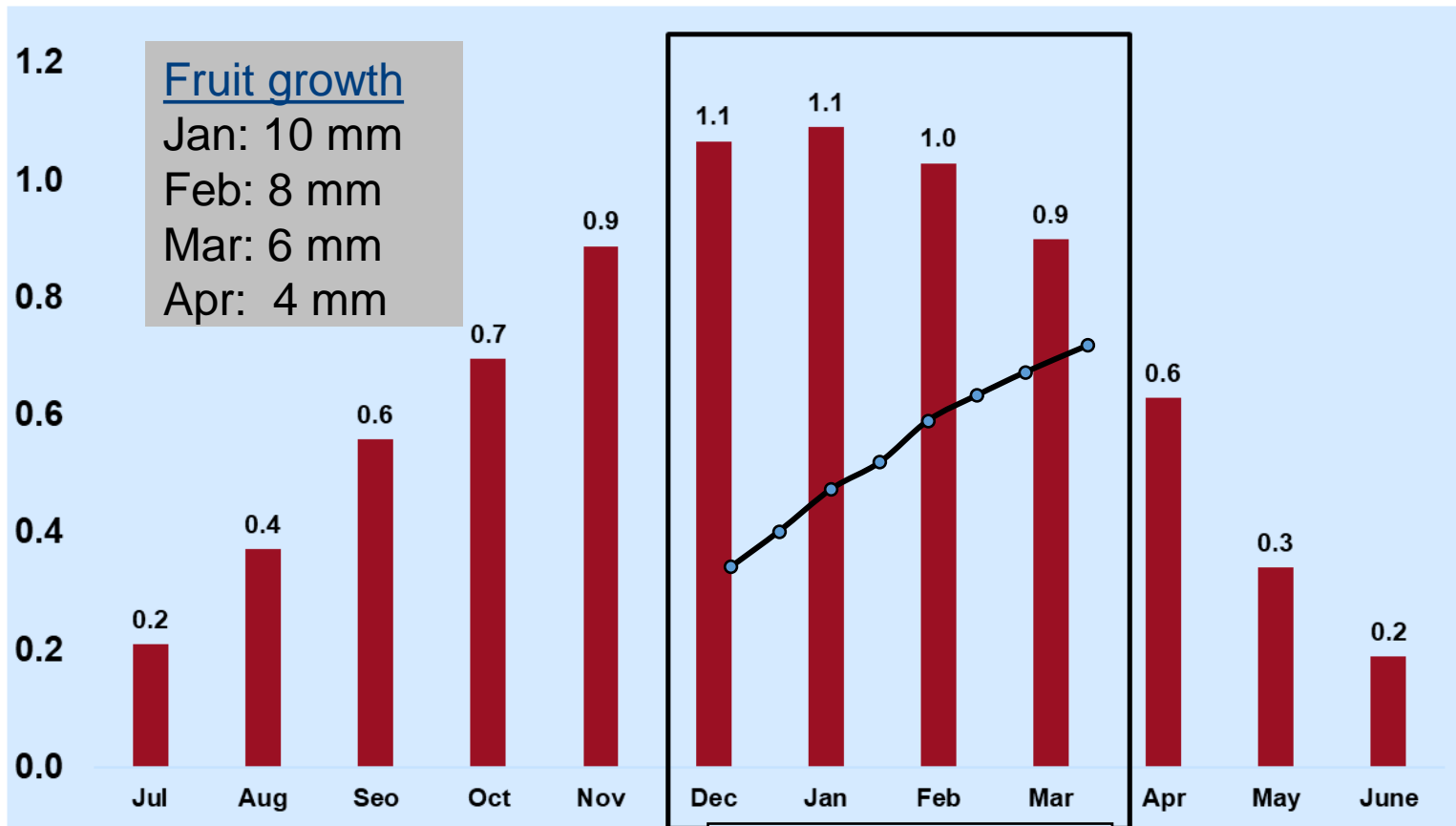
**Drip irrigation system & deep sandy loam soil**

**Viedo footage of trial (2020)**



**Planted 2010 (9 years old)**

# Monthly irrigation requirement for navel oranges (ML/ha)



Summer (4.1 ML)

# Stress methodology

## Year 1:

- When to stress?
- How to stress?
- For how long to stress?

# Data collection

- Fruit growth (weekly)
- Sugar profiles (weekly)
- Leaf Water Potential (twice a week) – Pressure Chamber

## Harvest

- Full tree harvest (yield, fruit numbers, fruit weight)
- Size distribution in 5 size classes
- Fruit quality (TSS, acid%, BrimA, fruit weight, juice%)



# Soil moisture & tree monitoring

- Enviro probes (0-80 cm) – data sent live to the computer
- Water mark sensors (30, 60 and 90 cm depth) – data sent live to the computer
- Tensiometers (30, 60 and 90 cm depth) – manual recording
- Leaf water potential (pre-dawn) - Pressure Chamber data
- Visual stress data



Enviro probe



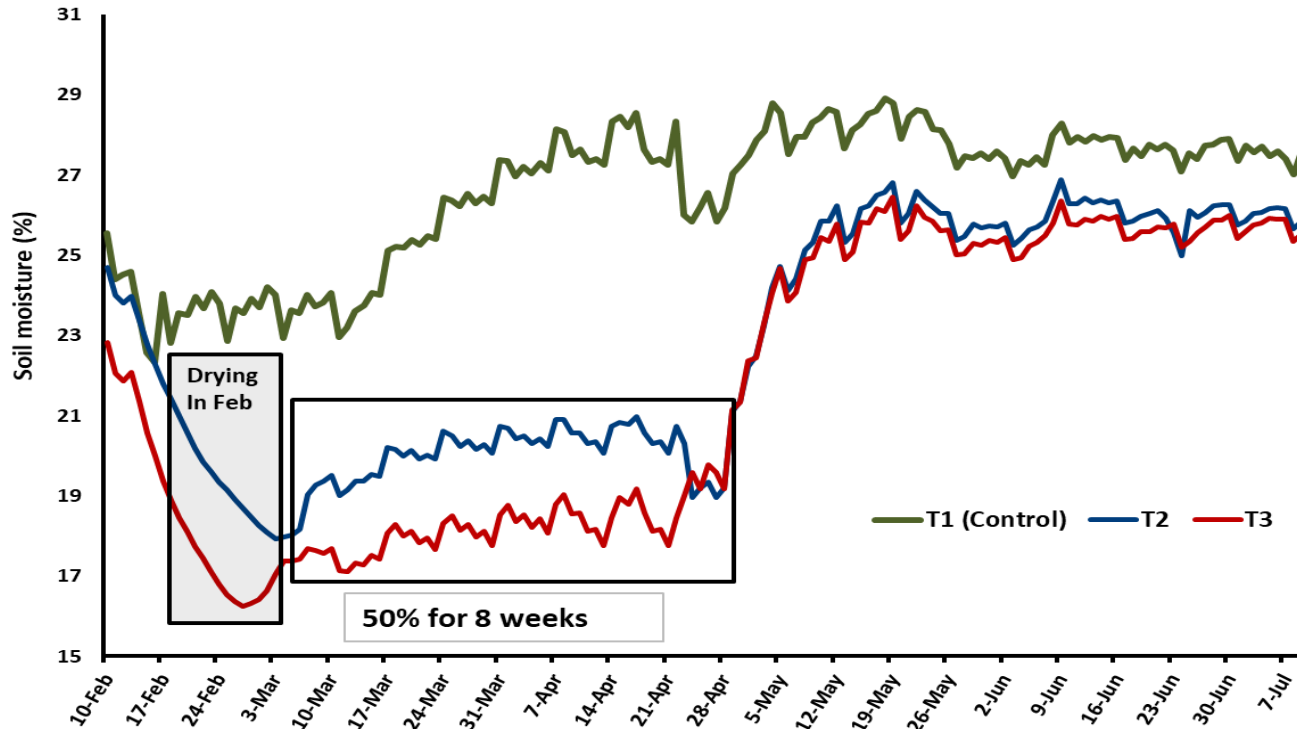
Water mark



# RDI treatments in 2018

	Feb	Mar	Apr	May	June	July-Jan
Control						
RDI-1	2 weeks	50% for 8 weeks		100%		
RDI-2	3 weeks	50% for 8 weeks				
RDI-3		2 weeks	50% for 8 weeks			

# Stress monitoring (Enviro Probes)



# Stressed vs. un-stressed tree



Stressed

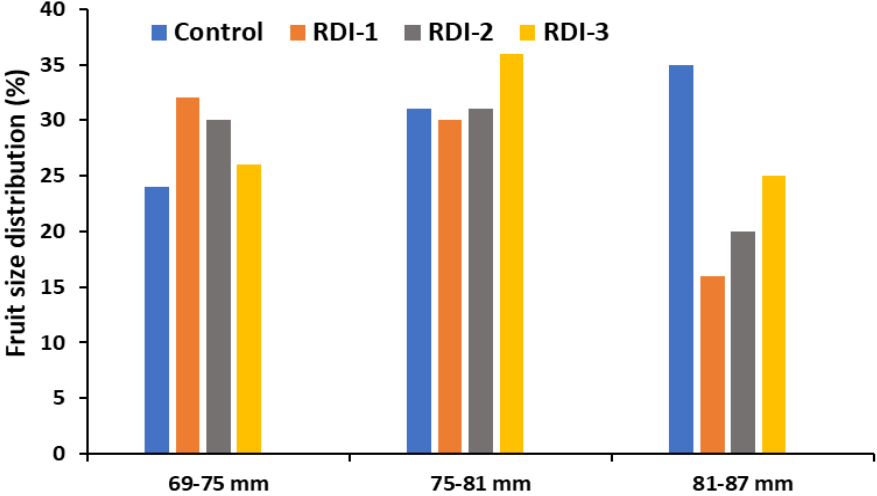


non-stressed

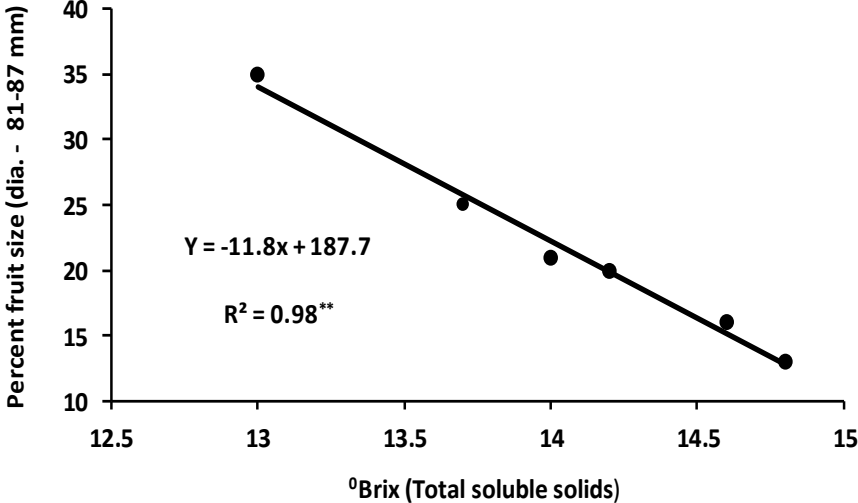
# Fruit quality and yield for 2018

	Washington navel			Lanes Late		
	°Brix	%acid	Yield - (kg/tree)	°Brix	%acid	Yield - (kg/tree)
Control	<b>13.0</b>	<b>1.1</b>	<b>34.4</b>	<b>12.8</b>	<b>1.0</b>	<b>51.4</b>
RDI-1	14.6	1.3	28.3	14.6	1.2	36.8
RDI-2	14.8	1.3	30.1	14.9	1.2	40.9
RDI-3	14.2	1.3	28.7	14.7	1.2	46.0

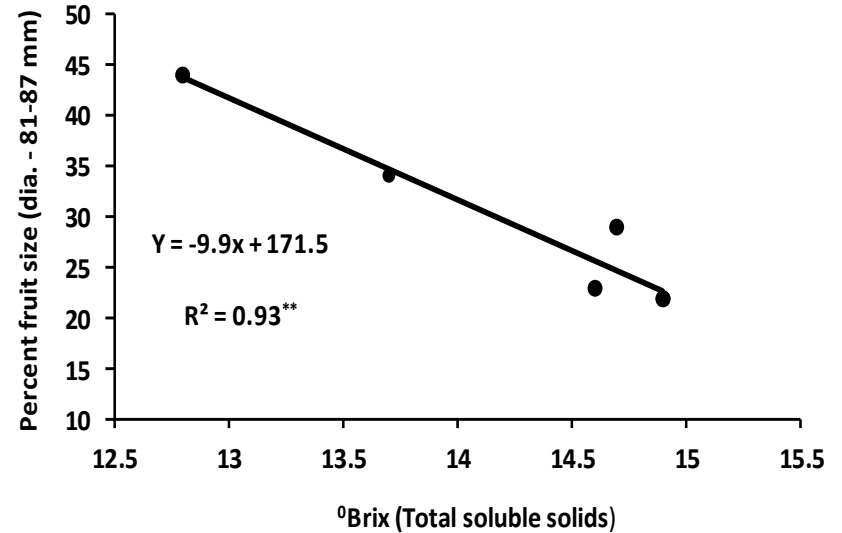
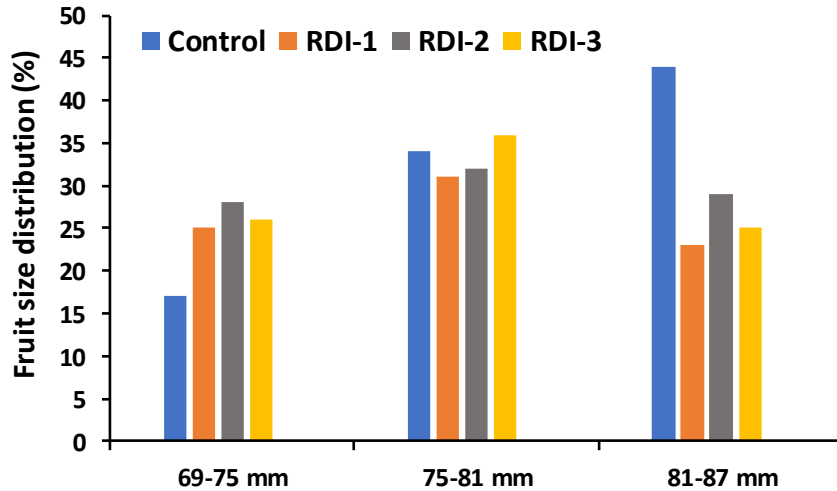
# 2018 (Washington navel) – Fruit size distribution



Count/Box (16 kg) >>	88	72	56
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# 2018 (Lane late navel) – Fruit size distribution



# RDI treatments 2019-2021

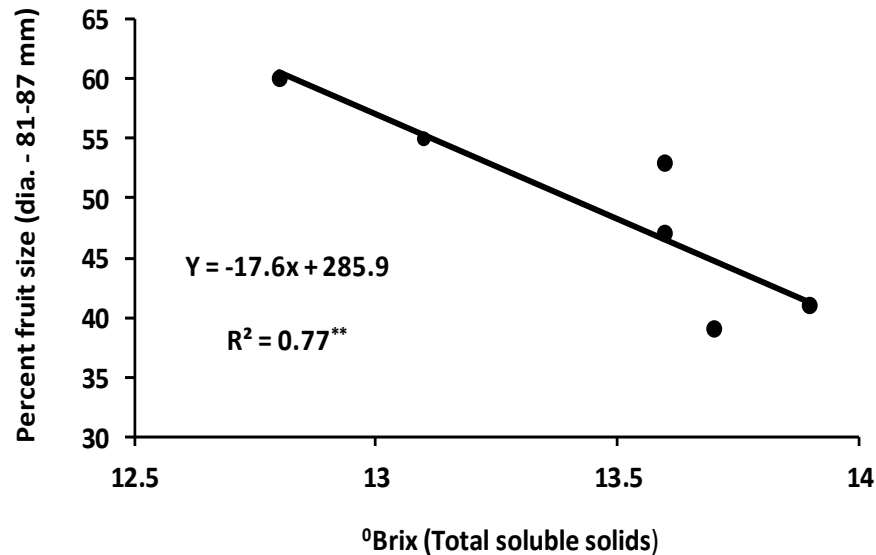
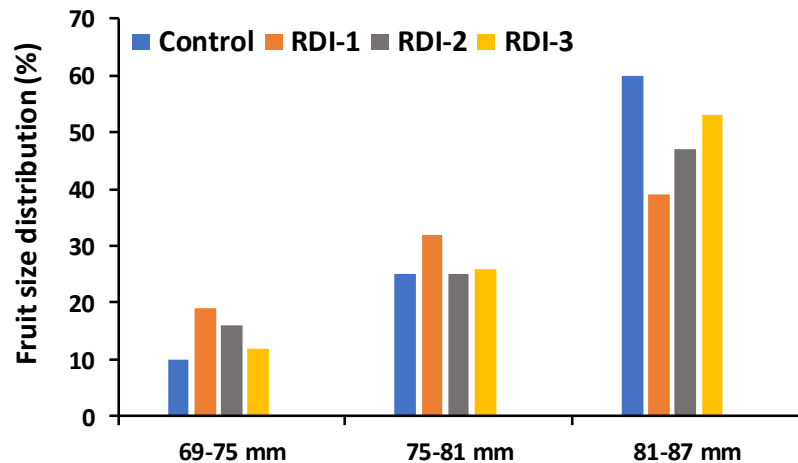
	Feb		Mar		Apr		May		June		July-Jan	
<b>Control</b>												
<b>RDI-1</b>			2 weeks	50% for 8 weeks				100%				
<b>RDI-2</b>				2 weeks	50% for 8 weeks							
<b>RDI-3</b>					2 weeks	50% for 8 weeks						



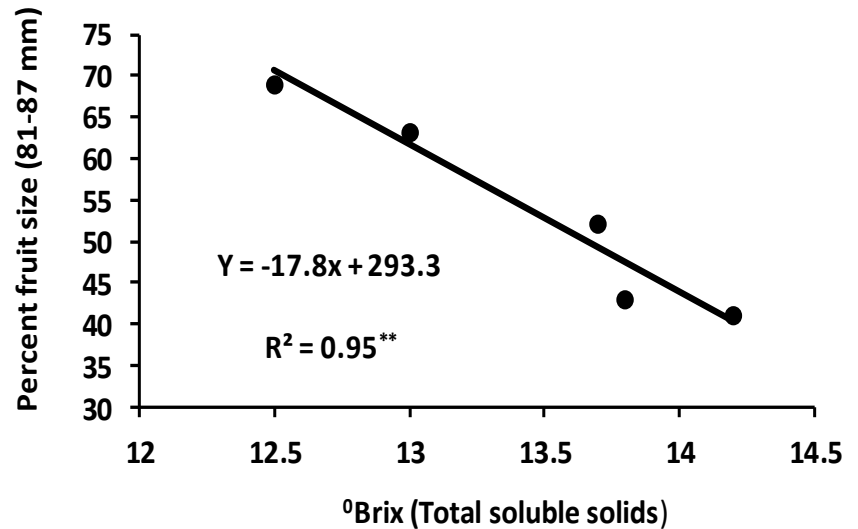
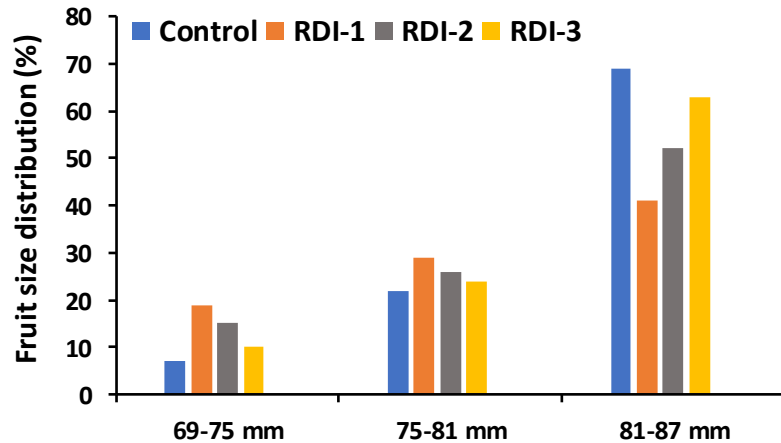
# Fruit quality and yield for 2019

	Washington navel			Lanes Late		
	Brix	Acid	Yield	Brix	Acid	Yield
Control	<b>12.8</b>	<b>1.0</b>	<b>55.0</b>	<b>12.5</b>	<b>1.0</b>	<b>54.5</b>
RDI-1	13.7	1.2	47.0	14.2	1.1	40.5
RDI-2	13.6	1.2	50.9	13.7	1.1	43.8
RDI-3	12.6	1.0	55.4	13.0	1.0	46.8

# 2019 (Washington navel) – Fruit size distribution



# 2019 (Lane late navel) – Fruit size distribution

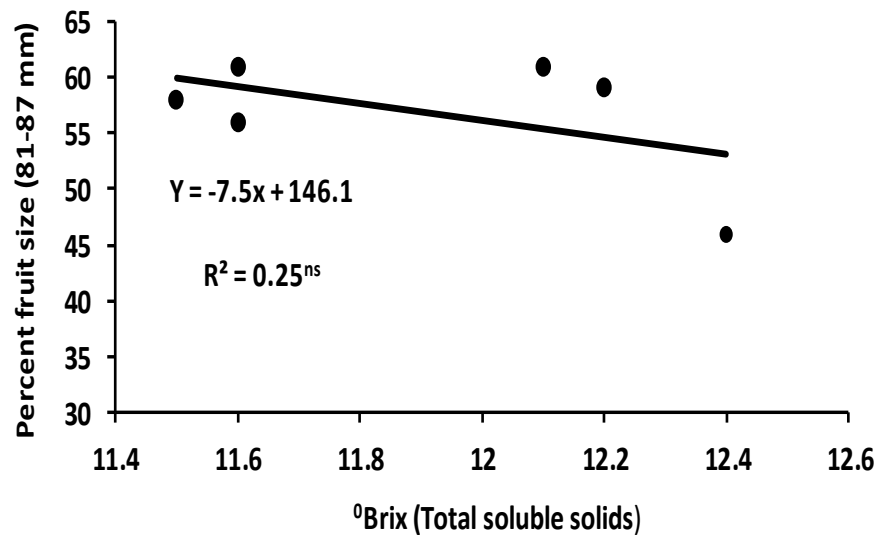
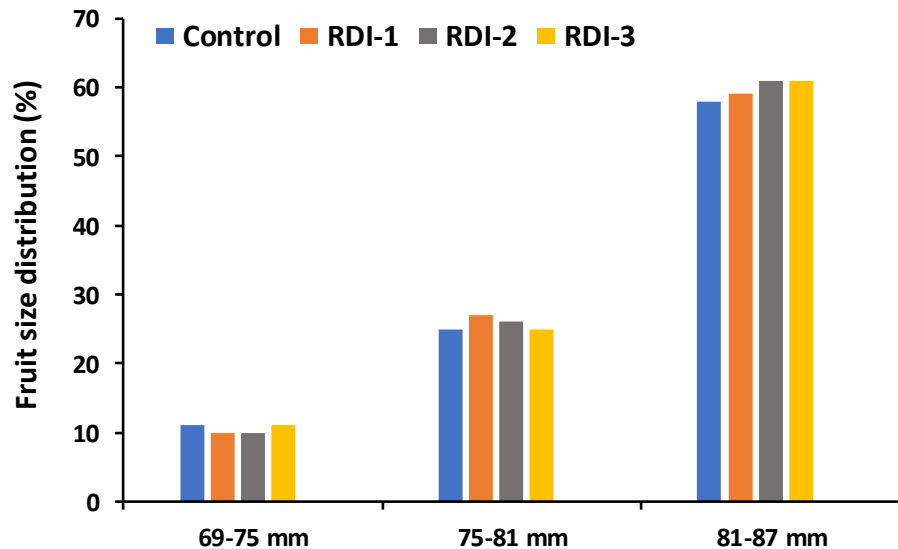


# 2020 - rainy season



	Jan	Feb	Mar	Apr	May
Rainfall (mm)	6	21	26	72	1

# 2020 (Washington navel) – Fruit size distribution



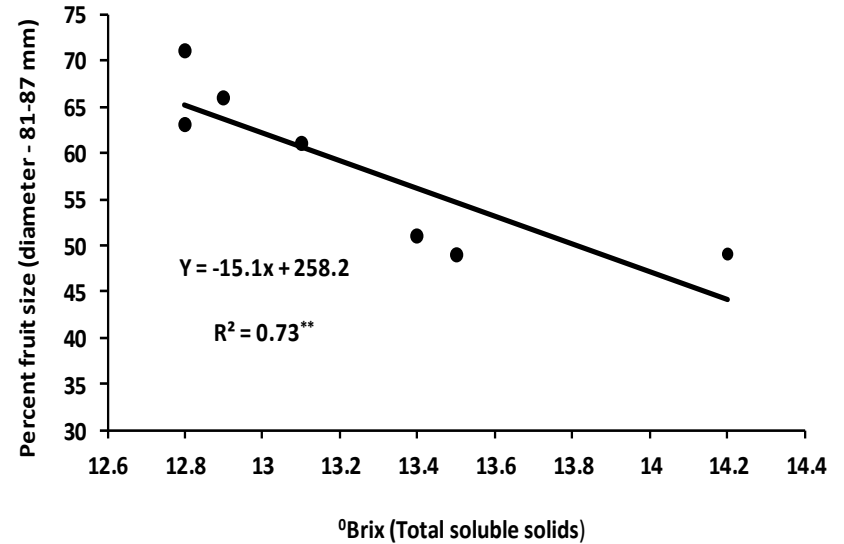
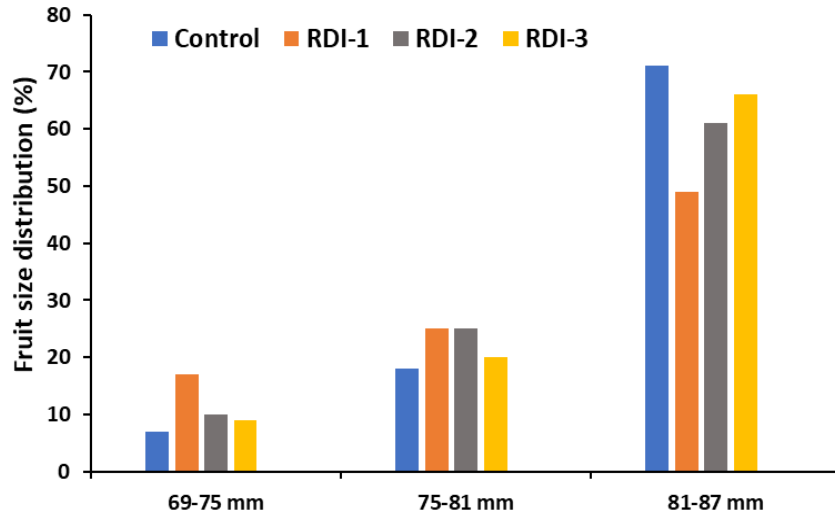
# RDI treatments 2021

	Feb		Mar		Apr		May		June		July-Jan
<b>Control</b>											
<b>RDI-1</b>			2 weeks	50% for 8 weeks				100%			
<b>RDI-2</b>				2 weeks	50% for 8 weeks						
<b>RDI-3</b>					2 weeks	50% for 8 weeks					

# Fruit quality and yield for 2021

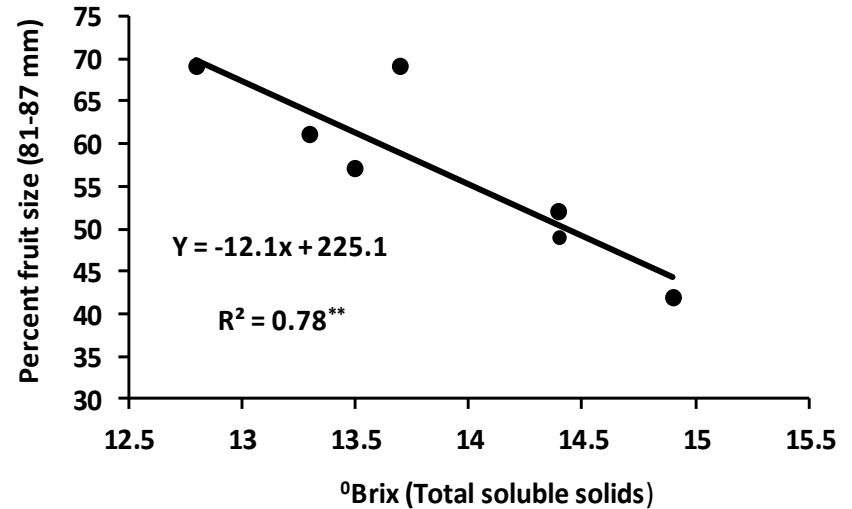
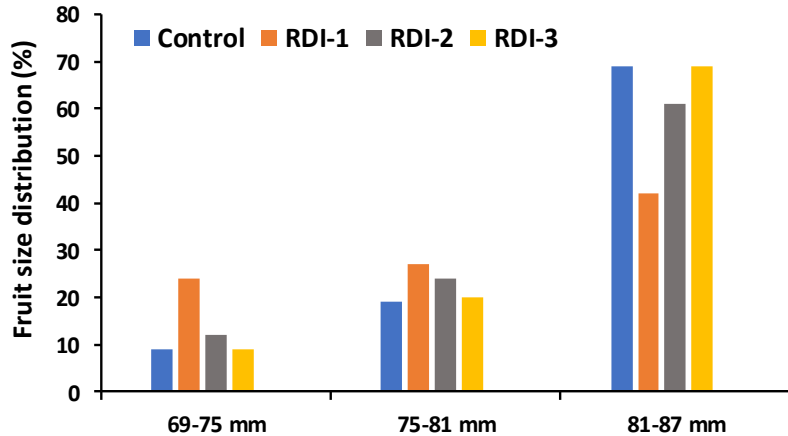
	Washington navel			Lanes Late		
	°Brix	%acid	Yield/kg	°Brix	%acid	Yield/kg
Control	<b>12.8</b>	<b>1.2</b>	<b>70.0</b>	<b>12.8</b>	<b>1.1</b>	<b>53.1</b>
RDI-1	<b>13.8</b>	<b>1.3</b>	<b>55.0</b>	<b>13.9</b>	<b>1.3</b>	<b>34.7</b>
RDI-2	<b>13.7</b>	<b>1.3</b>	<b>60.1</b>	<b>13.8</b>	<b>1.2</b>	<b>36.2</b>
RDI-3	<b>12.9</b>	<b>1.1</b>	<b>64.7</b>	<b>12.7</b>	<b>1.3</b>	<b>43.5</b>

# 2021 (Washington navel) – Fruit size distribution





# 2021 (Lane late navel) – Fruit size distribution



# °Brix vs. large fruit size decrease

°Brix	% fruit size decrease (81-87 mm)
0.5	5
1.0	10
1.5	15
2.0	20
2.5	25

# Economic analysis of RDI

\$ loss/ha (40 t/ha) with RDI treatments

	Washington navel		Lane Late	
	<i>P. trifoliata</i>	<i>T. citrange</i>	<i>P. trifoliata</i>	<i>T. citrange</i>
1-15 Mar	753	1198	791	1187
15-30 Mar	170	886	350	750
1-15 Apr	242	286	87	240

# Water savings for 10 weeks during stress period (ML/ha)

	Control	1-15 Mar	15-30 Mar	1-15 Apr
Water used	2.42	1.53	1.64	0.67
Water saved	-	<b>0.89</b>	<b>0.79</b>	<b>0.75</b>

**Includes drying period (2 weeks) + 8 weeks (50%)**

# Recommendations

Sugar can be increased in oranges by RDI

- **Washington navel & Lane Late navel**

**Soil profile drying** (15-30 Mar) > -60 kPa) Tensiometer  
**50% for 8 weeks** (1 Apr-30 May)  
**100% irrigation** (1 June to harvest)

- **Later stress:**

**1-15 Apr drying >> 50% irrigation for 8 weeks**

**Low temp**

**Rainfall (60-year Long time average)**

18 mm Mar

35 mm Apr

- **Average fruit size**

> 70 mm for Navel & > 68 mm for Lanes when stress is imposed

# Acknowledgements

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