وزارة التغير المناخي والبيئة
MINISTRY OF CLIMATE CHANGE & ENVIRONMENT

ICARDA
Science for resilient livelihoods in dry areas

Subsurface irrigation system using Ultra Low-Pressure dripper powered by solar energy

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An important question

- Indigenous to the Middle East and North African arid regions, the date palm thrives in harsh desert conditions with extreme temperatures and poor soil.
- Its deep roots stabilize dunes, combatting desertification.
- Its fruits provide vital sustenance for humans and animals.
- A symbol of desert life, the date palm is a keystone species crucial to desert ecosystem balance.

But How much water does a date palm tree need per day? (average for the whole year)

Crop water requirements of date palm based on actually applied water and Penman–Monteith calculations in Saudi Arabia

Abdulrasoul AL-Omran
Samir Eid
Fahad Alshammari

https://link.springer.com/article/10.1007/s13201-019-0936-6

When considering the proportion of the cultivated area per tree, the annual irrigation water requirements were notably high in all regions, ranging from 73 m3/tree (Al Jouf and Tabuk) to 95 m3/tree (Medina).

Its 200 to 260 liters/day

Date Palm Water Productivity

Assessment of farmers' practices to date palm soil fertilization and its impact on productivity at Al-Hassa oasis of KSA (published 2021)

Almadini AM, Ismail AIH, Ameen FA. Assessment of farmers practices to date palm soil fertilization and its impact on productivity at Al-Hassa oasis of KSA. Saudi J Biol Sci. 2021 Feb;28(2):1451-1458. doi: 10.1016/j.sjbs.2020.11.084. Epub 2020 Dec 4. PMID: 33613072; PMCID: PMC7878831.

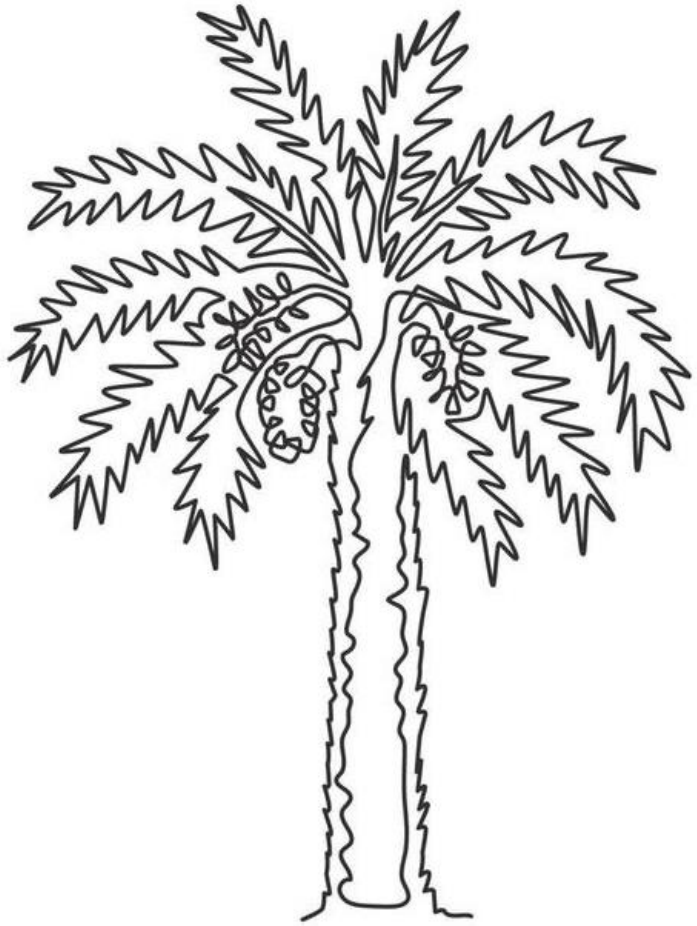
The average annual production of a date palm tree in the old oasis is 81.4 kg, while it is 54.6 kg in the new oasis.

$81.4kg/95m^3=0.89kg/m^3$

$81.4kg/73m^3=1.12kg/m^3$

About 1200 m3 for each ton of date

One date palm tree use about the same amount of water per day as a Hydroponics net house (8x30 meter), producing 3600-4000 kg of tomato



Subsurface irrigation

In subsurface drip irrigation, drip tape is buried below the soil surface

http://www.cottoninc.com/fiber/AgriculturalDisciplines/Engineering/Irrigation-Management/Irrigation-Systems-Overview/
http://home.howstuffworks.com/irrigation4.htm

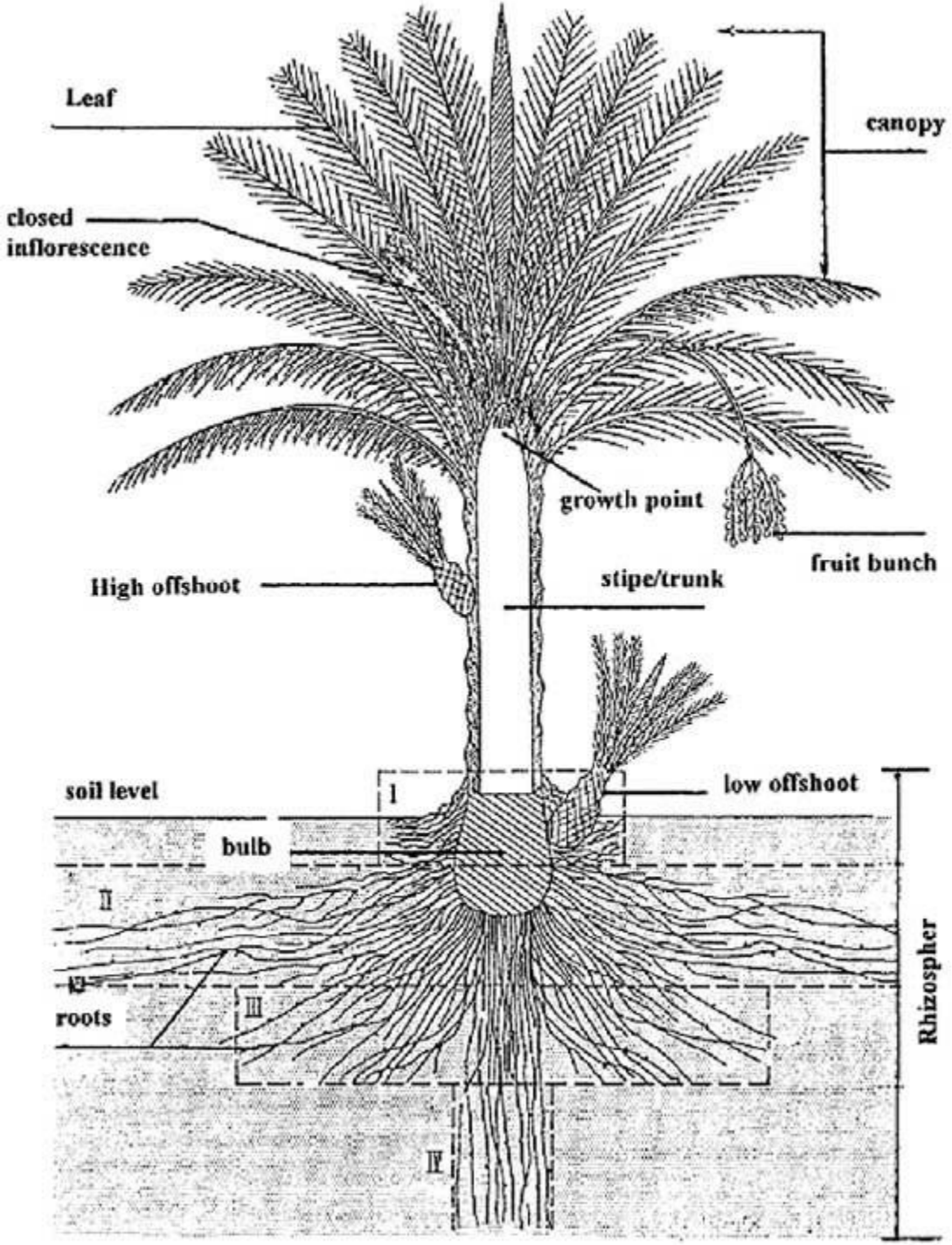
Date palm Root System

Zone I - Respiratory Zone: Around the palm base, within 25 cm depth, with mainly primary and secondary roots for respiration.

Zone II - Nutritional Zone: Largest zone, 0.90 to 1.50 m deep, with abundant primary and secondary roots for nutrition.

Zone III - Absorbing Zone: Depth of 1.5 to 1.8 m, fewer roots (about 200/m²), importance depends on water depth.

Zone IV: Varies with water depth, roots with positive geotropism, often resembling vessels.



Sub-surface irrigation for date palm trees in GCC

- Previous study shows that sub-surface irrigation saved up to 40% of annual water saving compared to Bubbler irrigation

Dhehibi , Boubaker , Mohamed Ben Salah, Aymen Frija, Aden Aw-Hassan, Hamdane El Ouhibi, and Youssef M. Al Raisi. "Economic and Technical Evaluation of Different Irrigation Systems for Date Palm Farming System in the GCC Countries: Case of Oman." *Environment and Natural Resources Research* 8, no. 3 (2018).

Subsurface irrigation saves water through a few key mechanisms

1.Reduced Evaporation: By applying water directly to the root zone beneath the soil surface, subsurface irrigation significantly reduces water lost to evaporation compared to traditional surface irrigation methods.

2.Controlled Application: Subsurface irrigation systems can deliver water at a controlled rate directly to the root zone, reducing runoff and oversaturation, which can lead to water waste.

3.Efficient Water Use: Since water is delivered directly to the roots, it is more effectively used by the plants, minimizing the volume of water needed.

4.Leakage and Overflow Minimization: Traditional irrigation methods can often lead to water waste through leakage or overflow. Subsurface irrigation limits this by applying water only where it's needed, and in controlled amounts.

5.Less Weed Growth: Since the surface remains relatively dry, weed growth is limited, which indirectly results in water savings, as less water is consumed by unwanted plants.

Sub-surface irrigation for date palm

Advantage	Disadvantage
Water Efficiency Fertilizer Efficiency Reduced Weed Growth Minimizes Disease Spread Erosion Prevention Saves Labor Reduced Salinity	Initial Cost High Maintenance Limited Access Root Intrusion Limited Indication of Problems and access Energy Consumption Drainage Risk of Salt Accumulation Requires Technical Knowledge

Factors Influencing Subsurface Drip Irrigation (SDI) Design

1. **Flow Rate & Water Supply:** SDI system must deliver the required flow rate with an adequate water supply. The crop with the highest water demand should be prioritized in crop rotation.
2. **Climate Considerations:**
    1. Humid areas require less water due to reduced vapor pressure gradient for evapotranspiration.
    2. Factors like temperature, sunshine, and wind also influence evapotranspiration.
    3. Evaporation from irrigation is minimized as SDI does not usually wet the soil surface.

Factors Influencing Subsurface Drip Irrigation (SDI) Design

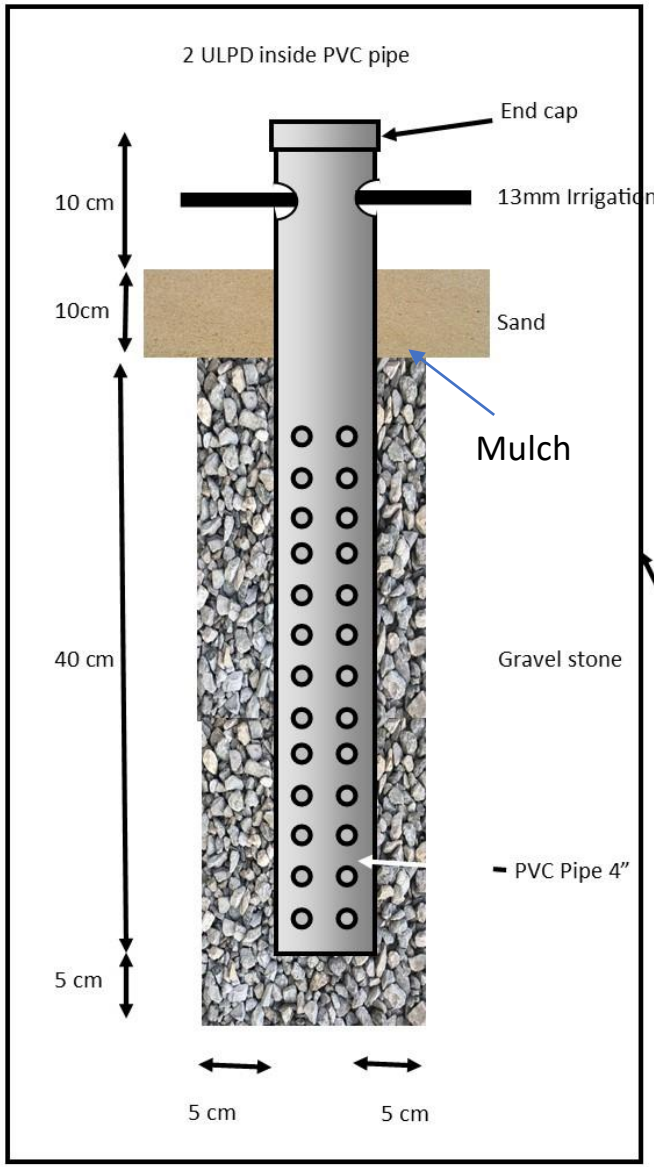
Crop Water Use:

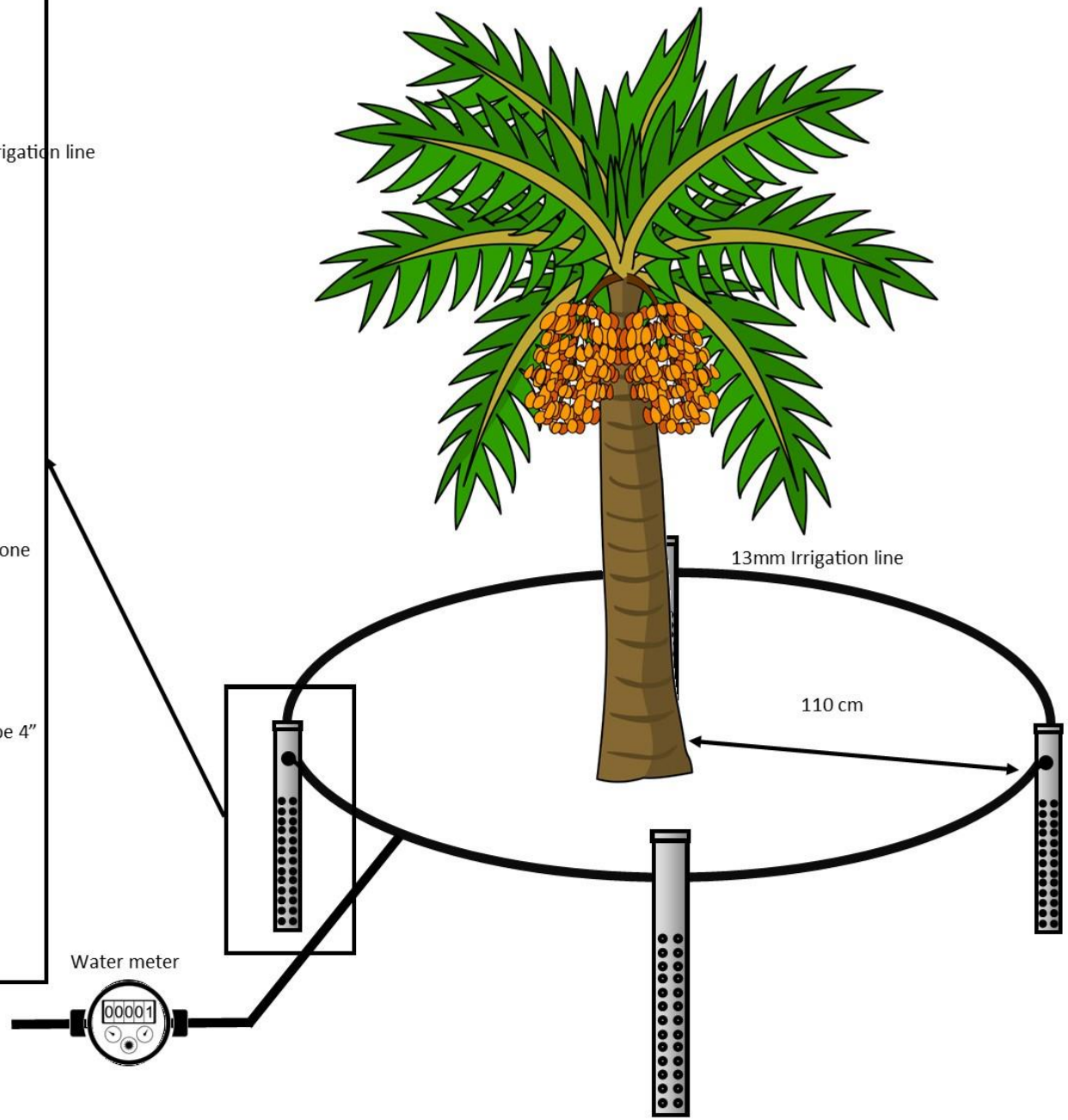
- Crucial for SDI design is the crop's "peak" water requirement - the amount used during its highest water-use period.
- Rain may reduce the irrigation requirement for a season but should not be factored into peak use rate calculation.
- The design flow rate for crop water needs must match the drip line flow rates as specified by the manufacturer.

Factors Influencing Subsurface Drip Irrigation (SDI) Design

Soil Characteristics:

1. Soil type impacts SDI system design.
2. Texture, structure, and layering of soil can affect hydraulic characteristics like infiltration rate and conductivity.
3. Drip lines are spaced closer in sandy soil due to less lateral spread of water.
4. Slower emitter emission rates might be needed in heavy-textured soils like clay.
5. Generally, drip line depths should be shallower in coarser soils and deeper in finer soils.


2 ULPD inside PVC pipe
End cap
13mm Irrigation line
10 cm
10cm
Sand
Mulch
40 cm
Gravel stone
PVC Pipe 4”
5 cm
5 cm
5 cm

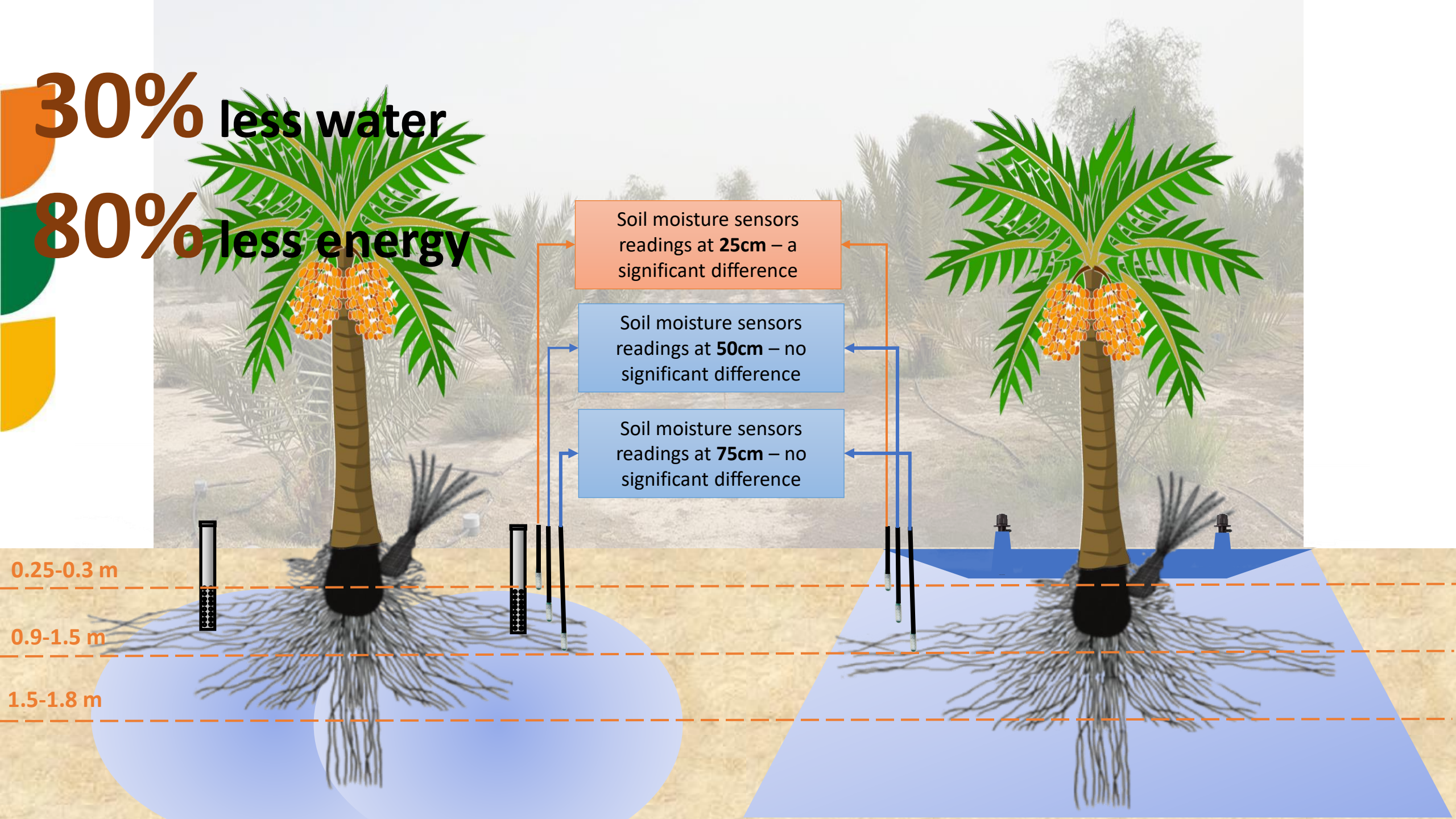

13mm Irrigation line
110 cm
Water meter
00001


20 cm

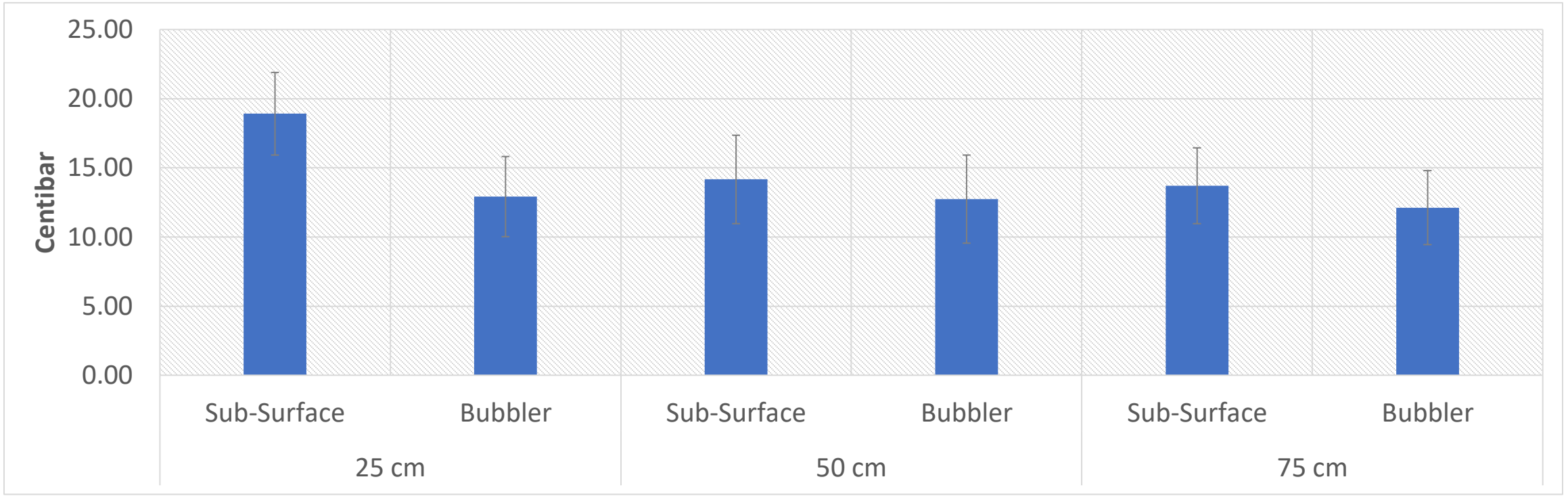
- Reduce pump size

220 V, 1 HP pump

12V, 0.2 HP pump, powered by solar energy

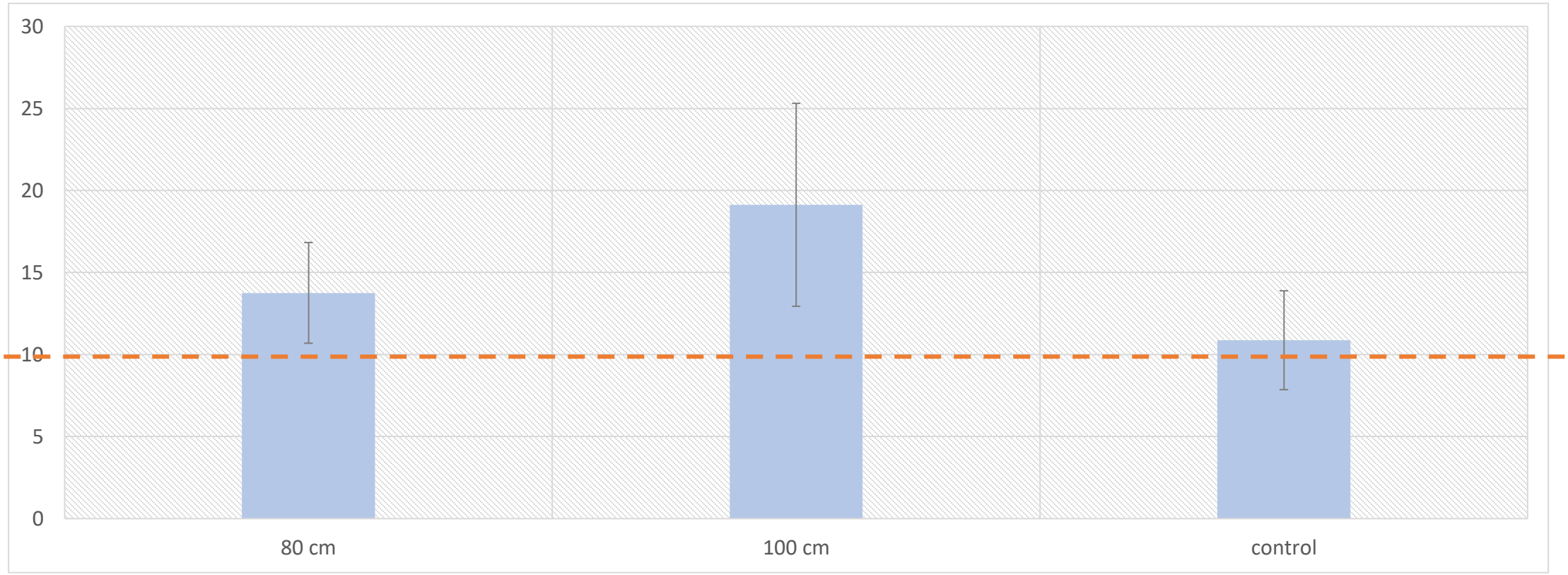

30% less water
80% less energy
Soil moisture sensors readings at **25cm** – a significant difference
Soil moisture sensors readings at **50cm** – no significant difference
Soil moisture sensors readings at **75cm** – no significant difference
0.25-0.3 m
0.9-1.5 m
1.5-1.8 m

Comparing the average reading of the humidity sensor in Centibar for the two irrigation systems at three different depths (six-week daily reading start from 7 Nov 2022)



0-10 Centibars	Saturated soil
10-30 Centibars	Soil is adequately wet (except for coarse sands, which are drying)
30-60 Centibars	Usual range for irrigation (most soils)
60-100 Centibars	Usual range for irrigation in heavy clay
100-200 Centibars	Soil is becoming dangerously dry- proceed with caution

Average of four weeks reading (10 min Before) irrigation, Dhaid ARS



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Impact on Yield and Quality of production

The study aims to compare the yield and water use efficiency of date palm trees using different irrigation methods (bubbler and modified-subsurface)

- The date palm trees for this study were selected randomly among trees of the same age at Dhaid ARS.
- 12 date palm trees are selected and divided into 4 groups of three trees each.
    1. Group One: Modified sub-surface irrigation using 60cm (4-inch) PVC pipes installed at 80cm from the trees.
    2. Group Two: Modified sub-surface irrigation using 60cm (4-inch) PVC pipes installed at 110cm from the trees.
    3. Groups Three and four: Control groups using the bubbler irrigation system.
- Groups One and Two will receive 20% less water daily than Group Three.
- Soil moisture at a depth of 50cm is being measured using soil moisture sensors.
- Six sensors (two in each group) installed.
- Sensor readings are being taken at three different times:
    1. 10 minutes before irrigation,
    2. 10 minutes after irrigation,
    3. and once 3 days after irrigation.
- All trees will be irrigated weekly for 35min throughout the study period.


THANK
YOU

Thank you