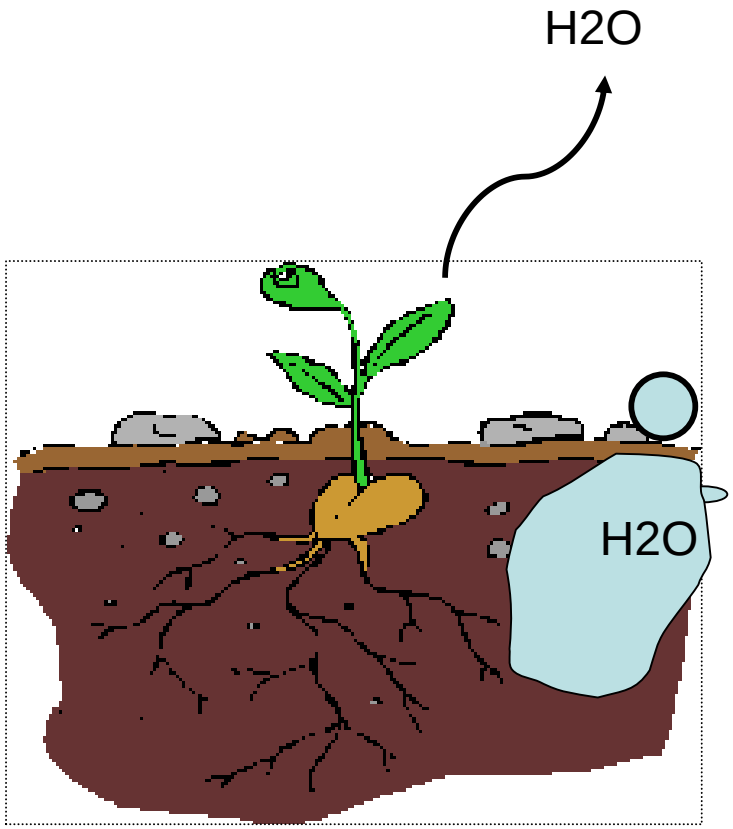
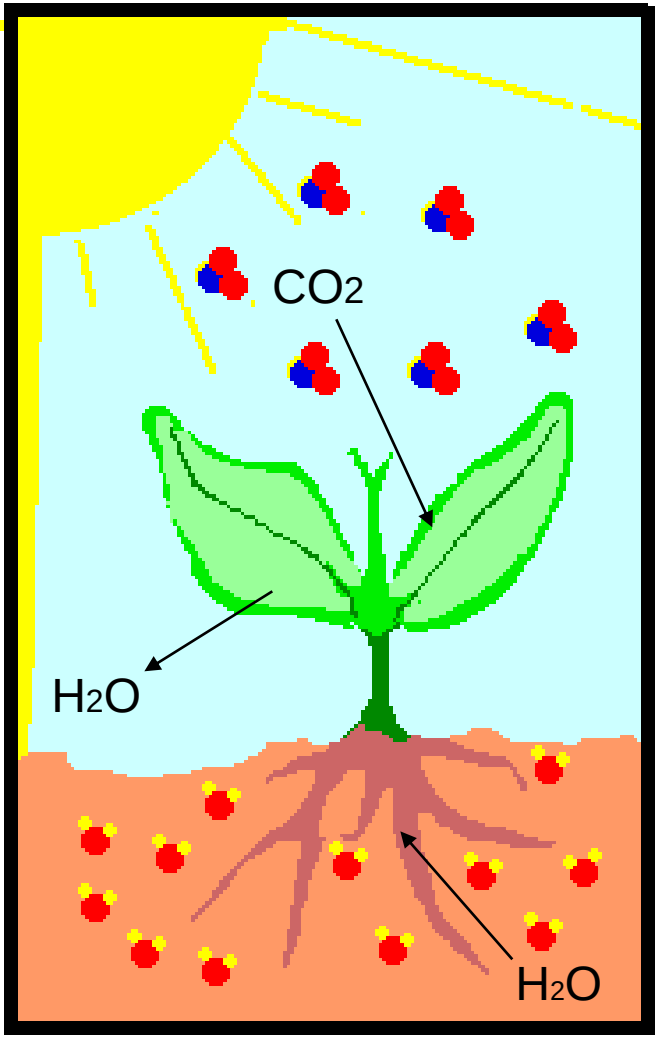
Soil/Water/Plant/Atmosphere Continuum



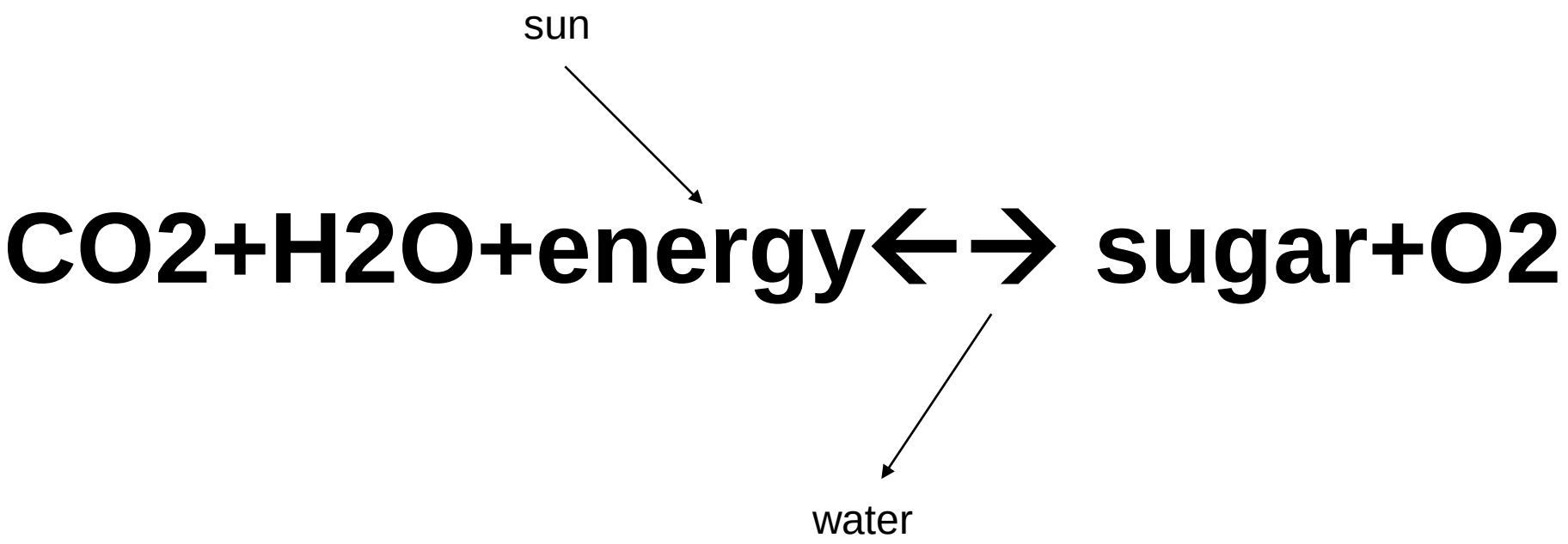
Or

Why Water?

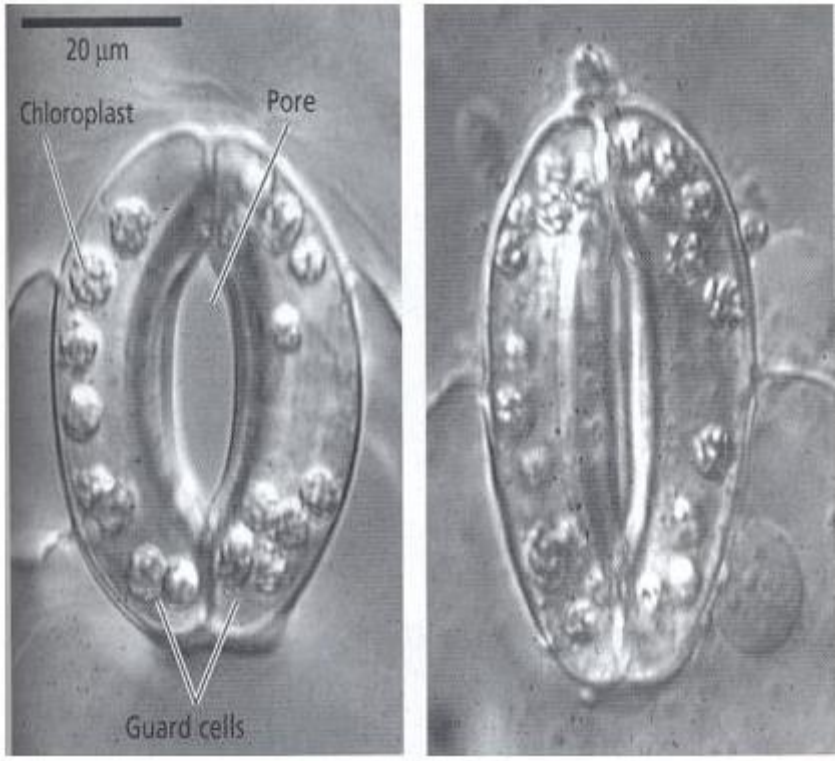
ceventura.ucdavis.edu/avocado



A plant must lose water in order to grow


sun
CO2+H2O+energy←→ sugar+O2
water

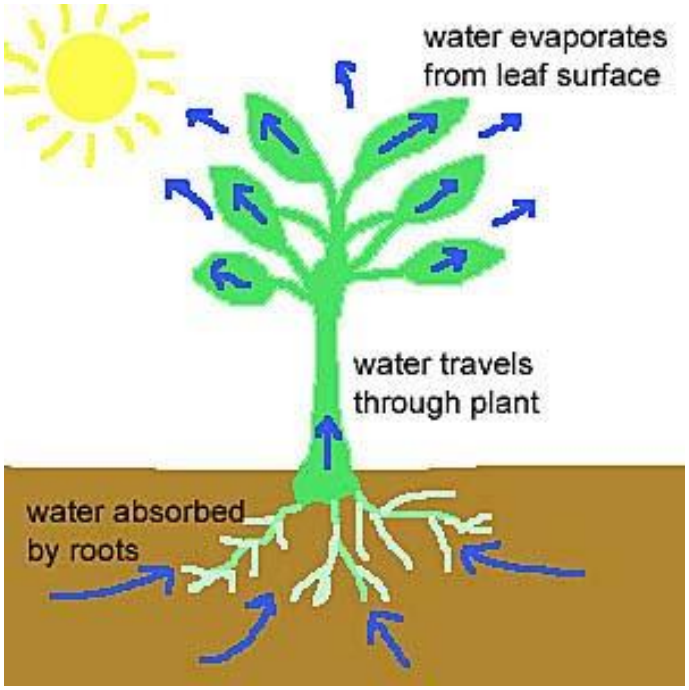
Stomata-
openings on leaves



open

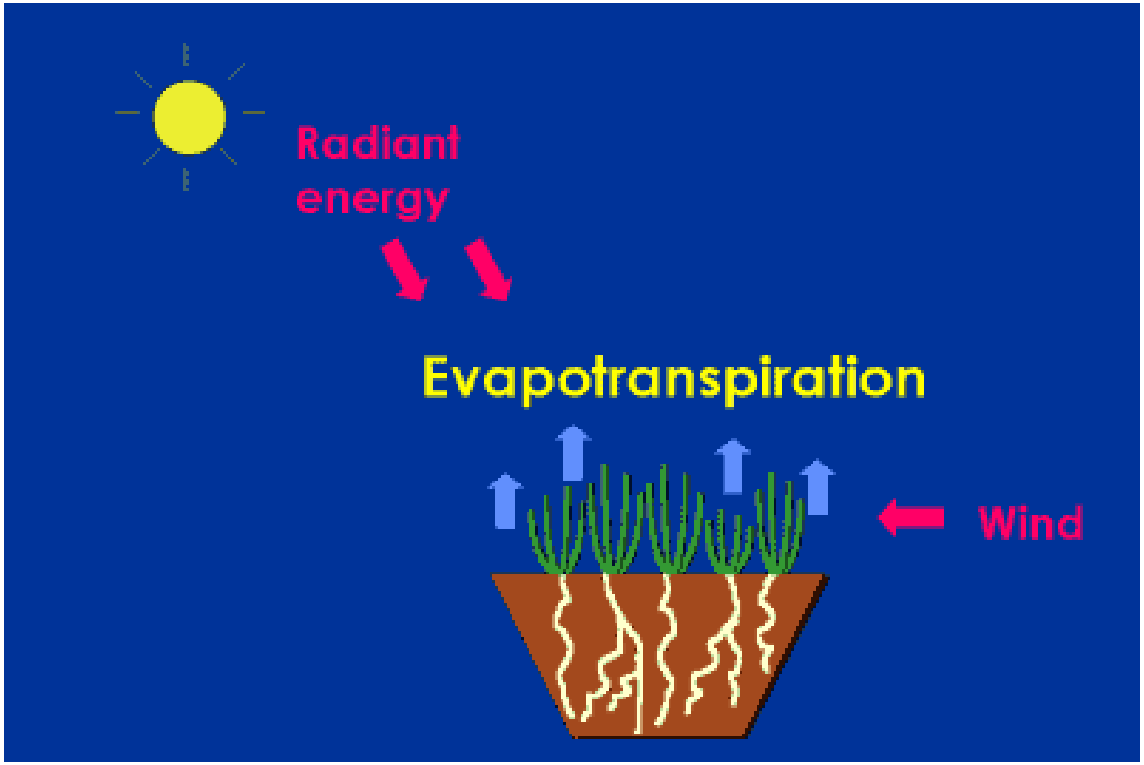
closed

Water lost through stomata
is called TRANSPIRATION



Which is the same process as
EVAPORATION

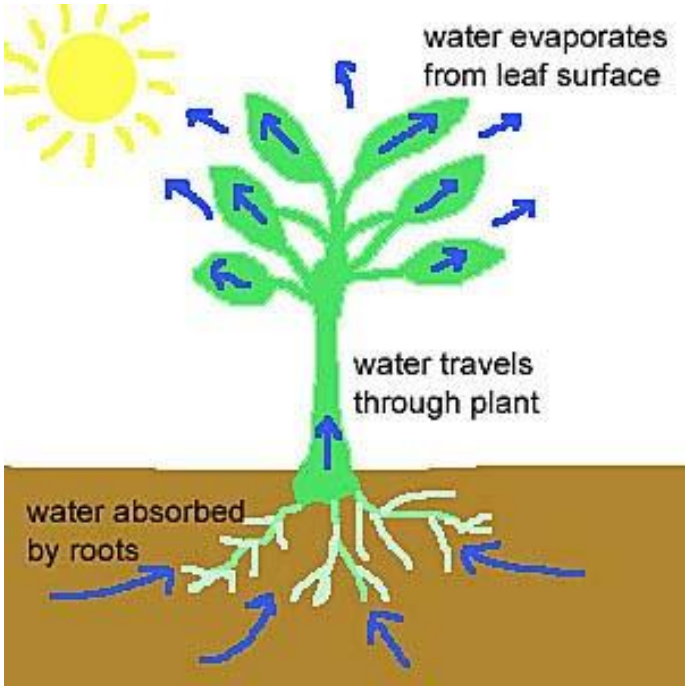
Water lost from a landscape or crop
is called
EVAPOTRANSPIRATION



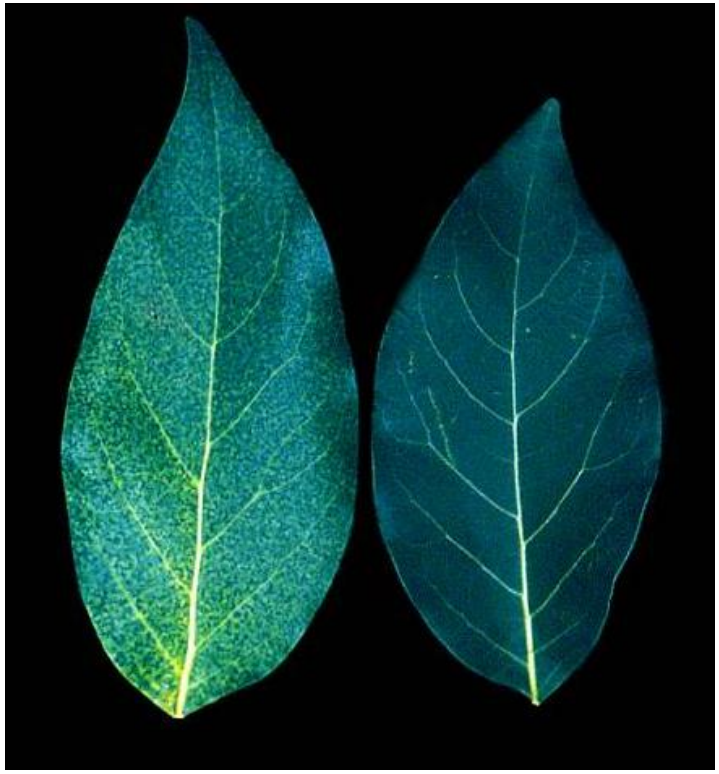
The stomata must be open for transpiration to occur!!!!!
Otherwise the plant heats up, and sunburn occurs.

RADIATIVE COOLING

And cools the plant



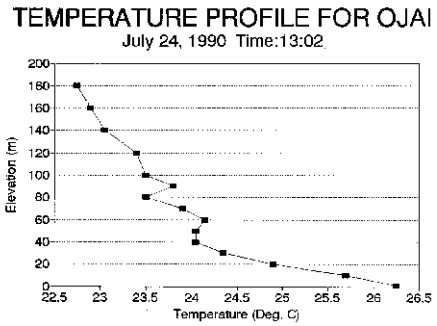
When water stops moving through the plant, nutrients stop moving through the plant

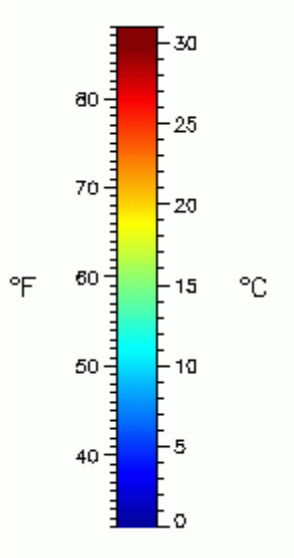


N deficiency

Evapotranspiration is driven by:

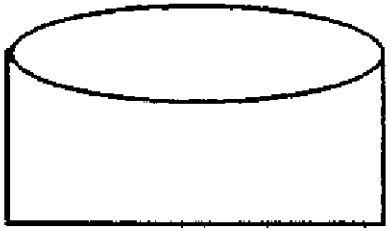
Sun – day length, clouds
Wind
Humidity
Temperature





And there must be leaves
if water is lost through transpiration
NO Leaves, No transpiration !!!!

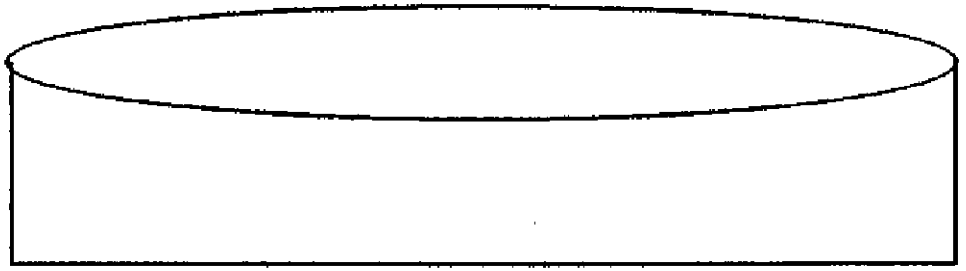
400 sq. ft.



250 gallons

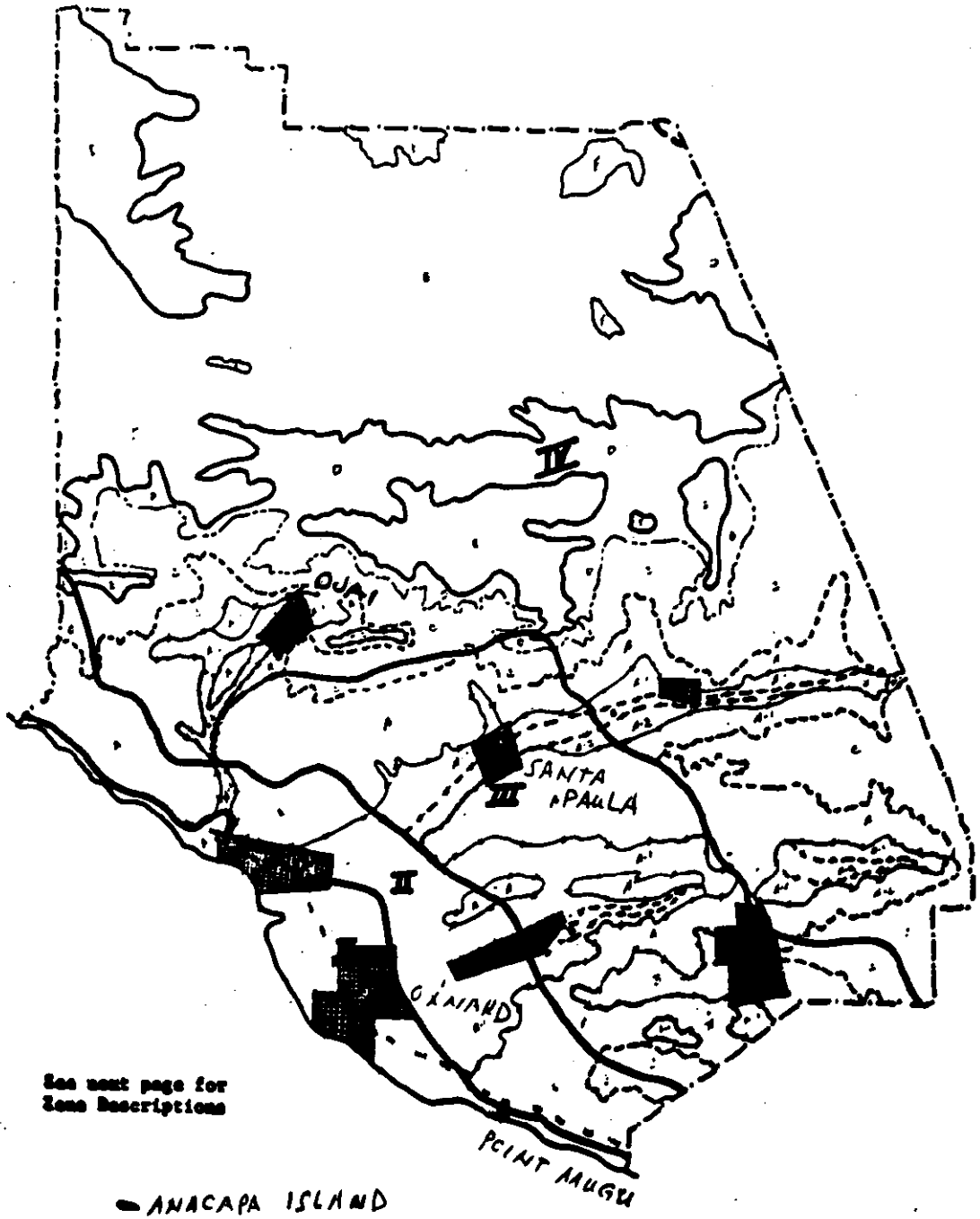
one inch in each
equals

43,560 sq. ft.



27,154 gallons

one acre-inch



PLANTCLIMATES OF VENTURA COUNTY

Table 12

Average Daily Evapotranspiration (ET) Rates by Location in California*

Location	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(inches/day)											
Northeastern Mountain Valleys	0.02	0.04	0.07	0.12	0.16	0.19	0.26	0.23	0.16	0.09	0.03	0.02
North Coast -- Coastal Valleys/Plains	0.02	0.04	0.06	0.08	0.11	0.12	0.11	0.11	0.09	0.06	0.04	0.02
North Coast -- Interior Valleys	0.03	0.04	0.08	0.11	0.16	0.20	0.23	0.20	0.15	0.09	0.04	0.02
Sacramento Valley	0.04	0.06	0.10	0.15	0.19	0.24	0.26	0.22	0.17	0.11	0.06	0.03
San Joaquin Valley	0.03	0.06	0.10	0.15	0.21	0.25	0.25	0.21	0.16	0.11	0.05	0.02
Central Coast -- Coastal Valleys/Plains	0.06	0.08	0.10	0.13	0.15	0.16	0.17	0.16	0.13	0.10	0.07	0.05
Central Coast -- Interior Valleys	0.05	0.08	0.11	0.14	0.18	0.21	0.22	0.19	0.16	0.12	0.08	0.05
Sierra (Tahoe Basin)	--	--	--	0.10	0.13	0.16	0.20	0.17	0.13	0.09	--	--
South Coast -- Coastal Valleys/Plains	0.06	0.09	0.10	0.13	0.14	0.17	0.18	0.18	0.15	0.11	0.09	0.07
South Coast -- Interior Valleys	0.06	0.09	0.11	0.14	0.16	0.20	0.22	0.22	0.17	0.12	0.08	0.06
Southern California Deserts	0.09	0.13	0.19	0.25	0.33	0.38	0.37	0.31	0.28	0.20	0.12	0.06

*Source: California Department of Water Resources and University of California (UC), as printed in UC Division of Agriculture and Natural Resources Leaflet #2976. Each of the 11 locations listed is considered a climate zone within the state.

Different Plant Deal with Water Differently

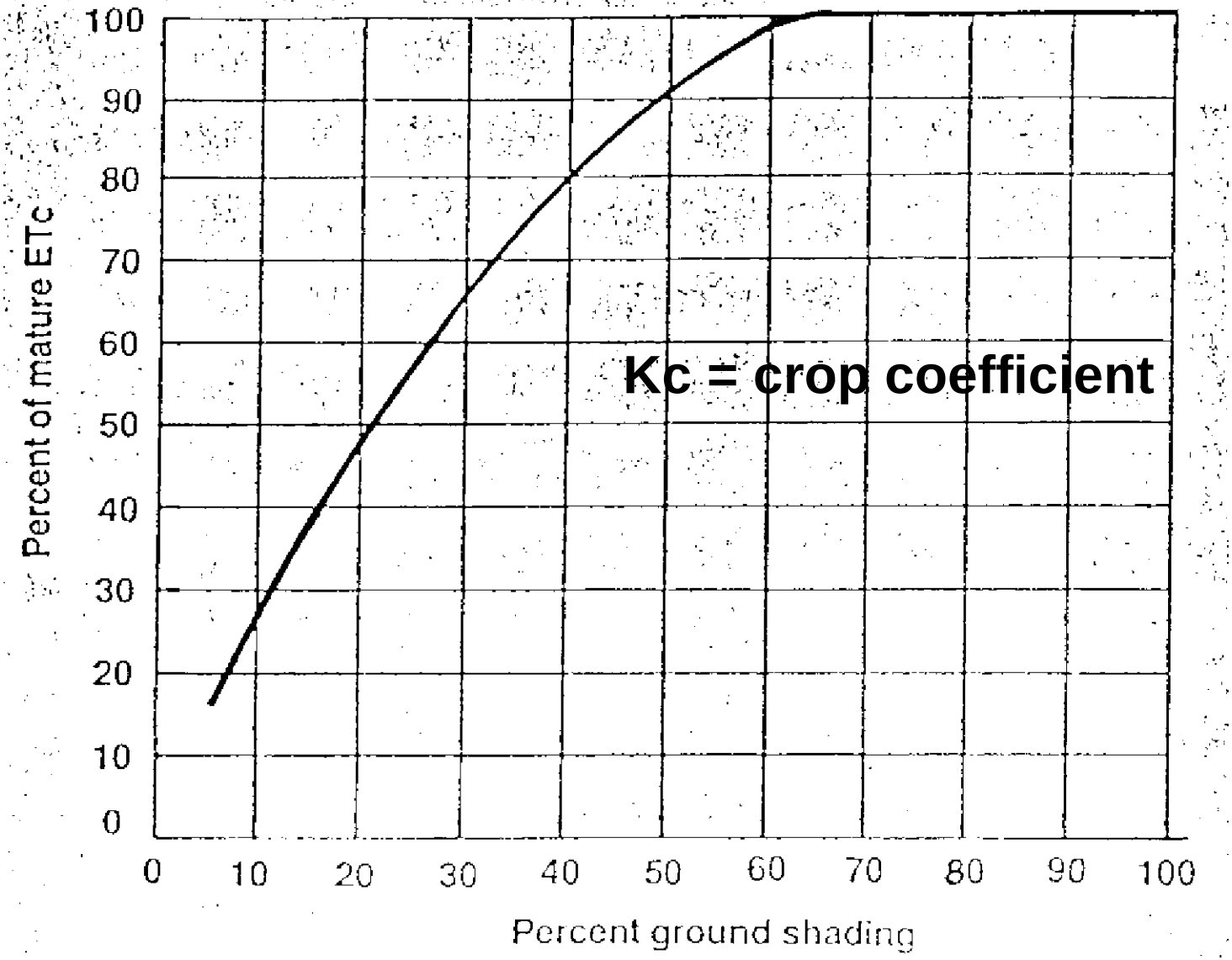


Fig. 3. Relationship between the percent ground area shaded by tree canopy in midsummer and ETc of drip-irrigated young trees as a percent of ETc of mature orchards (estimated from figure 8 in UC Leaflet 21259).

CIMIS weather station – data and complex equations are used to calculate a reference crop ET

Crop ET = crop coefficient x reference crop ET

ETo x kc = ET plant

ETavocado = 0.65 in/week

27,154 gals/ac-in X 0.65 =

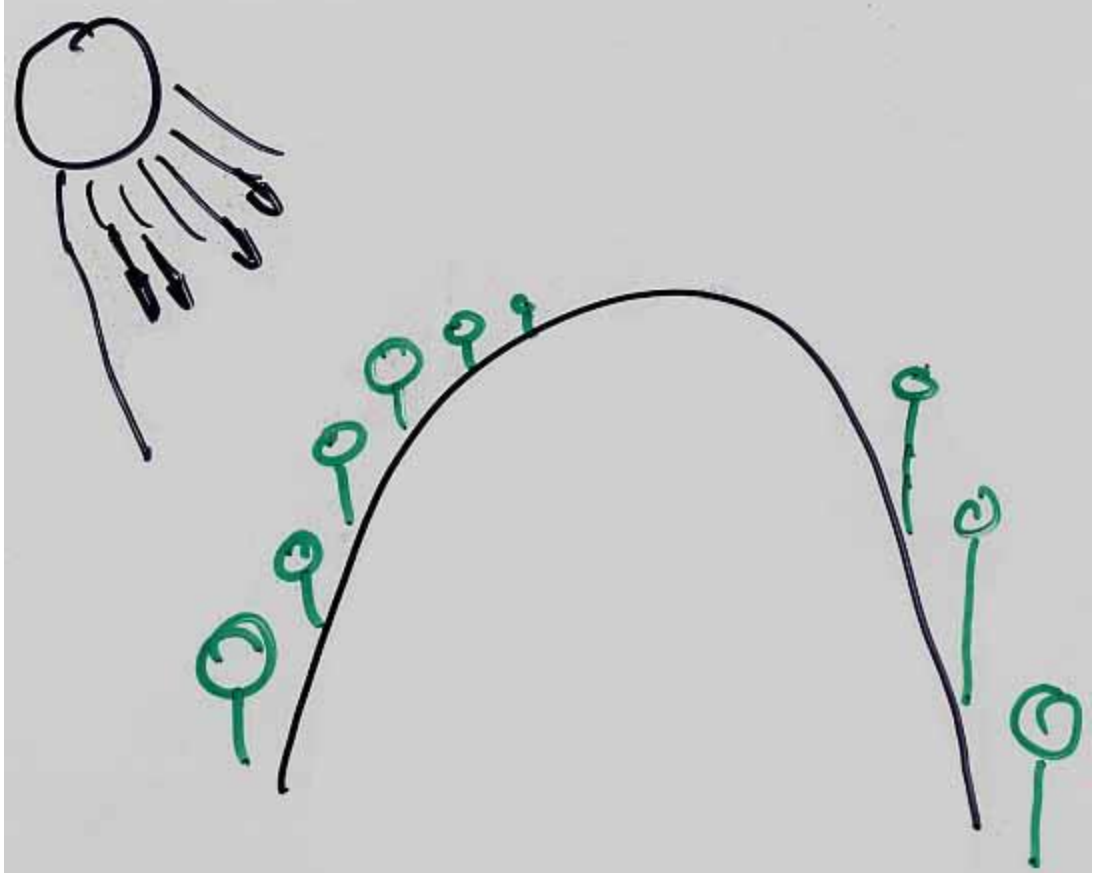
17,650 gals

17,650 gals /100 emitters/10gph=

17.7 hrs of irrigation

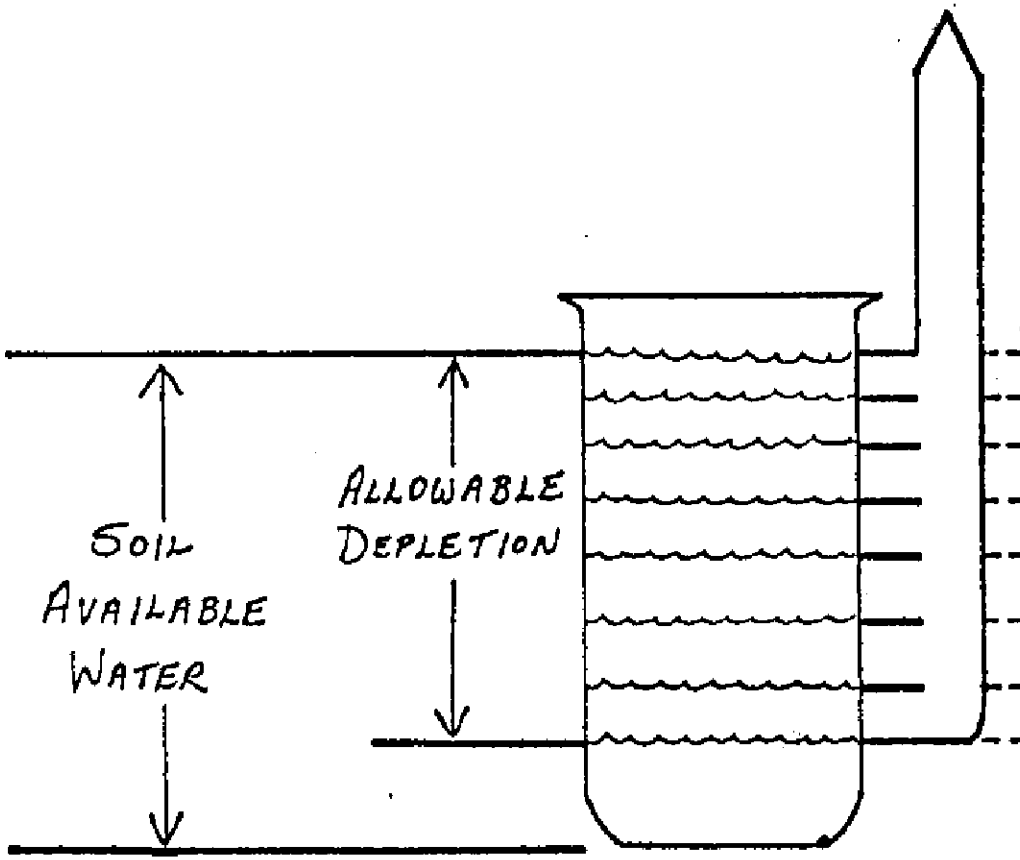
to replace water lost

In California, we plant avocados on slopes and irrigate all the trees with the same irrigation system and schedule.



9 atmometers
4 quadrants
3 positions
  toe
  mid-slope
  top

The Water Budget Method of Irrigation



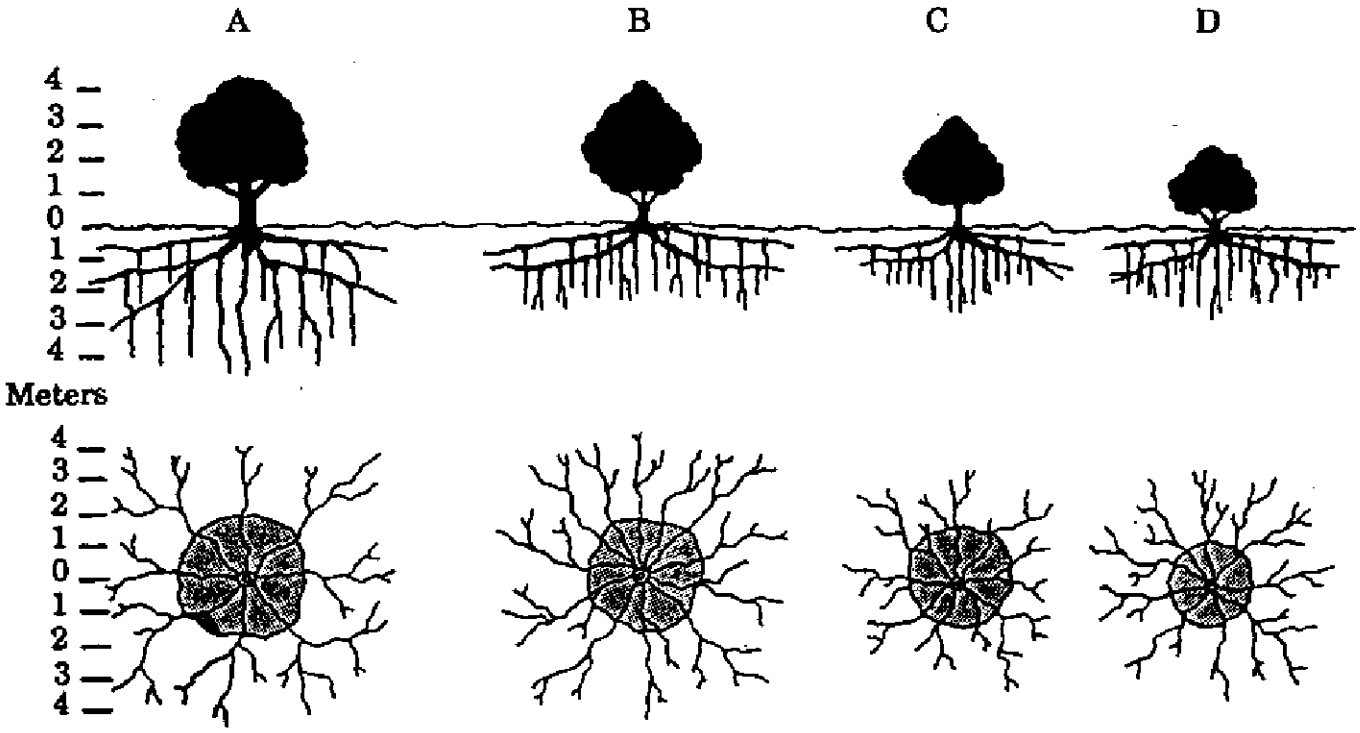
ET Loss To The Atmosphere

ET Inches / Day	Days
0.25	1
0.25	2
0.30	3
0.30	4
0.35	5
0.35	6
0.30	7
2.10	7

Irrigate 1. When ?_____ After 7 Days

2. How Much?___ Apply 2.10 Inches of Water + Losses (Efficiency consideration)

THE ROOT PATTERNS OF VARIOUS FRUIT TREES



Avocado roots are shallow, but dense

The soil is a reservoir

approximately 50% pores and 50% solids

***saturation*-when all pores are full**

***field capacity* -water held after draining**

***wilting point* -water content when plant won't revive**

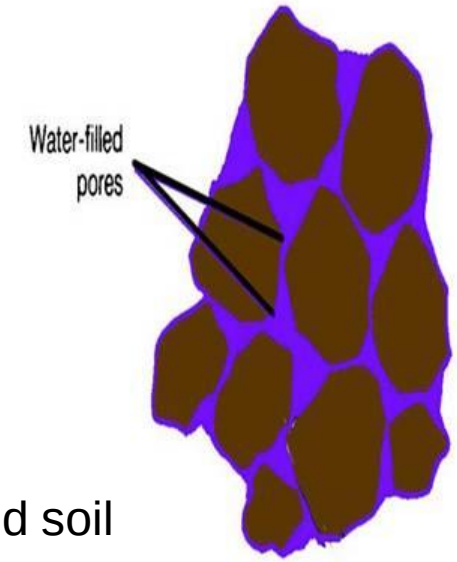
***available water* -between**

F.C

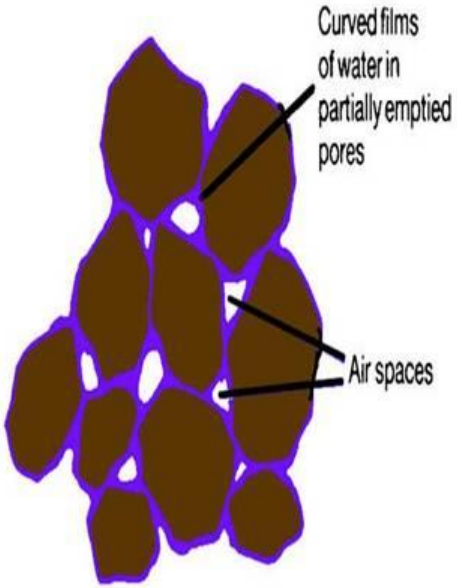
and

W.P.

Soil is a reservoir for water

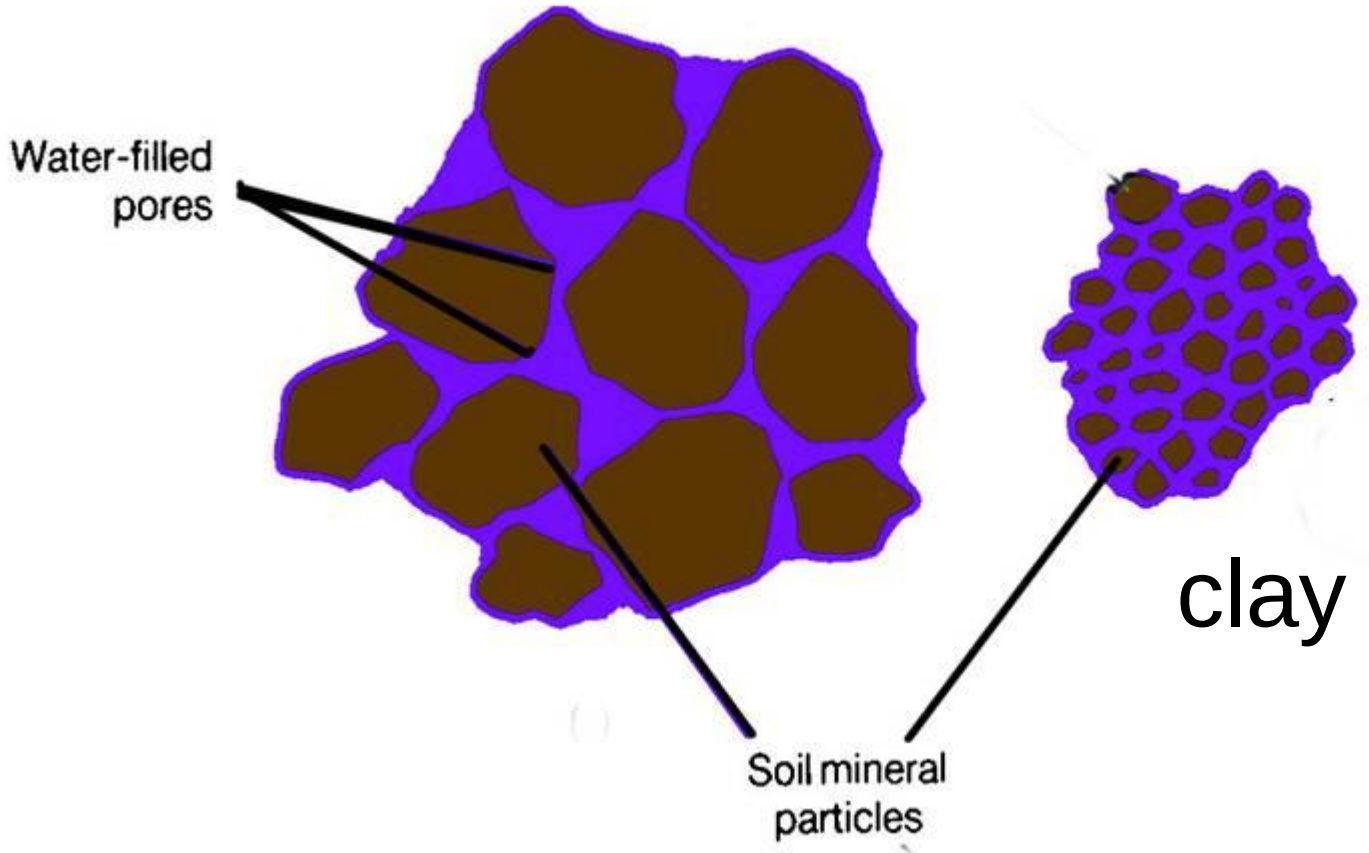


Saturated soil

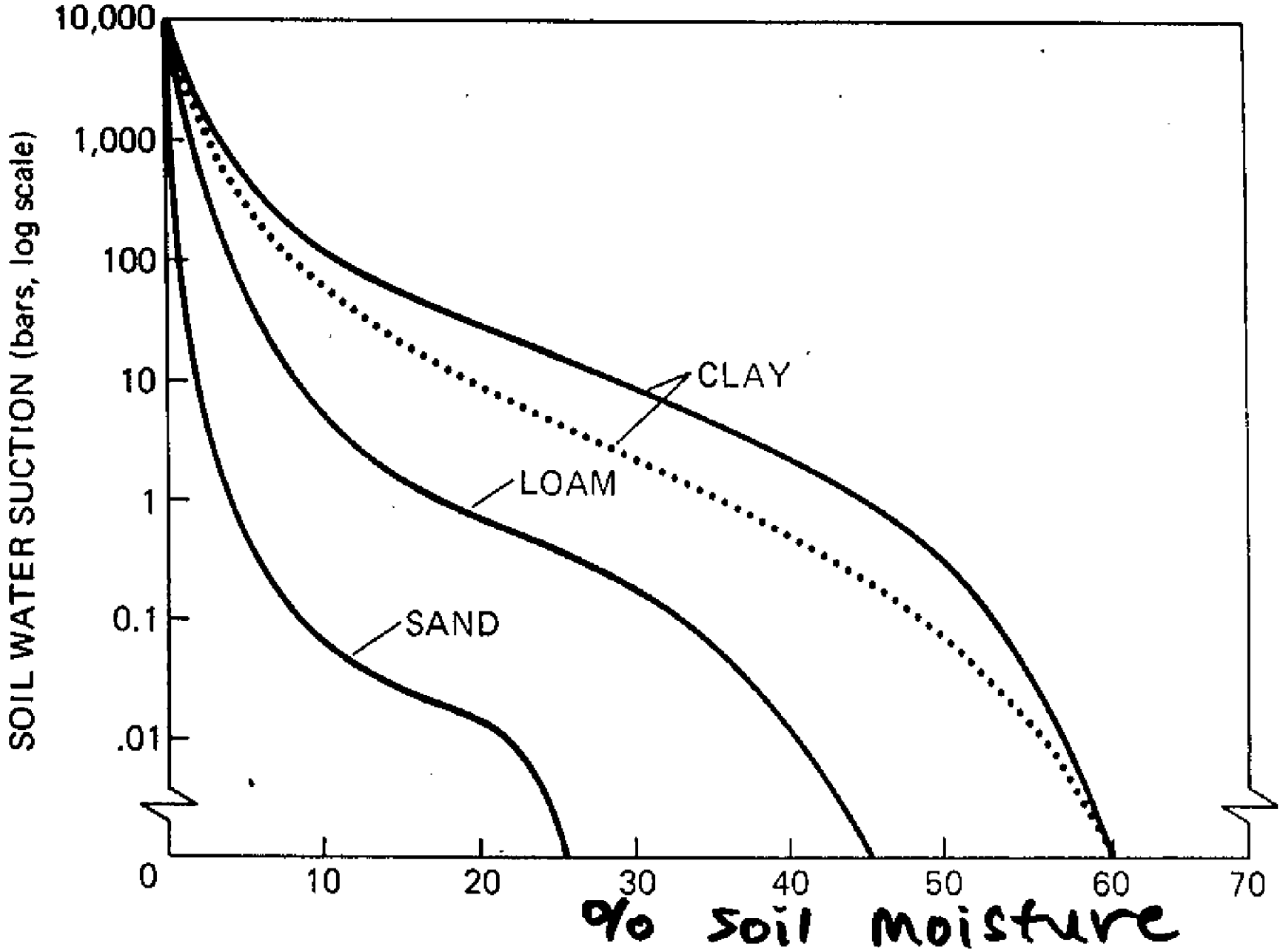


Field capacity

sand

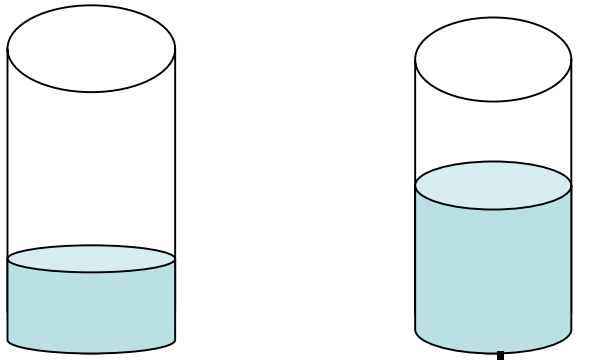


clay


SOIL WATER SUCTION (bars, log scale)
10,000
1,000
100
10
1
0.1
.01
0
10
20
30
40
50
60
70
CLAY
LOAM
SAND
% soil moisture

The amount of water in the soil between dry and field capacity is called AVAILABLE WATER

More water is held in a clay soil than a sandy soil with the same volume of soil



sand

clay

The speed that water moves in the soil is largely controlled by soil texture – how much sand or clay is in the soil

Clay has many small pores for carrying air and water

Sand has bigger, but fewer pores so water moves faster.

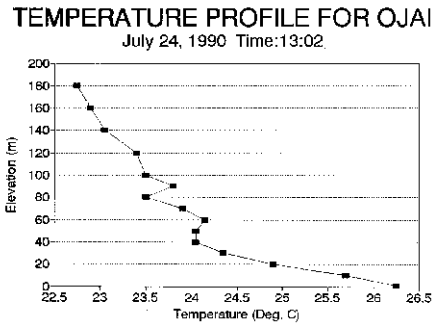
Plants need more water in a sandy soil

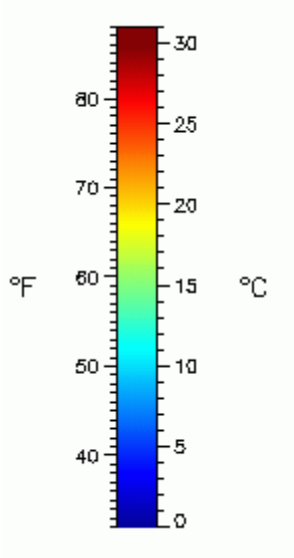
??????????

than they do in a clay soil?????????????

Evapotranspiration is driven by:

Sun – day length, clouds
Wind
Humidity
Temperature

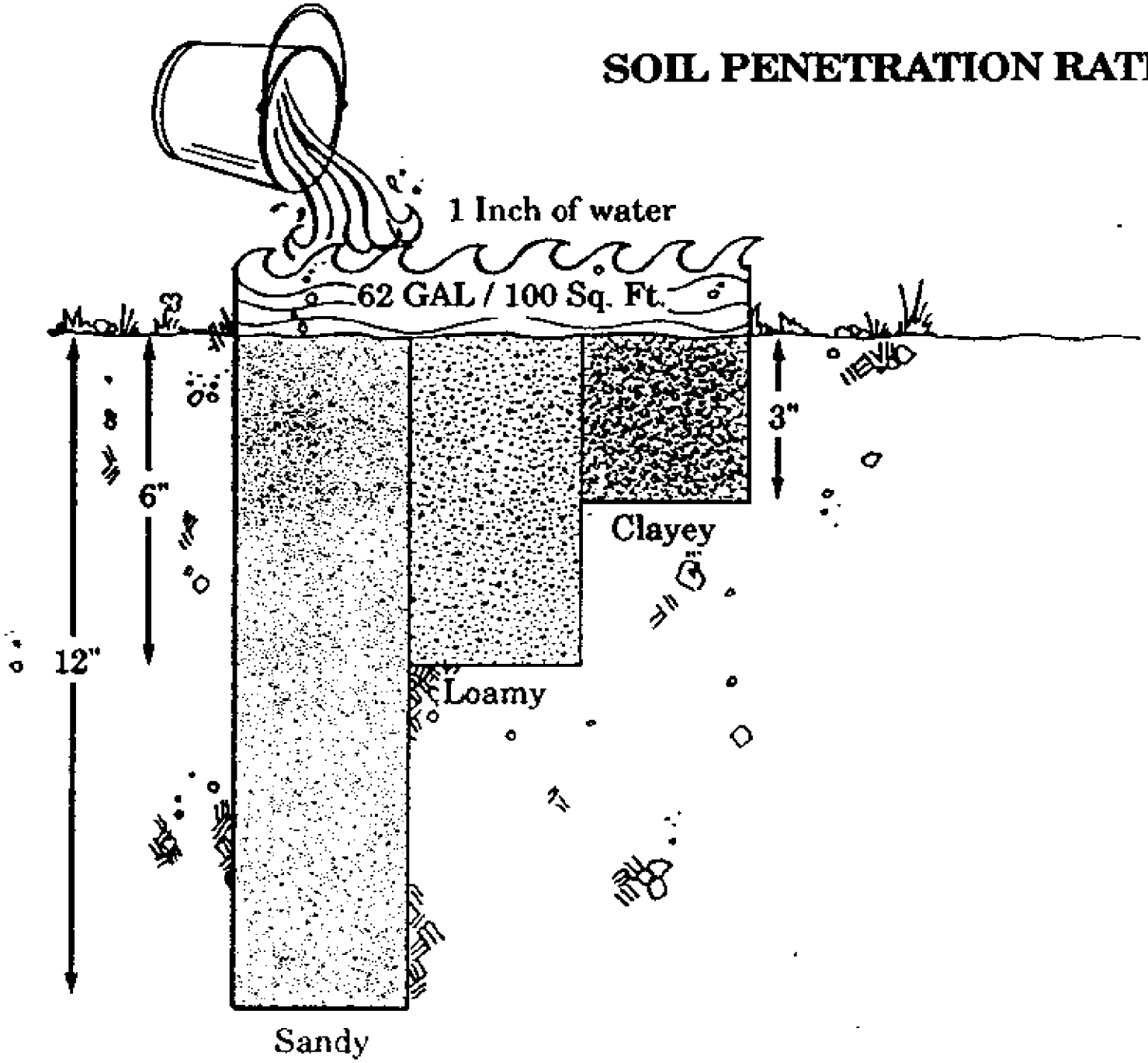




Sandy soils need more frequent, small irrigations than a clay soil

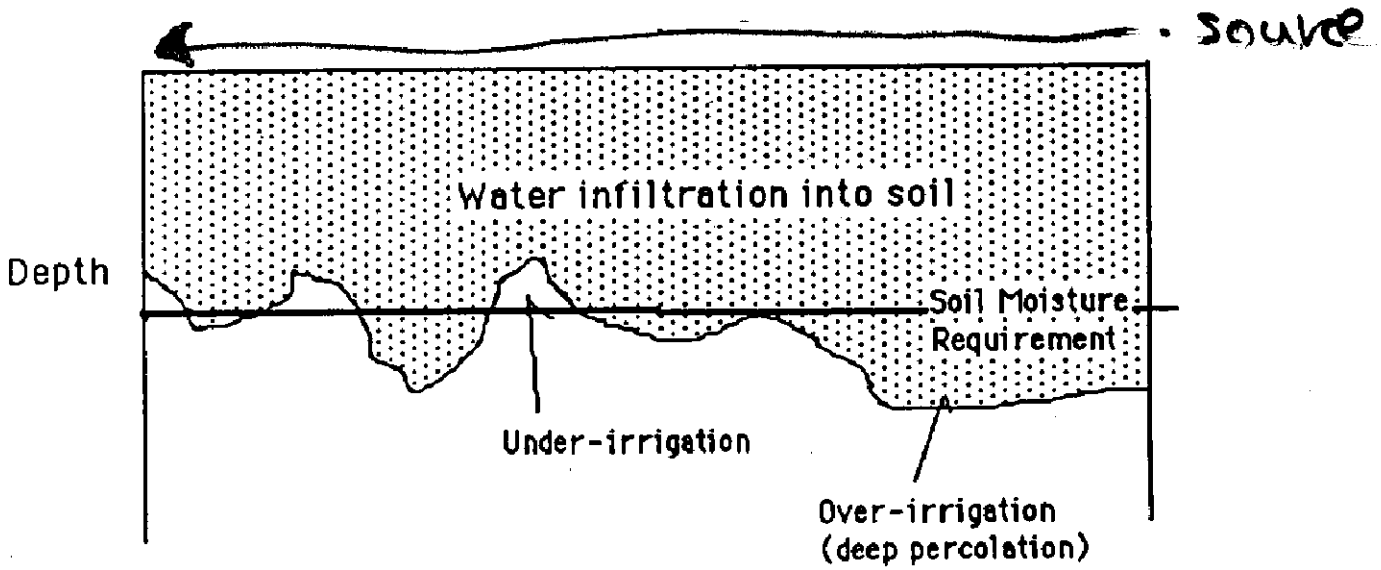
Putting the same amount of water on a sandy soil as a clay soil will push the water deeper in the sandy soil

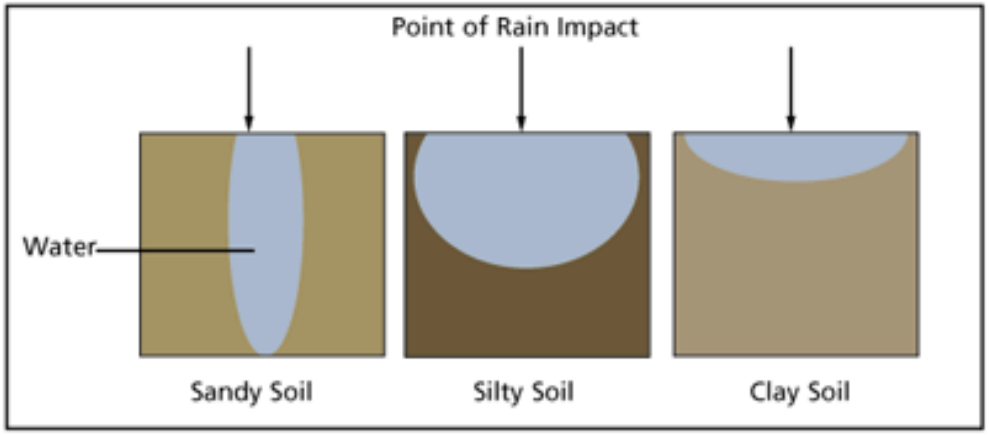
SOIL PENETRATION RATES



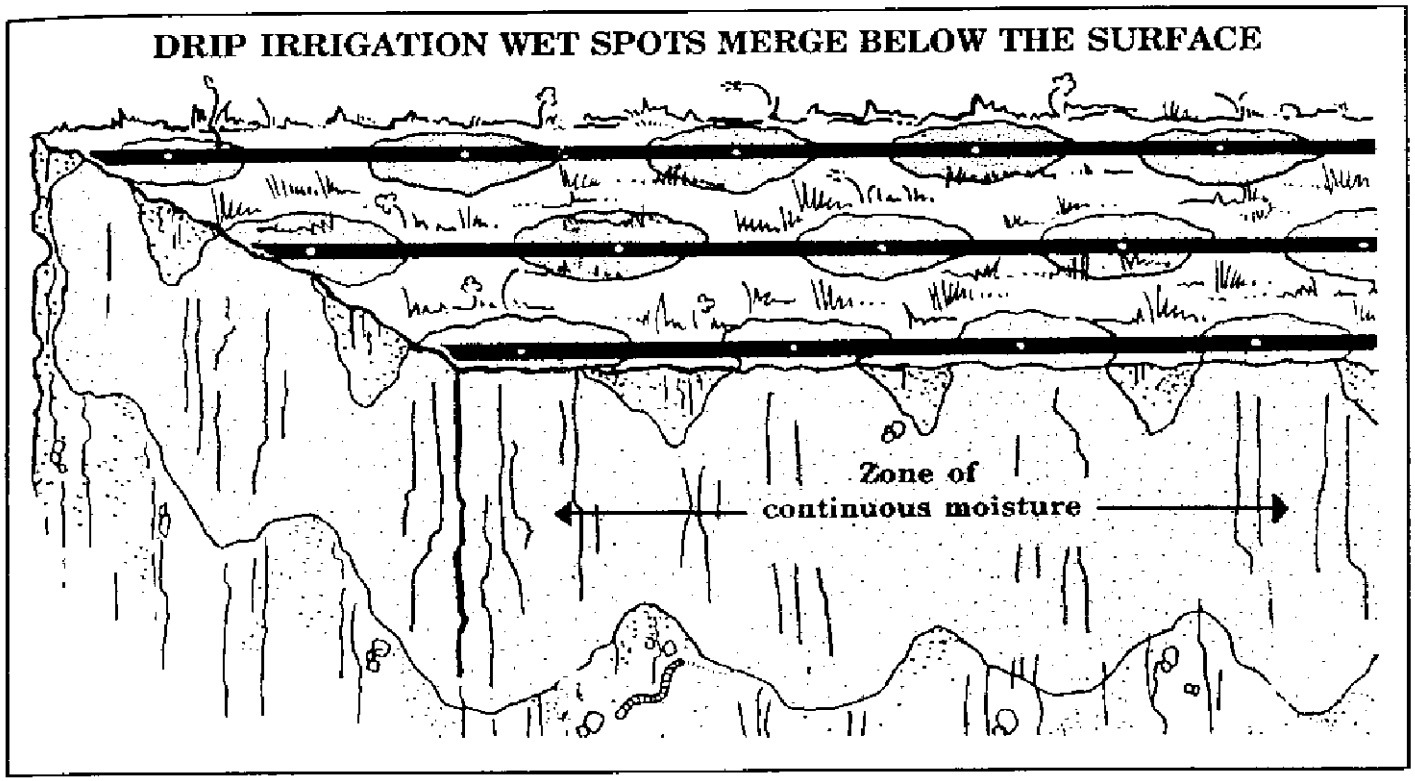
!!!!!!!!!!!!!!!

Don’t apply water at a greater rate than it can be infiltrated !!!!!!!!!

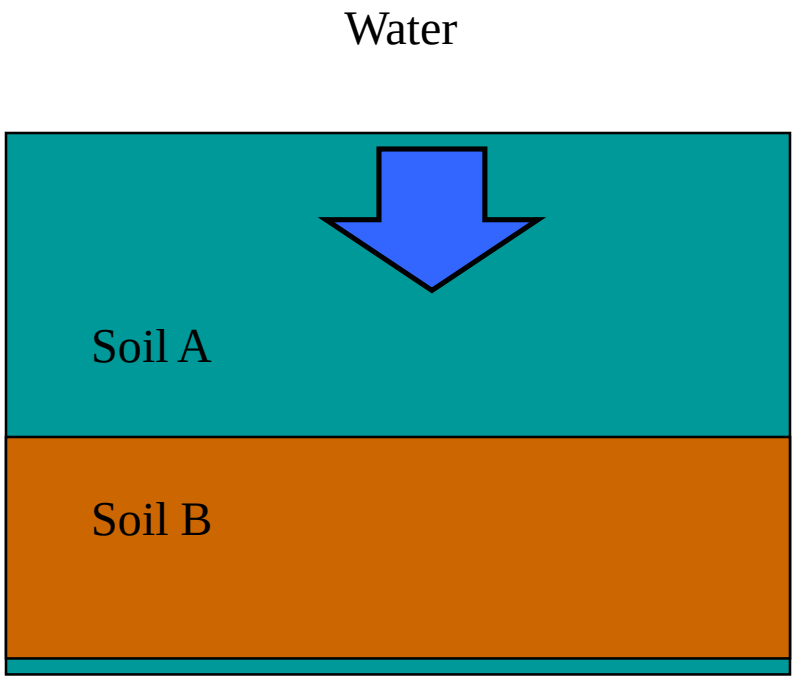

Source
Water infiltration into soil
Depth
Soil Moisture
Requirement
Under-irrigation
Over-irrigation
(deep percolation)



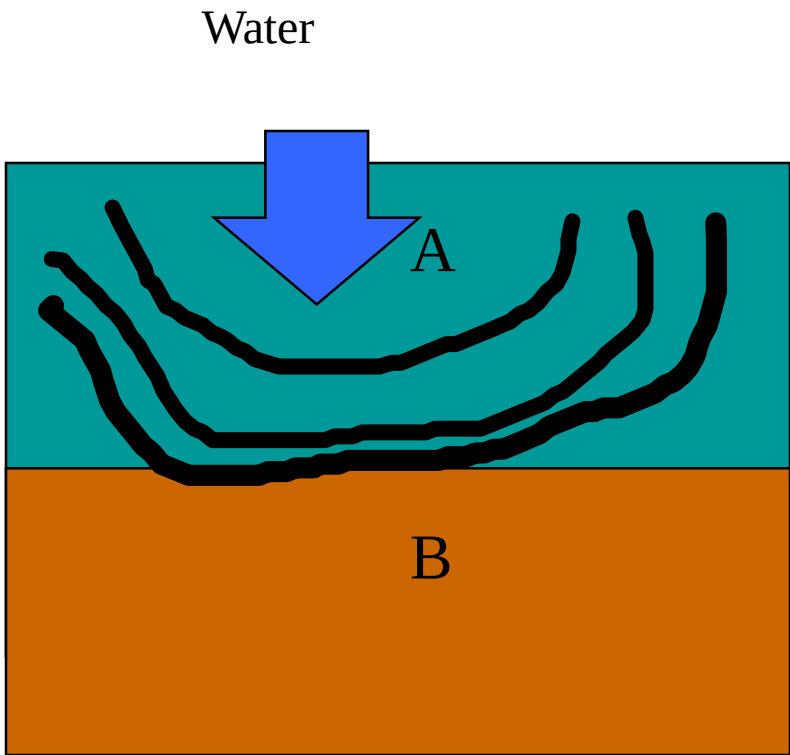
Soil texture affects the wetted pattern

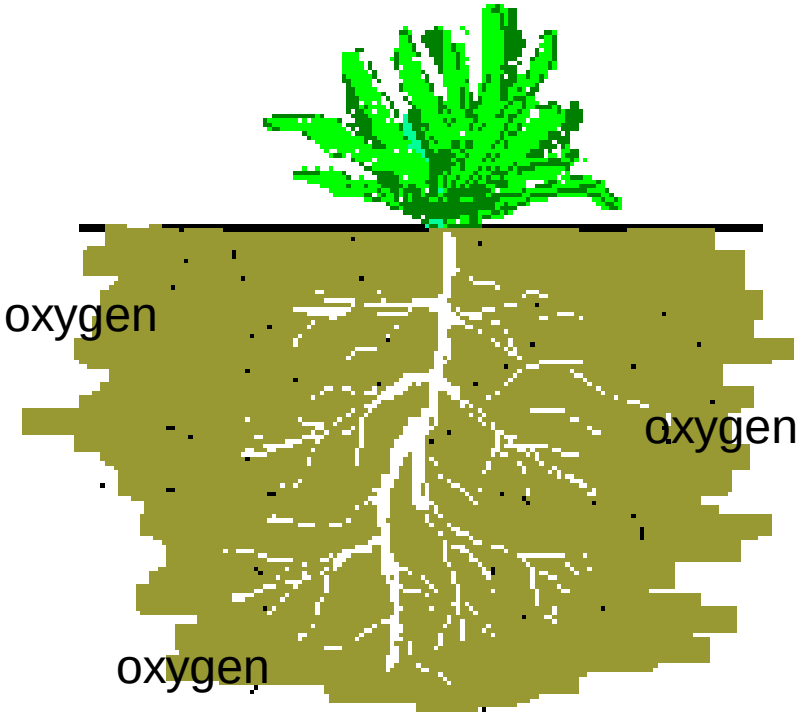

DRIP IRRIGATION WET SPOTS MERGE BELOW THE SURFACE
Zone of
continuous moisture

Water Movement



Water Movement





Roots need air
just like we do

When soil is saturated there is no air for the roots

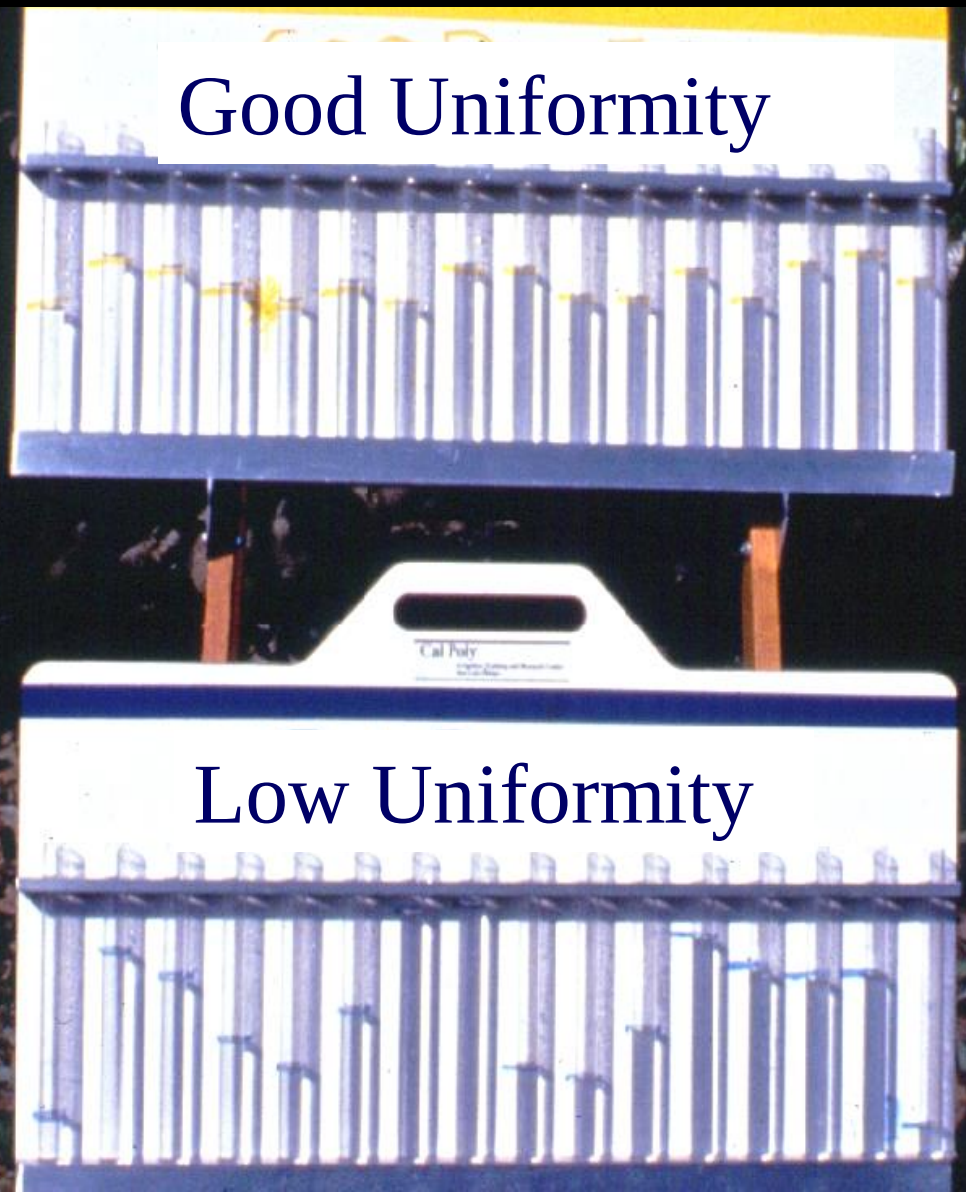
When
soil
is dry

Plants wilt

Water movement is controlled by:

1. gravity - down
2. concentration - wet to dry
3. salinity – less salty to more
4. surfaces – toward a surface

Assess Irrigation System Efficiency
Utilize Irrigation Mobile Lab Programs
Resource Conservation District (RCD)



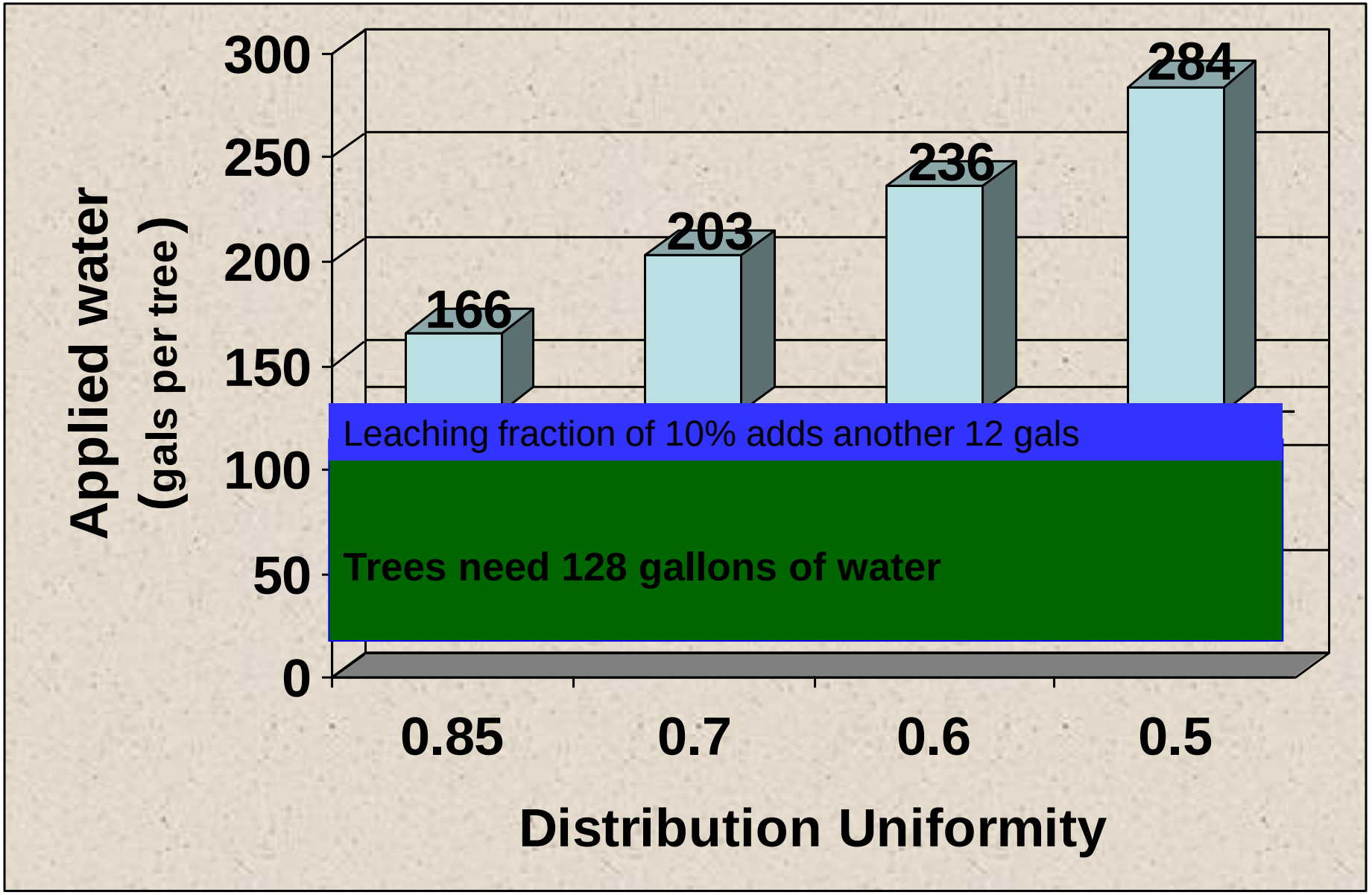
With poor Distribution Uniformity (DU) also called Emission U

Some plants get too much water and others don't get enough

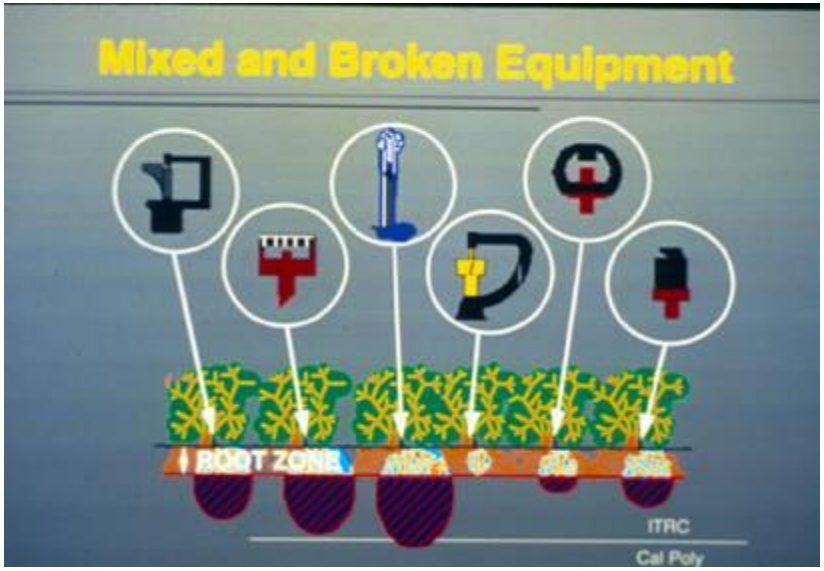
Perfect conditions for disease and DEATH

Distribution Uniformity (DU)

- A good DU for groves – 85%
  - 15% more water to meet needs of all the trees
- Poor DU
  - Plugged sprinklers and lines
  - Breaks and leaks
  - Poor pressure regulation


Applied water
(gals per tree)
300
250
200
150
100
50
0
166
203
236
284
Leaching fraction of 10% adds another 12 gals
Trees need 128 gallons of water
0.85
0.7
0.6
0.5
Distribution Uniformity

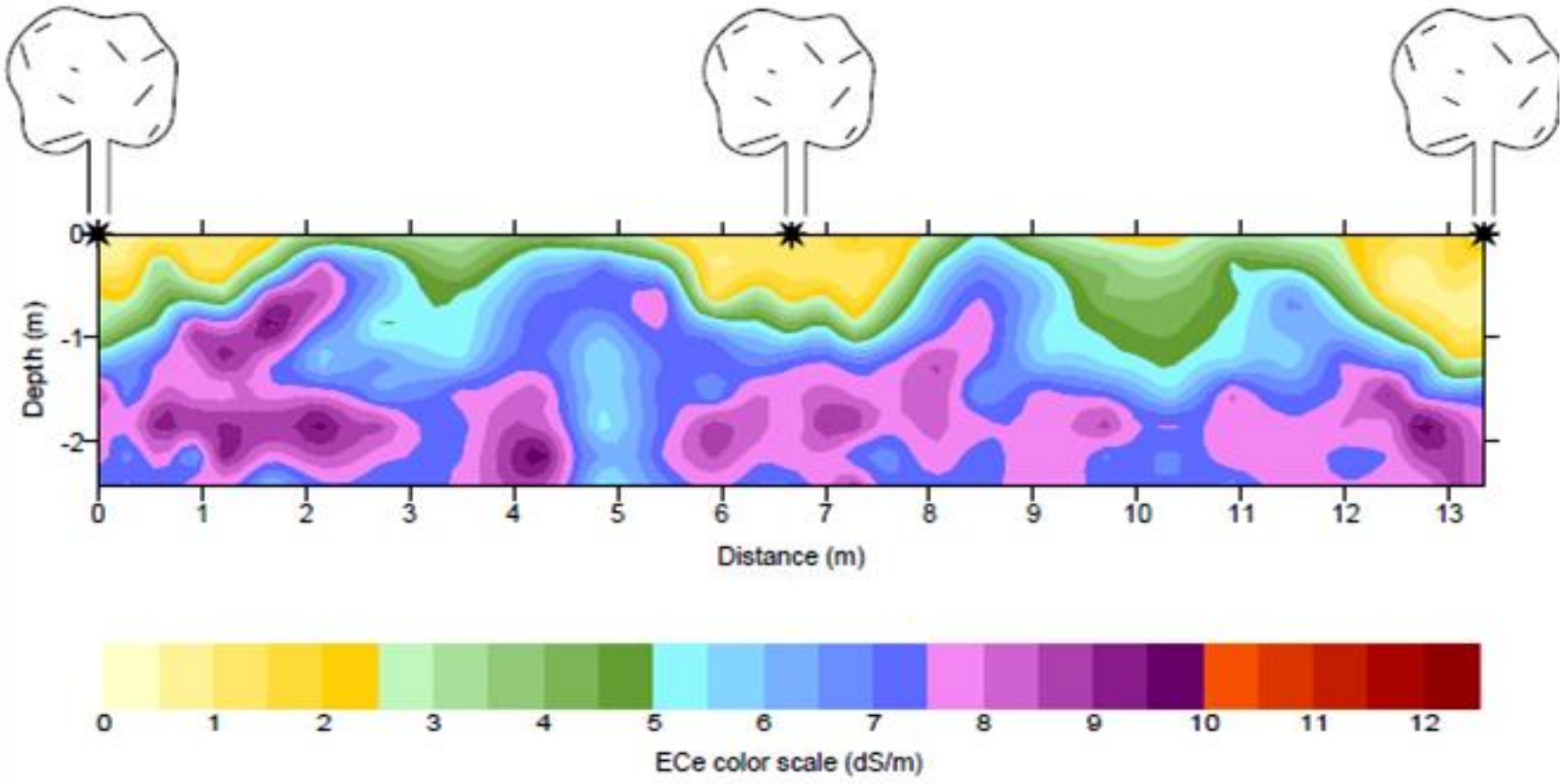
What causes poor DU?



Irrigation System Maintenance

- Check poly hose systems
- Flush lateral lines
- Clean filters
- Repair sprinklers

Salt Accumulation in Tree Crop Orchards Using Micro-Spray Irrigation



CDWR 2003

Soil Salinity Accumulation in Orchards with Drip and Micro-spray Irrigation in Arid Areas of California
http://www.itrc.org/reports/salinity/treecropsalinity.pdf ITRC Report No. R 03-005

Emitters

microsprinkler

fan jet

All companies use different colors

In-Line Dripper

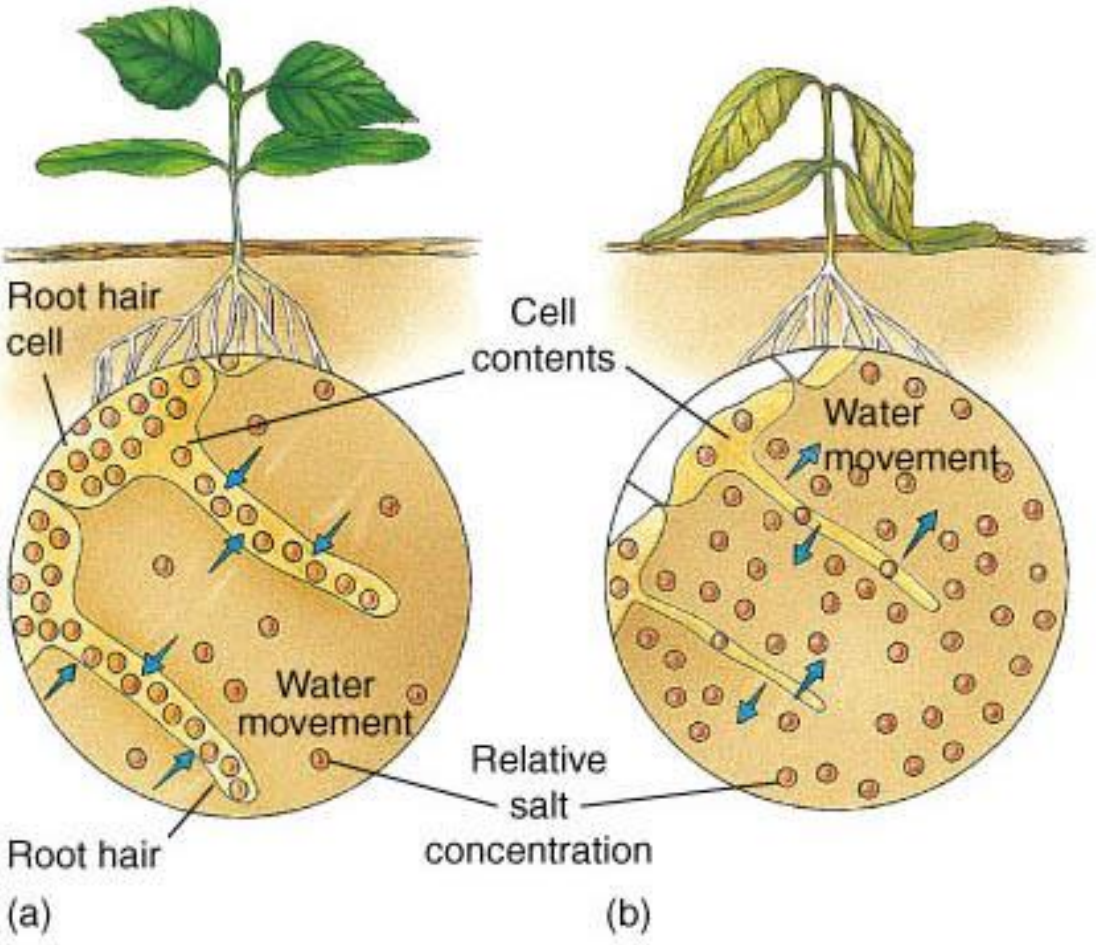
dripper

Water Rules
of
Thumb

Total Dissolved Solids (TDS) <1000 ppm

Specific Ions
Chloride <100 ppm
Sodium <100 ppm
Boron <1 ppm

The Problem with Total Dissolved Salt:
High Salt Inhibits Plant Water Uptake

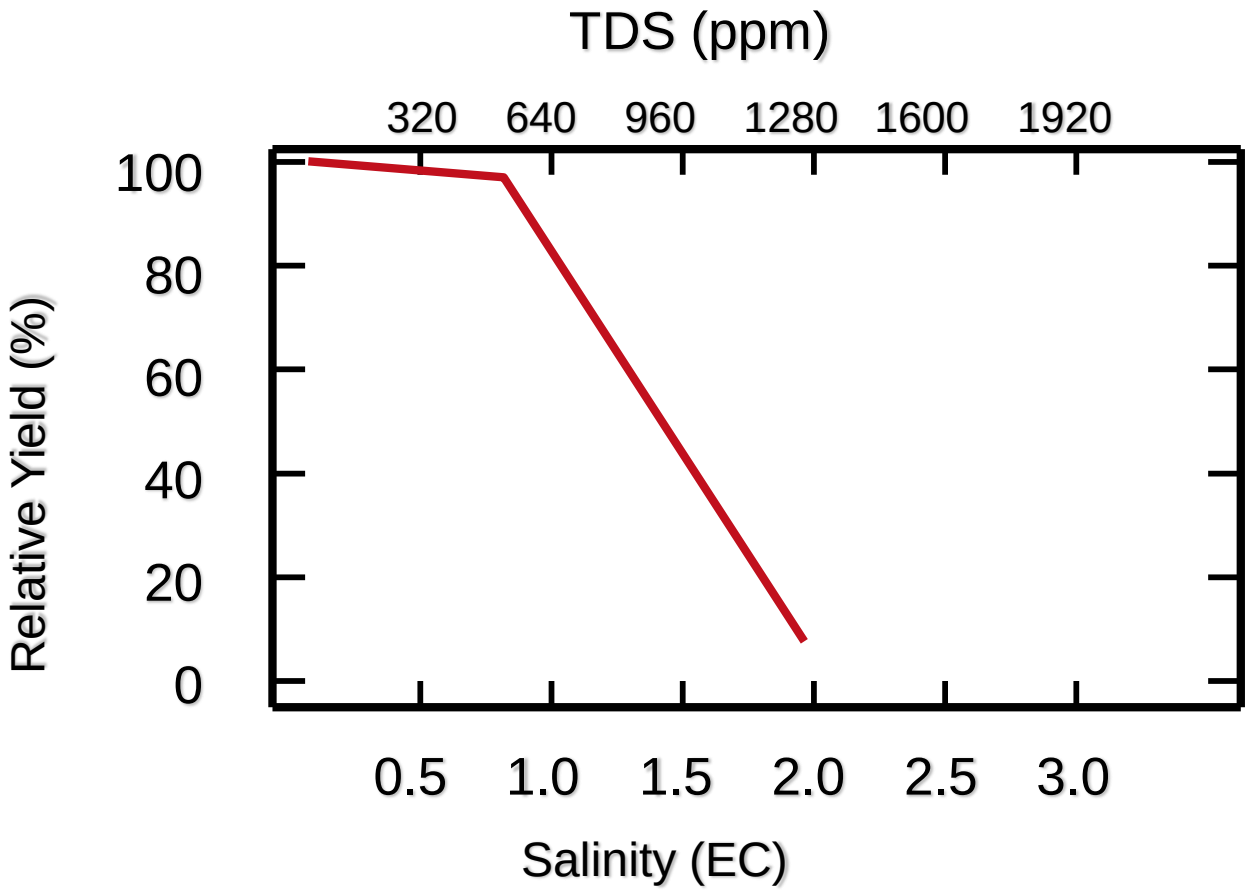


For avocado, this occurs at EC = 4 dS/m

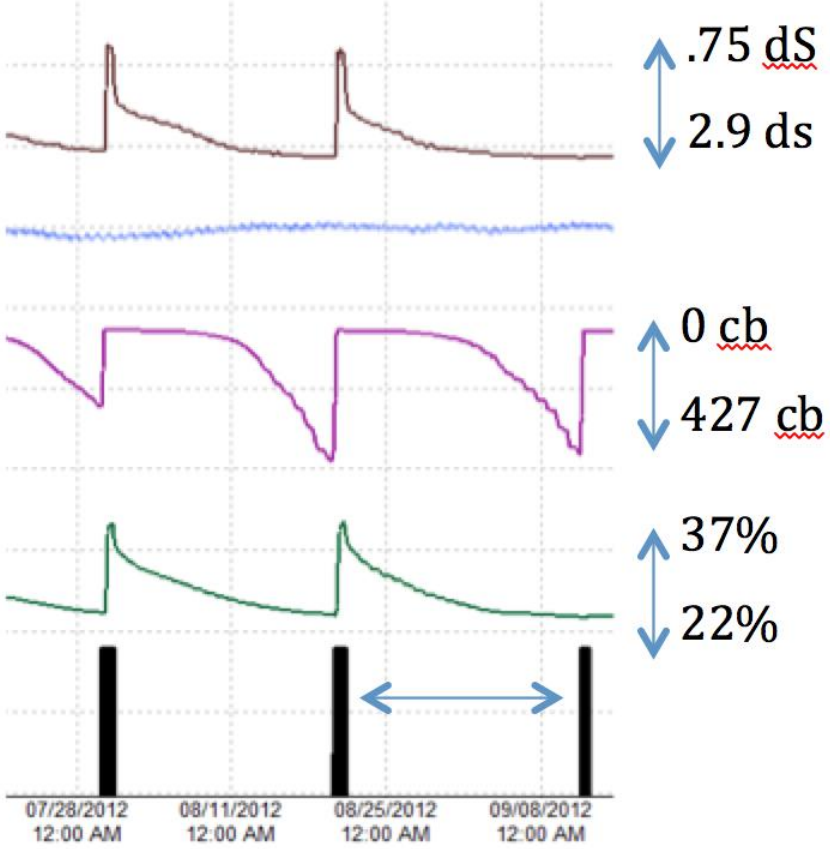
From D. Crowley, UCR, 2013

Avocado Yield Function for Irrigation Water Salinity

Oster and Arpaia, J. Am Soc. Hort Sci. 2007



From D. Crowley, UCR, 2013



Irrigation timer indicates that trees are being watered every 3 weeks.

Salt flush at beginning of each irrigation set. EC range between leaching is .75 to 2.9 dS/m.

Soil water potential (plant available water decreases from 0 to -427 cbars between irrigation sets.

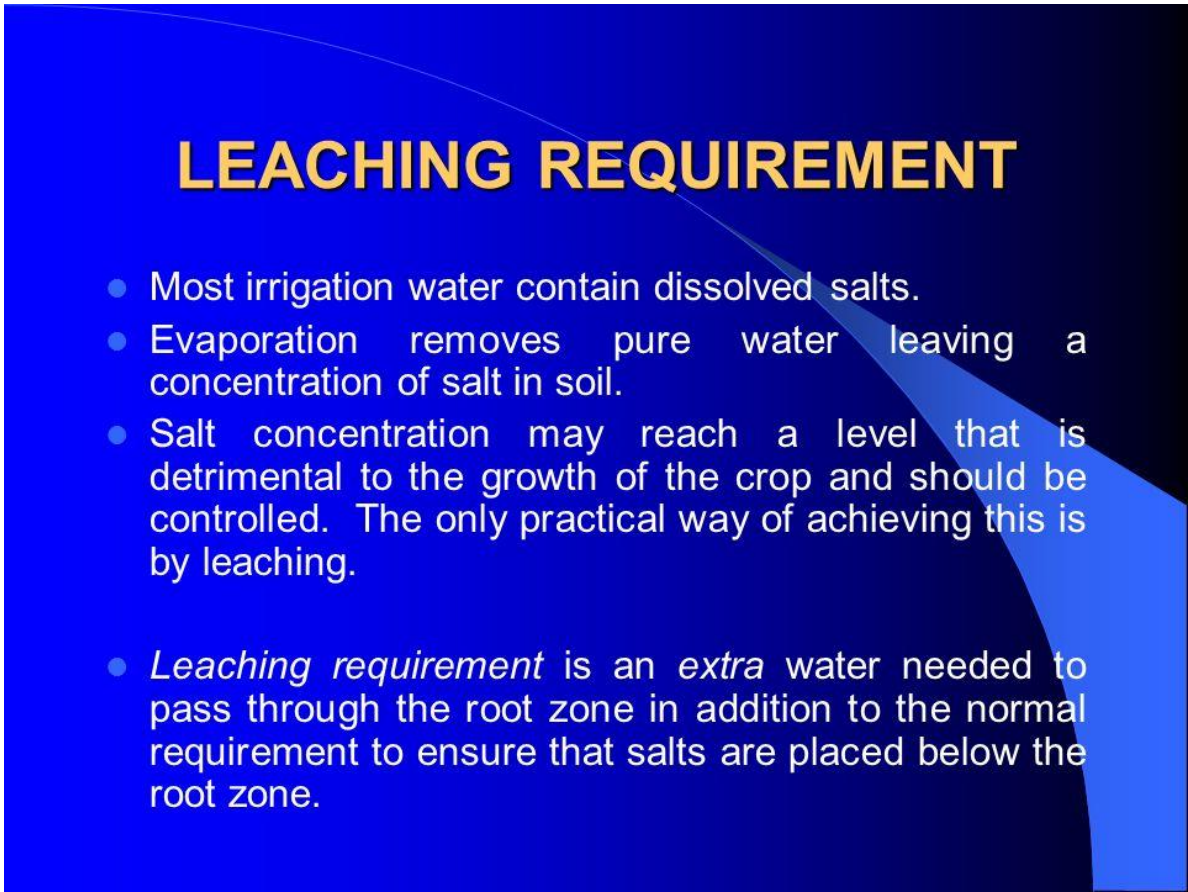
Soil volumetric water content at saturation is 37% decreasing to 22% as soil water potential reaches wilting point. Total available water ~40%.

From D. Crowley, UCR, 2013

One acre-foot of water (average house uses ¼ that)
With a TDS of 640 ppm
Has nearly a ton of salt

Soil water quality can be
No better than the initial
Quality of the applied water

So need to Leach



Schedule Irrigations Properly

- Proper Scheduling of Irrigations in Avocado Production

How much to put on, when?

Irrigation and Water Use Efficiency

AVOCADOSOURCE.COM Search Tools Site Index: <SELECT PAGE> Avocado Data

Instructions for the Irrigation Scheduling Calculator

English Español

Principles of Irrigation Select a Crop: Avocado

Kc Source: California (New Values) English Units Metric Units

Reference Evapotranspiration (ETo): in./day or period Data Source: <SELECT SOURCE>

Crop Coefficient (Kc): Get Kc for a month <SELECT>

Distribution Uniformity (DU): %

Leaching Requirement (LR): %

Method: Trees per Acre: Tree Spacing by ft.

Number of Emitters per Tree: 1

Surface area under tree canopy (ft^2): (enter only when surface area covered by canopy is less than 65%)

Emitter Output (Gal/Hour):

Grove Size (acres): 1

All fields with yellow boxes must be filled out, white fields are optional.

Calculate Click on 'Calculate' after any changes are made to recompute totals.

Water per tree per day or period: gallons

Watering time per tree per day or period: hours, minutes

Total Water Requirements for Grove: gallons

Allocated Water for Grove: gallons

Shortfall: gallons

Irrigation Check List

?????

Where are the roots?
Where is the water?
What is the water quality?
How evenly is it applied?
How fast is the water disappearing?
How soon does it need to be replaced?
How much extra water needs to be applied
to compensate for poor DU?
How much needs to be applied
to leach salts?
How much maintenance is required?

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Hope for more of this