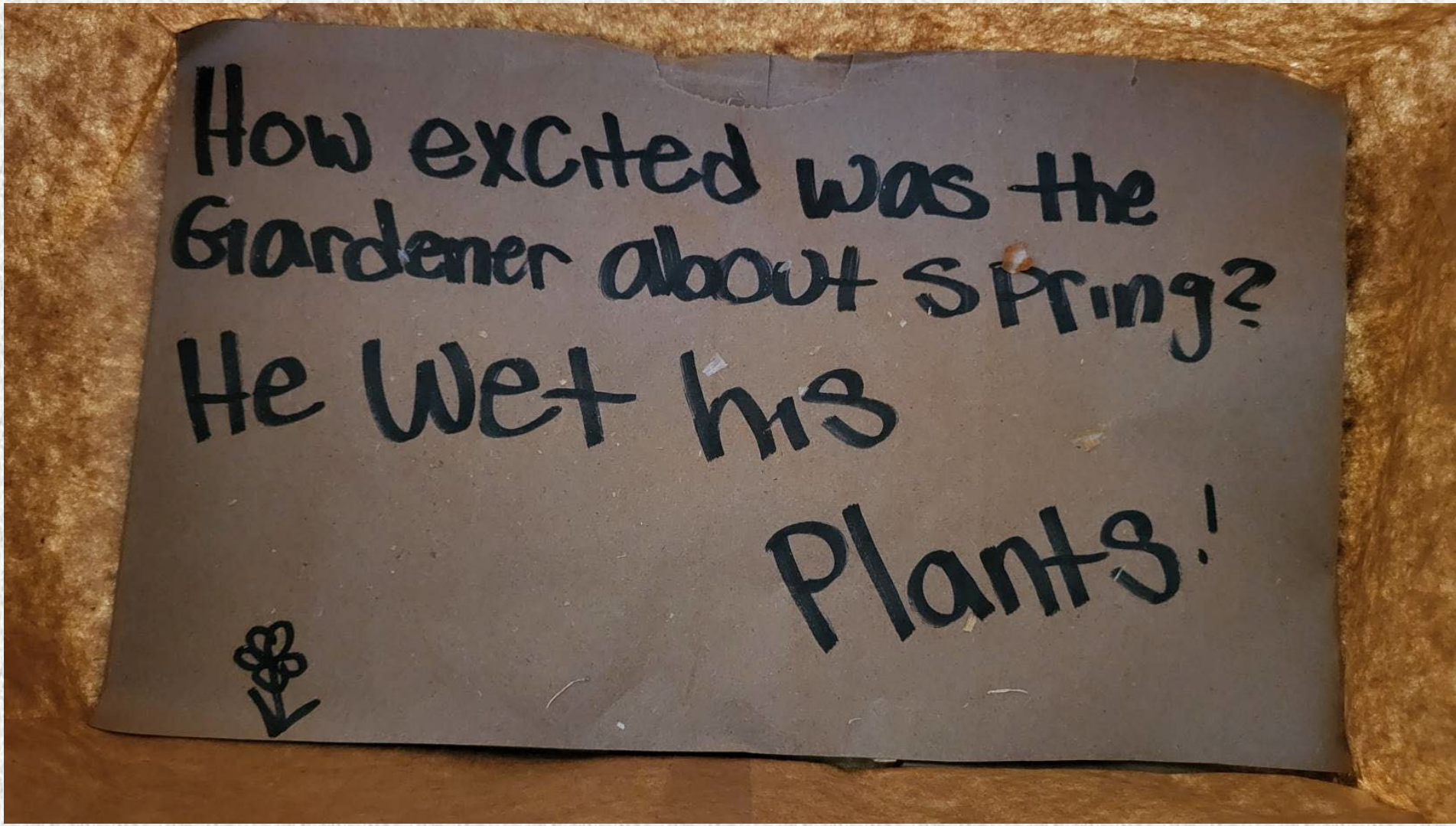
MANAGING UNDERGROUND SPRINKLER SYSTEMS

Dean E. Eisenhauer

June 2022

GOALS:

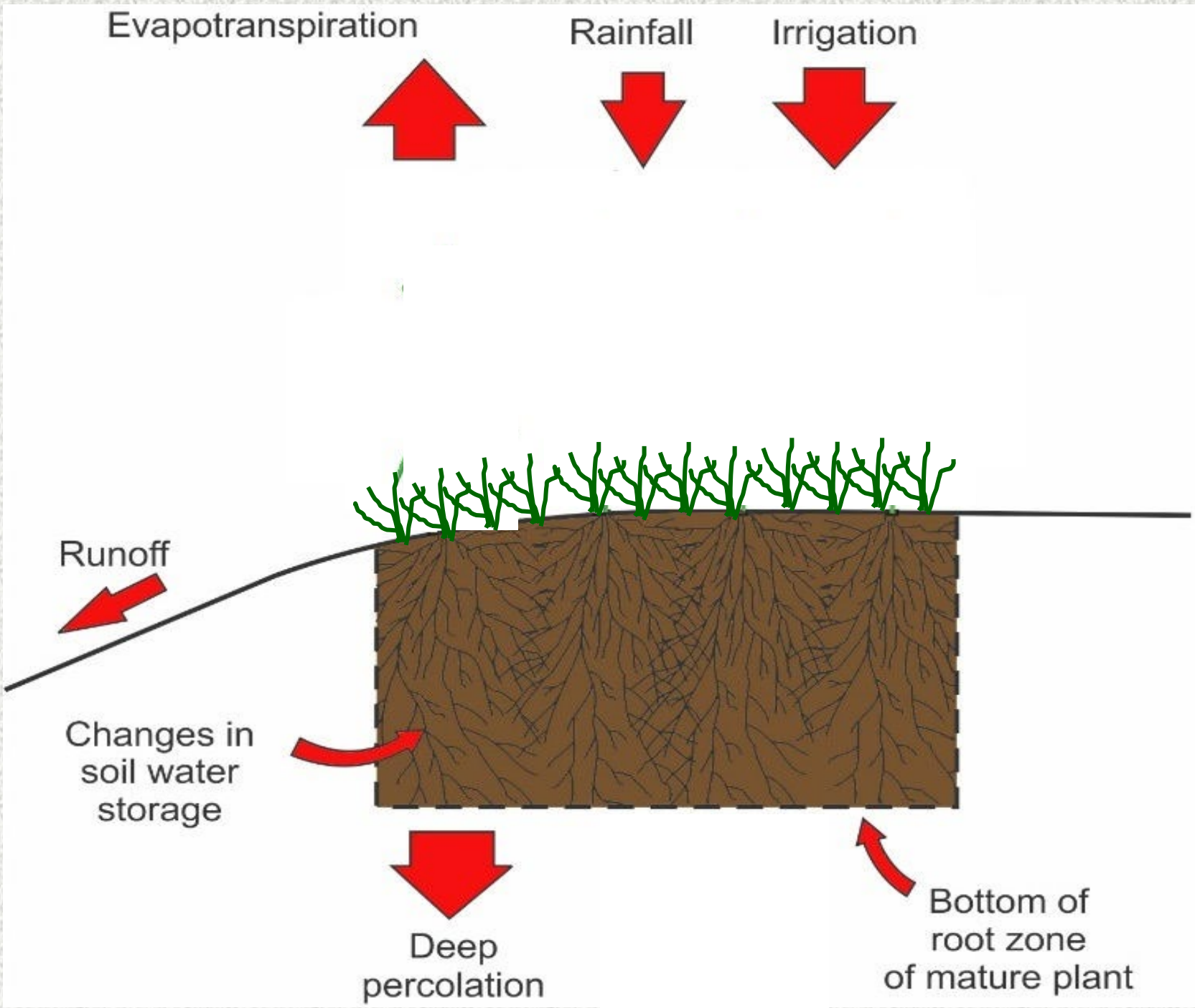
- *Understand how water is stored in soil and used in the landscape*
- *Apply this information to improve management of underground sprinkler systems*


How excited was the
Gardener about spring?
He wet his
Plants!

TODAYS TOPICS

- *Soil water storage and water "losses"*
- *Water use by plants*
- *How to determine water application amounts*
- *Setting the controller to match water needs*
  - *How often to water and how much to apply*
  - *Seasonal adjust*
  - *Rainfall shutoffs*

Soil Water Storage and Water Losses


Evapotranspiration
Rainfall
Irrigation
Runoff
Changes in soil water storage
Deep percolation
Bottom of root zone of mature plant

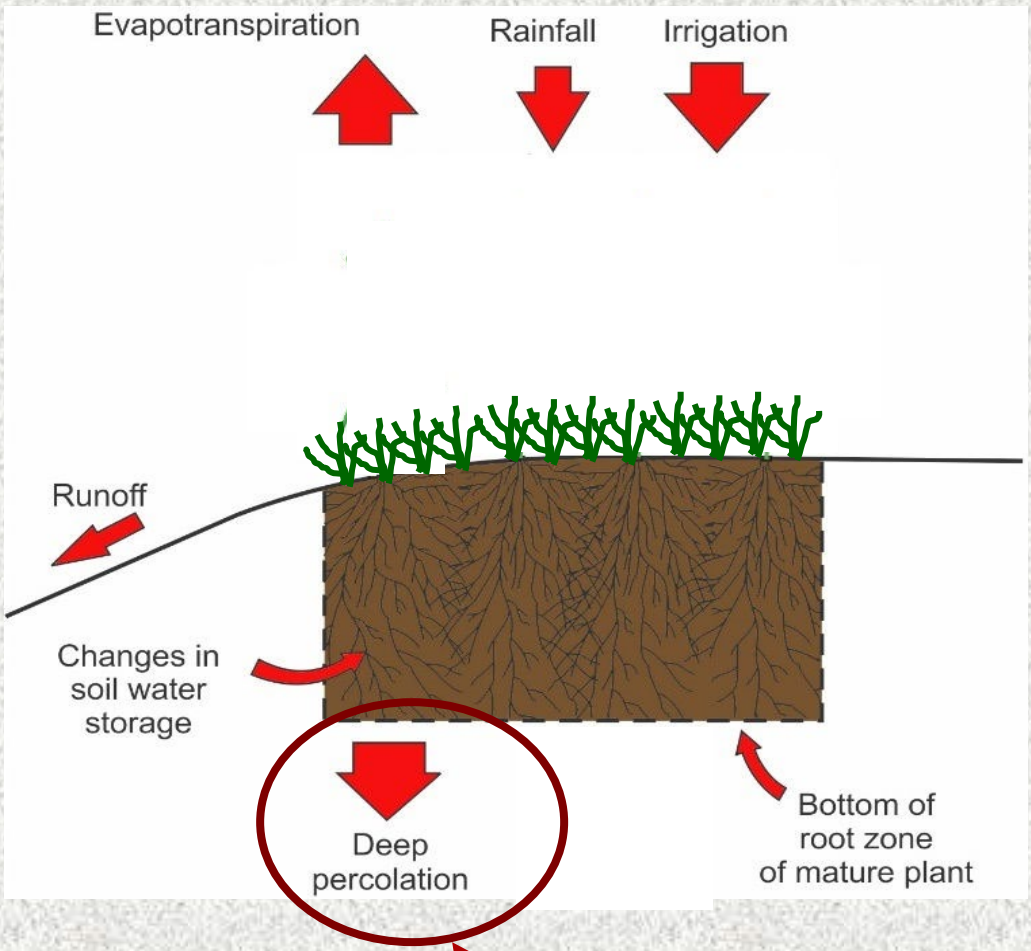
What Have You Seen?

- Runoff ?
- Evaporation ?
- Drift ?
- Deep Percolation ?

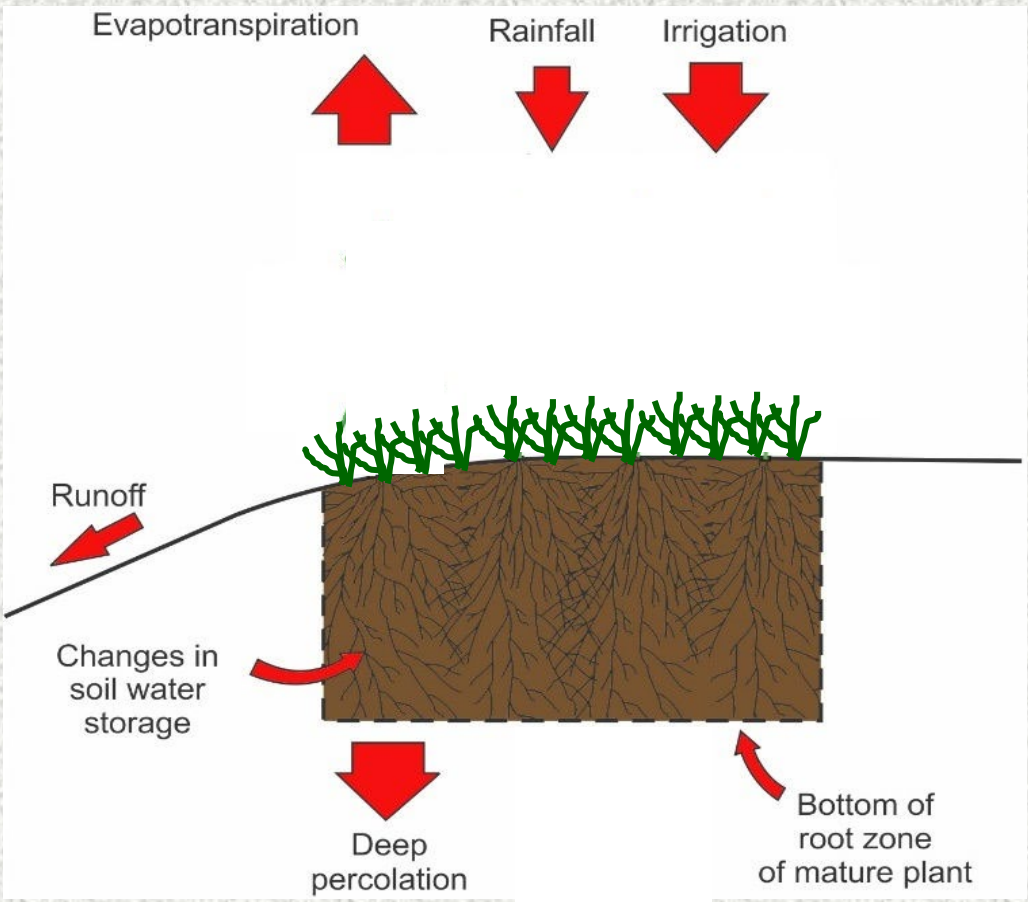
We’ve all seen runoff

It is easy to imagine evaporation

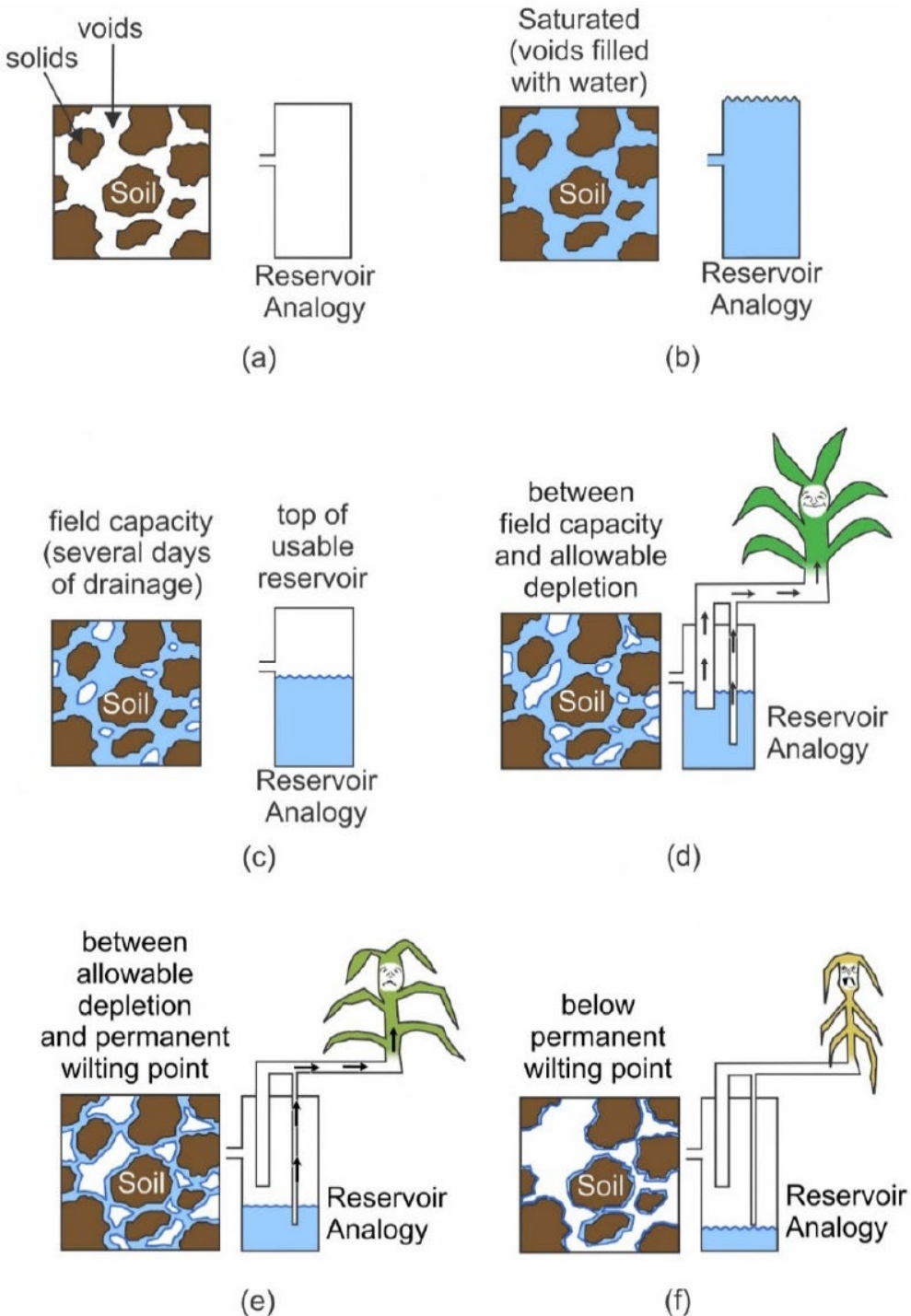
Drift is easy to see

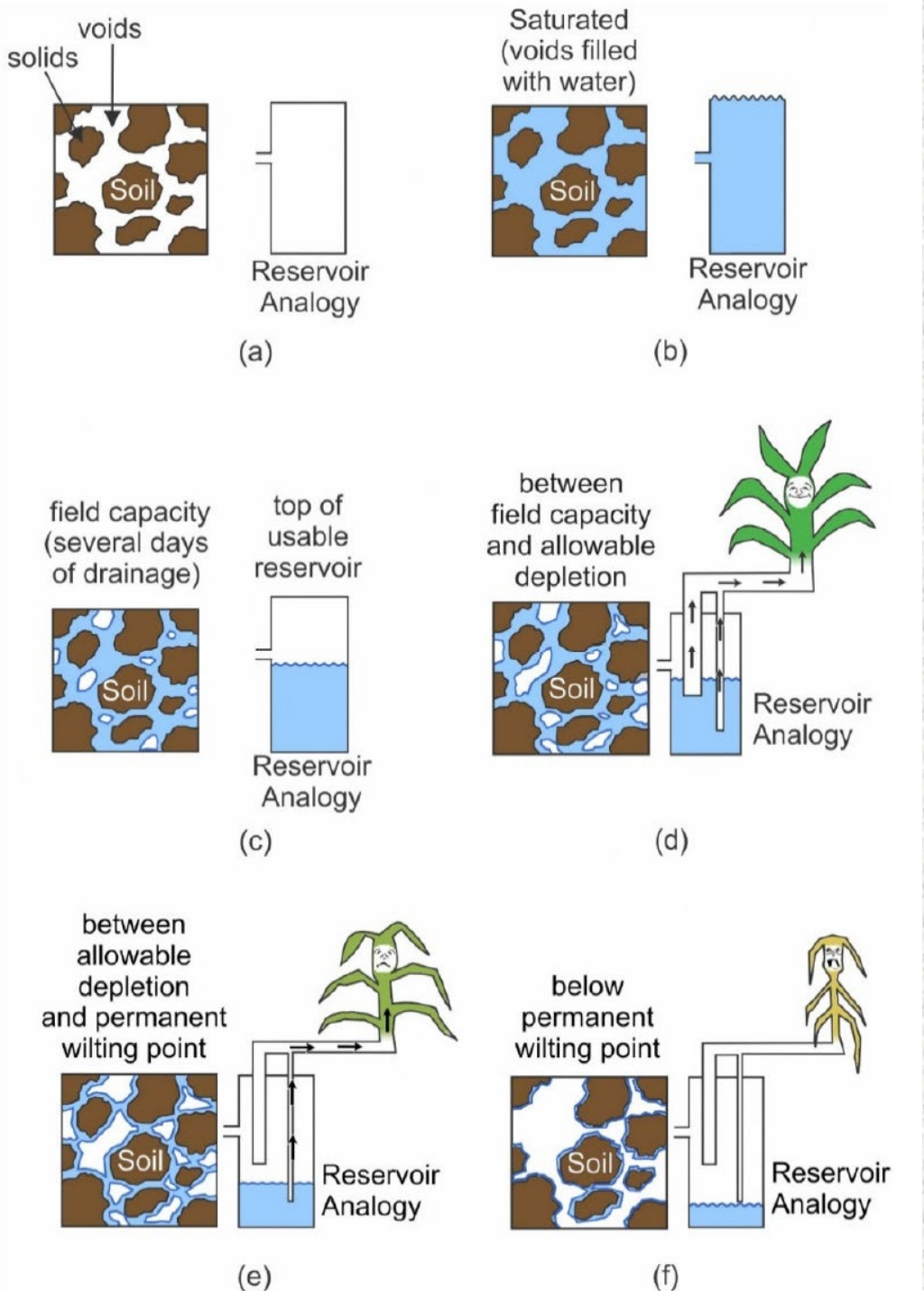


Deep percolation is not visible and for some hard to imagine



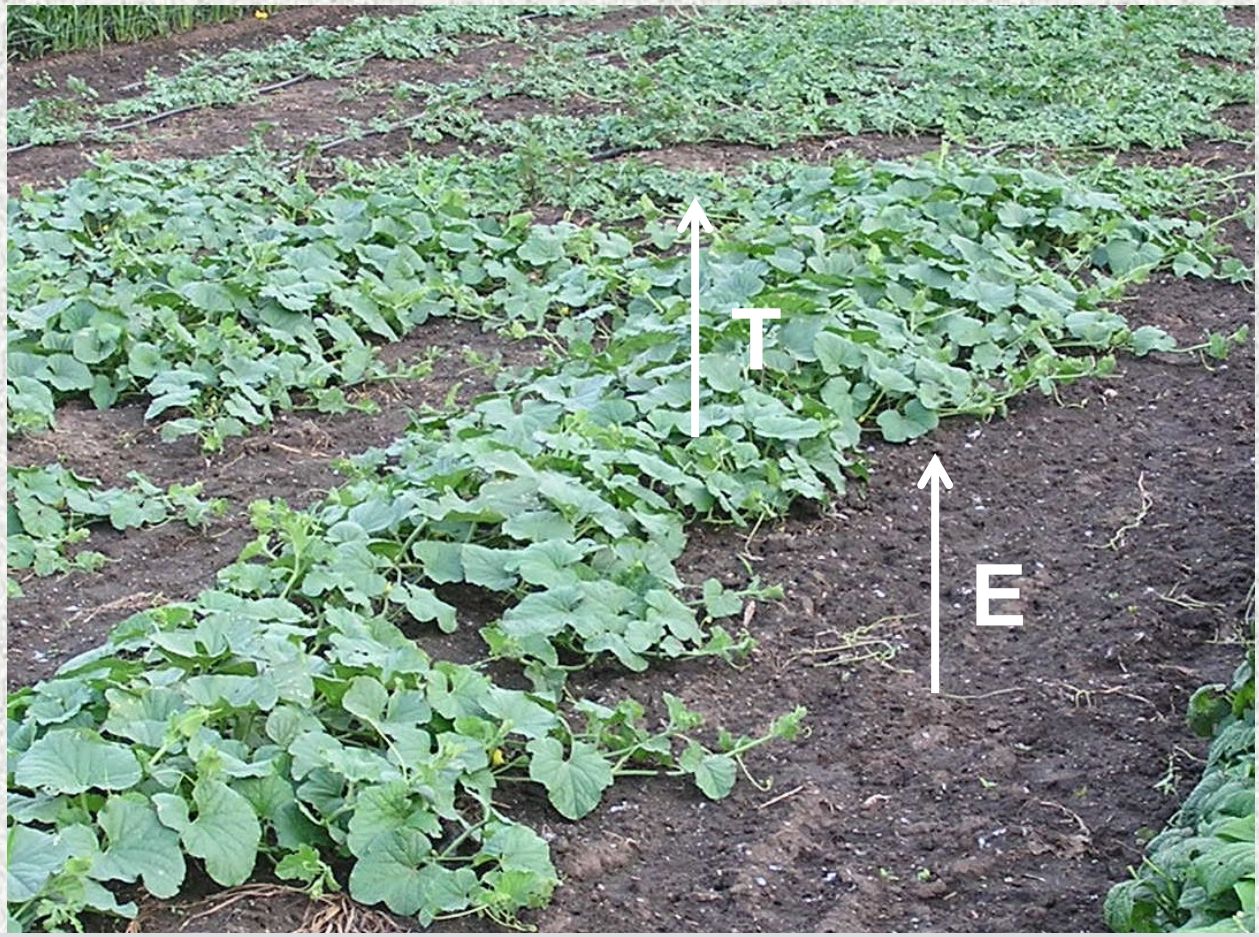
Think of the soil in the root zone as a reservoir for storing water for later use by plants


voids
solids
Soil
Reservoir
Analogy
(a)
Saturated
(voids filled
with water)
Soil
Reservoir
Analogy
(b)
field capacity
(several days
of drainage)
top of
usable
reservoir
Soil
Reservoir
Analogy
(c)
between
field capacity
and allowable
depletion
Soil
Reservoir
Analogy
(d)
between
allowable
depletion
and permanent
wilting point
Soil
Reservoir
Analogy
(e)
below
permanent
wilting point
Soil
Reservoir
Analogy
(f)



Plants begin to show stress when about 50% of the available water is gone

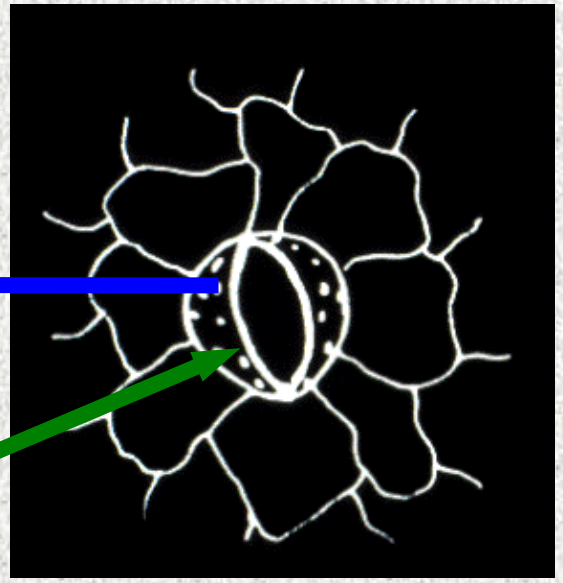
Water Use by Plants



Evapotranspiration = Evaporation from Soil + Transpiration from Plants = E +T

TRANSPIRATION AND PHOTOSYNTHESIS

No Stress
Stomata Open



TRANSPIRATION

H_2O

CO_2

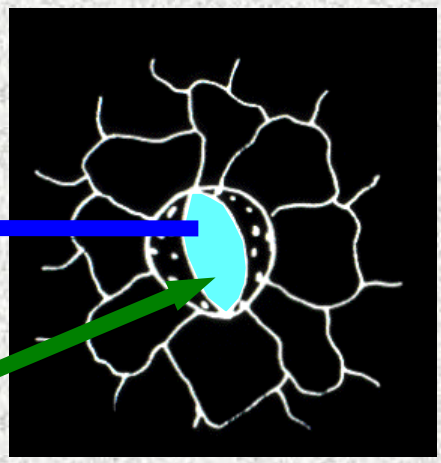
PHOTOSYNTHESIS

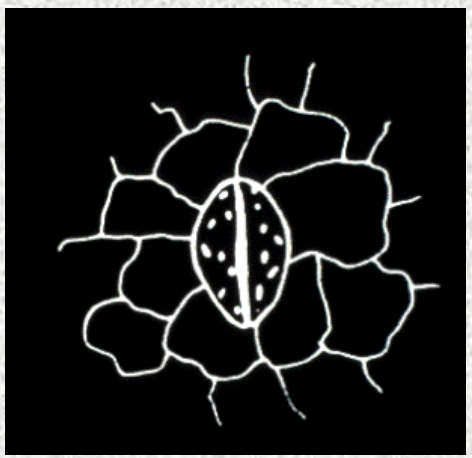
Modified from Derrel Martin

EFFECT OF WATER STRESS

No Stress
Stomata Open

Water Stress
Stomata Shut





TRANSPIRATION

H_2O

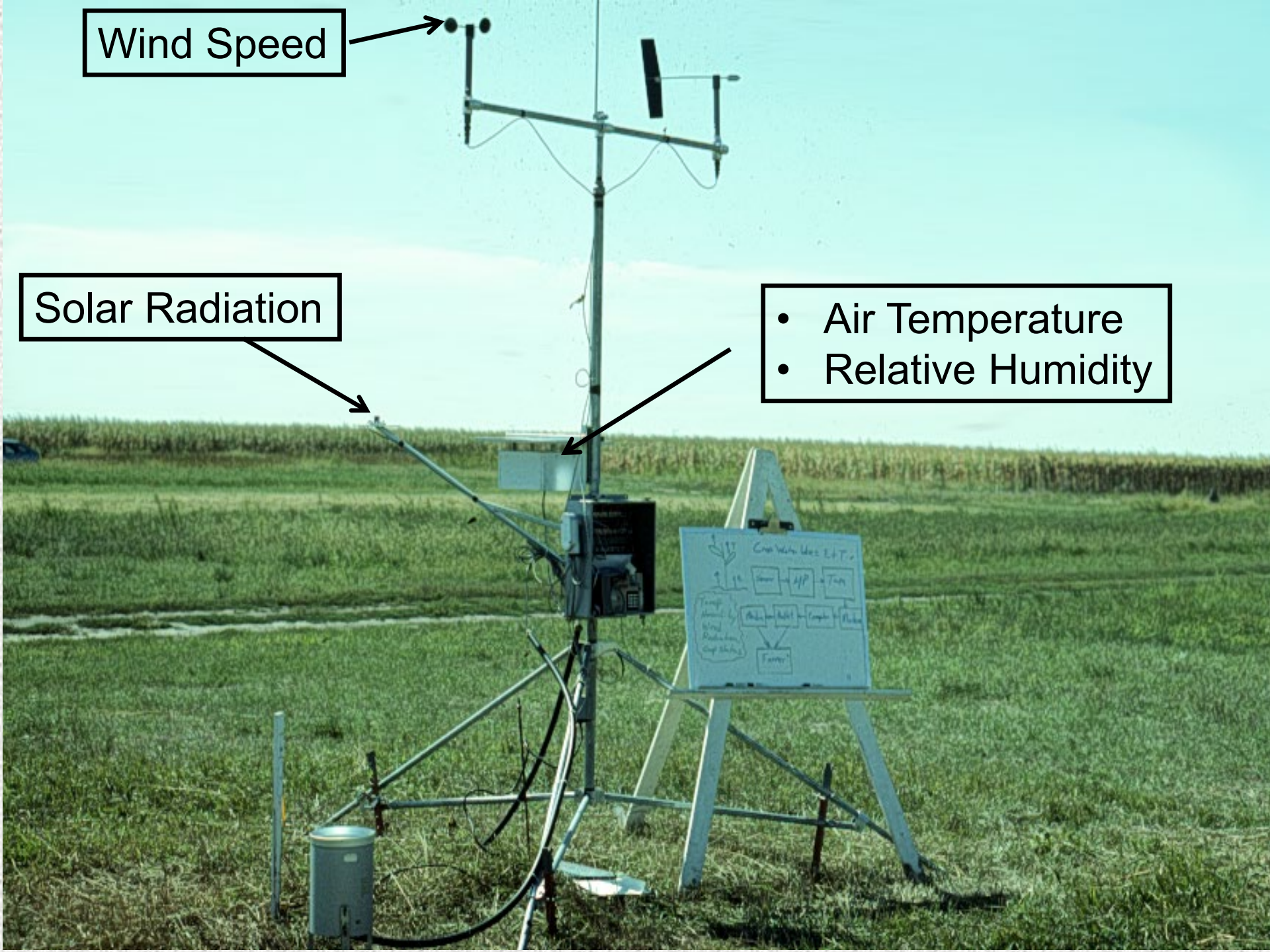
CO_2

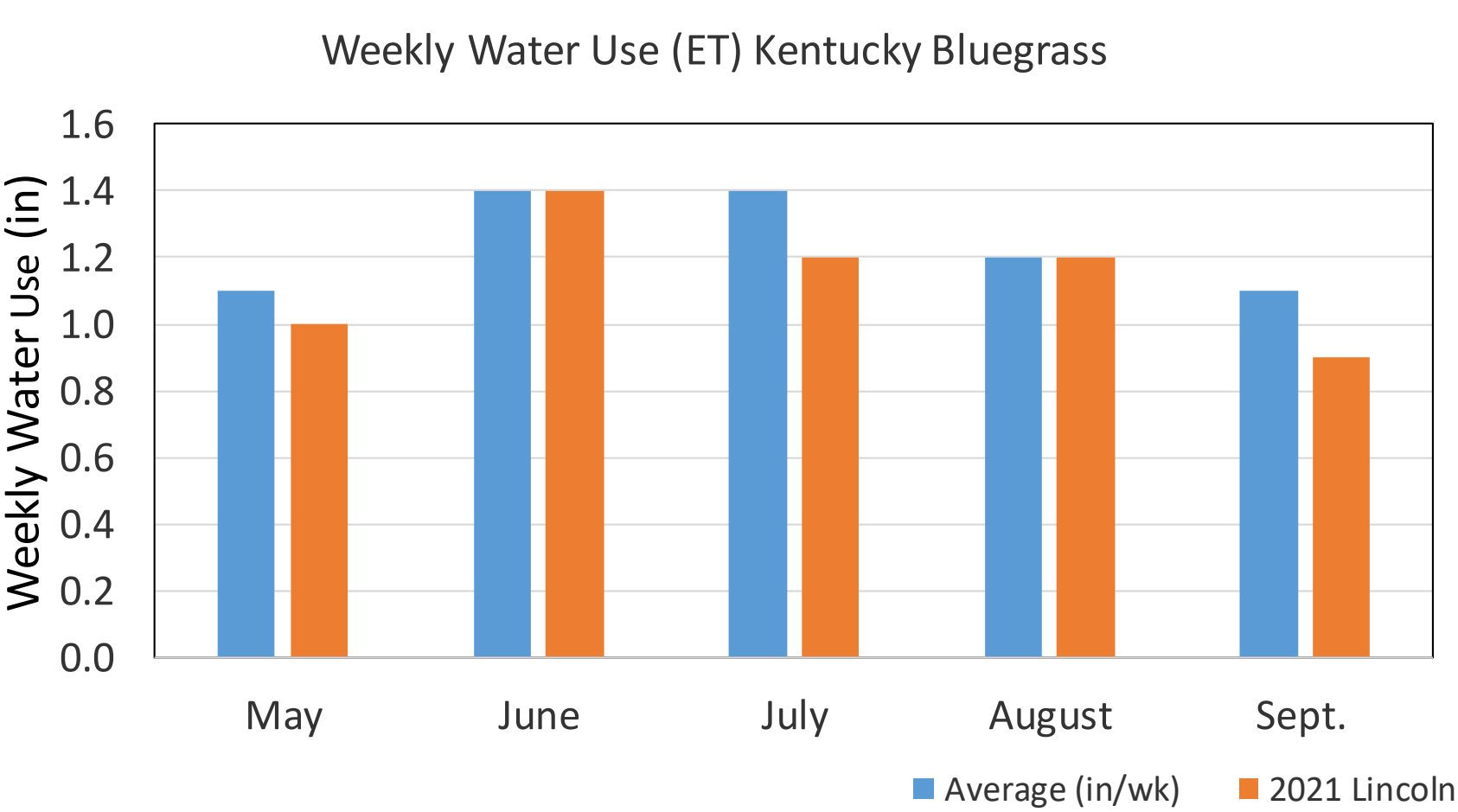
PHOTOSYNTHESIS

Modified from Derrel Martin

Transpiration is Essential for

- Plant cooling
- Photosynthesis
- Nutrient transport
- Maintaining plant turgor


Wind Speed
Solar Radiation
• Air Temperature
• Relative Humidity


Weekly Water Use (ET) Kentucky Bluegrass
Weekly Water Use (in)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
May
June
July
August
Sept.
Average (in/wk)
2021 Lincoln

Expect a Lot of Variation Because of Variations in Weather

- In June, 2021 weekly average was 1.4 in.
- Maximum 7 days in June used 1.7 in. or 25 % higher than average
- Minimum 7 days in June used 0.88 in. or 35 % lower than average
- Also we can expect higher ET for tall fescue, perhaps 10% higher

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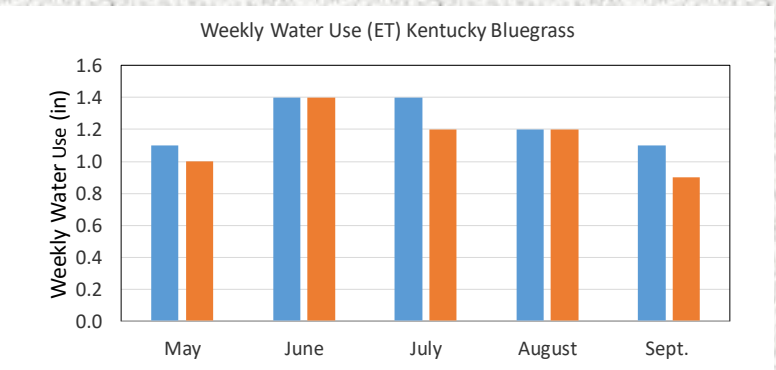
- **Also we can expect higher ET for tall fescue, perhaps 10% higher**

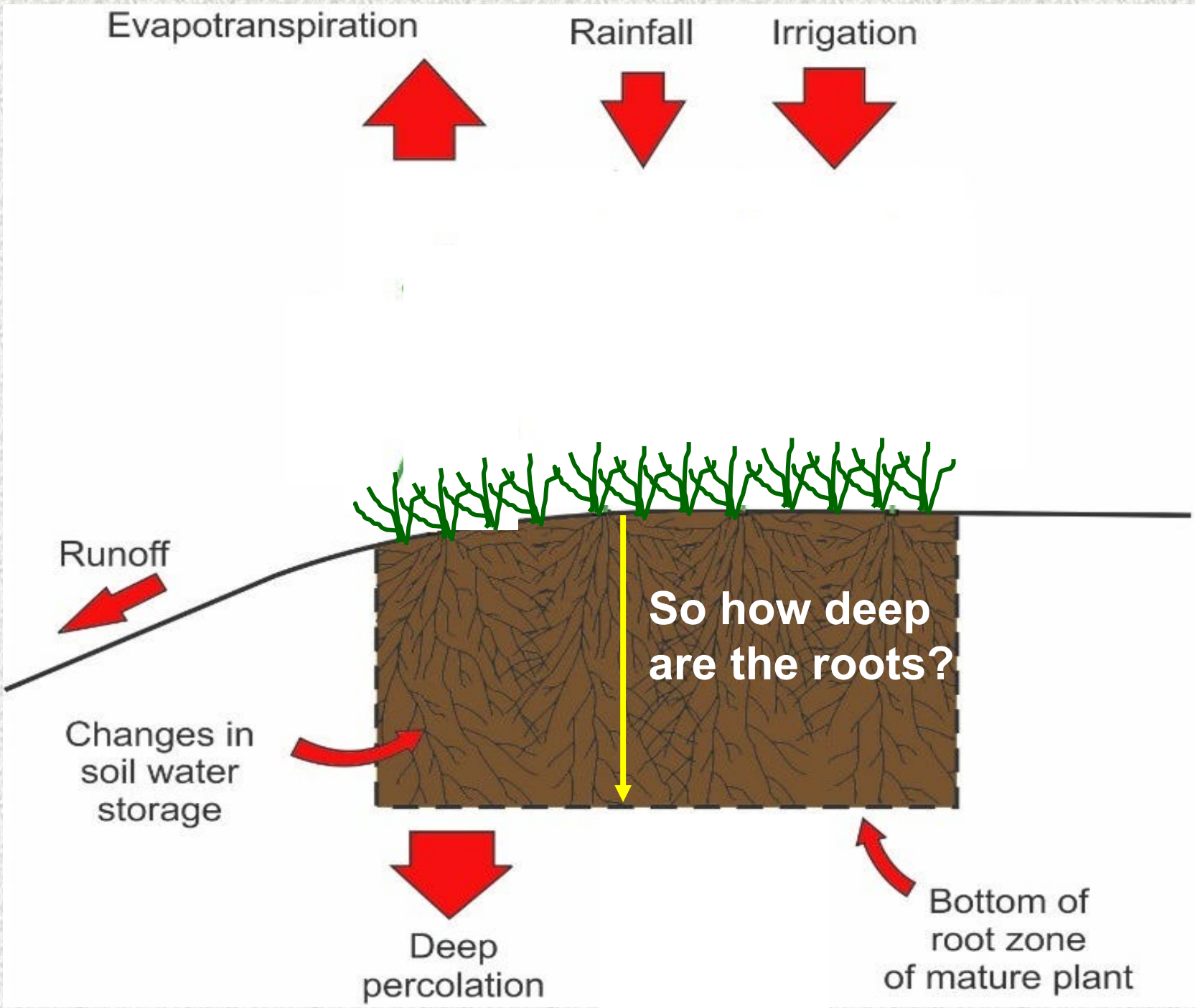
Irrigation Needed During Highest Water Use Periods If It Doesn't Rain

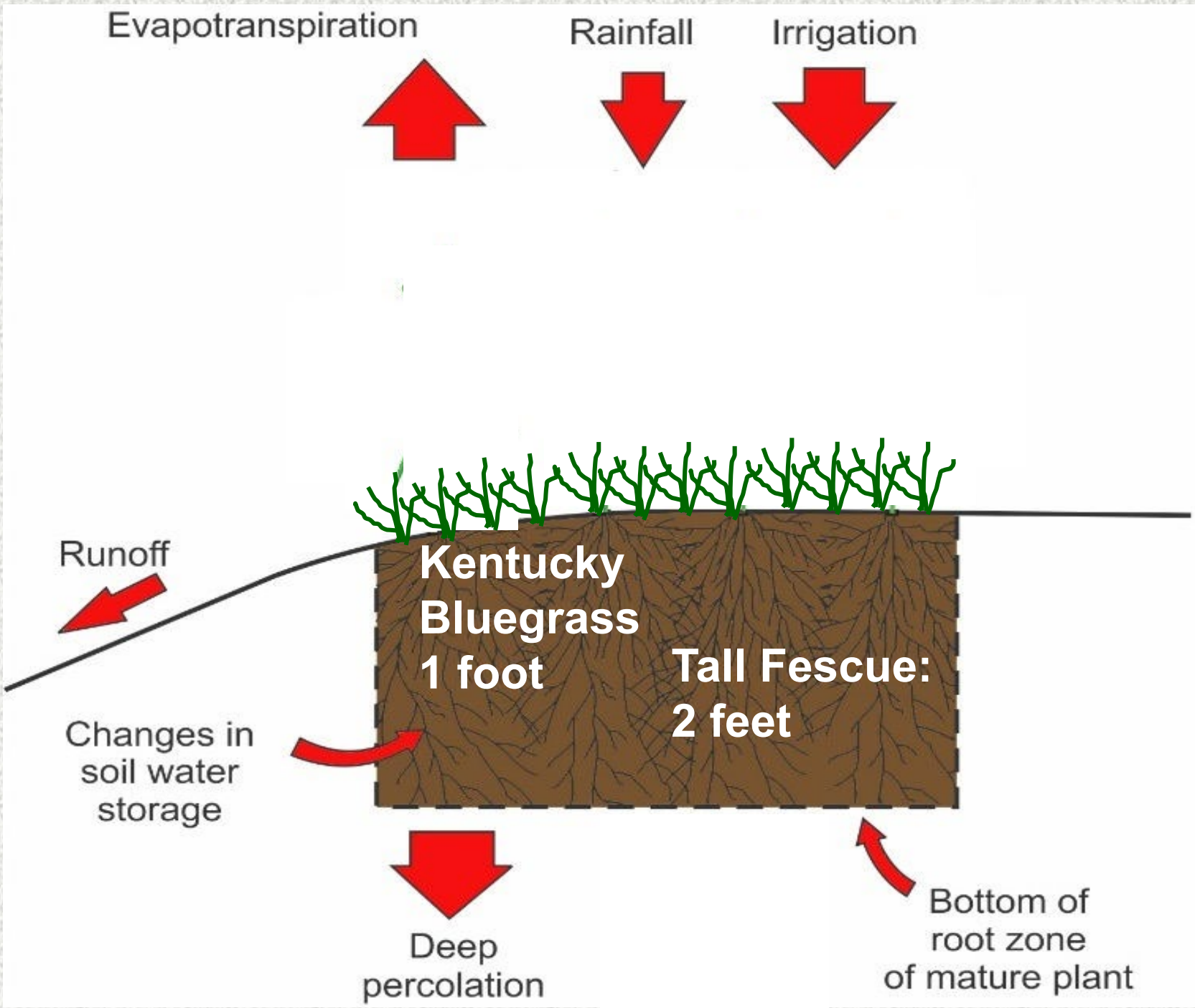
	Kentucky Bluegrass	Tall Fescue
Weekly	1.4 in.	1.5 in.
Daily	0.2 in.	0.21 in.
Every other day	0.4 in.	0.42 in.
Twice per week	0.7 in.	0.75 in.




Questions

How Often to Water and How Much to Apply


Evapotranspiration
Rainfall
Irrigation
Runoff
So how deep are the roots?
Changes in soil water storage
Deep percolation
Bottom of root zone of mature plant


Evapotranspiration
Rainfall
Irrigation
Runoff
Kentucky Bluegrass 1 foot
Tall Fescue: 2 feet
Changes in soil water storage
Deep percolation
Bottom of root zone of mature plant

But 70% of the water will come from the upper half of the root zone


ft
25ft
2
STANLEY
3
Life Guard
4
5
6
MADE IN U.S.A.
7
P.R. APP'D
NO. 339 TC
8
9
THE STANLEY
WORKS ©1988
10


7
P. R. APP'D
NO. 339 TC
8
9
THE STANLEY
WORKS ©1988
10

Available Water in Different Soils

Soil Texture	Available Water in 1 Foot of Soil
Fine sand	1.0 in.
Loamy fine sand	1.3 in.
Silt loam	2.2 in.
Silty clay loam	1.6 in.
Clay loam	1.4 in.

Web Soil Survey - Home

websoilsurvey.nrcs.usda.gov/app/HomePage.htm

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- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Series Extent Explorer
- Geospatial Data Gateway
- eFOTG
- National Soil Characterization Data
- Soil Health
- Soil Geography

The simple yet powerful way to access and use soil data.

START WSS

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Soil surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as soil quality assessments and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center at the following link: USDA Service Center or your NRCS State Soil Scientist at the following link: NRCS State Soil Scientist.

Four Basic Steps

1 Define.

Use the Area of Interest tab to define your area of interest.

I Want To...

- Start Web Soil Survey (WSS)
- Know Web Soil Survey Requirements
- Know Web Soil Survey operation hours
- Find what areas of the U.S. have soil data
- Find information by topic
- Know how to hyperlink from other documents to Web Soil Survey
- Know the SSURGO data structure
- Use Web Soil Survey on a mobile device

Announcements/Events

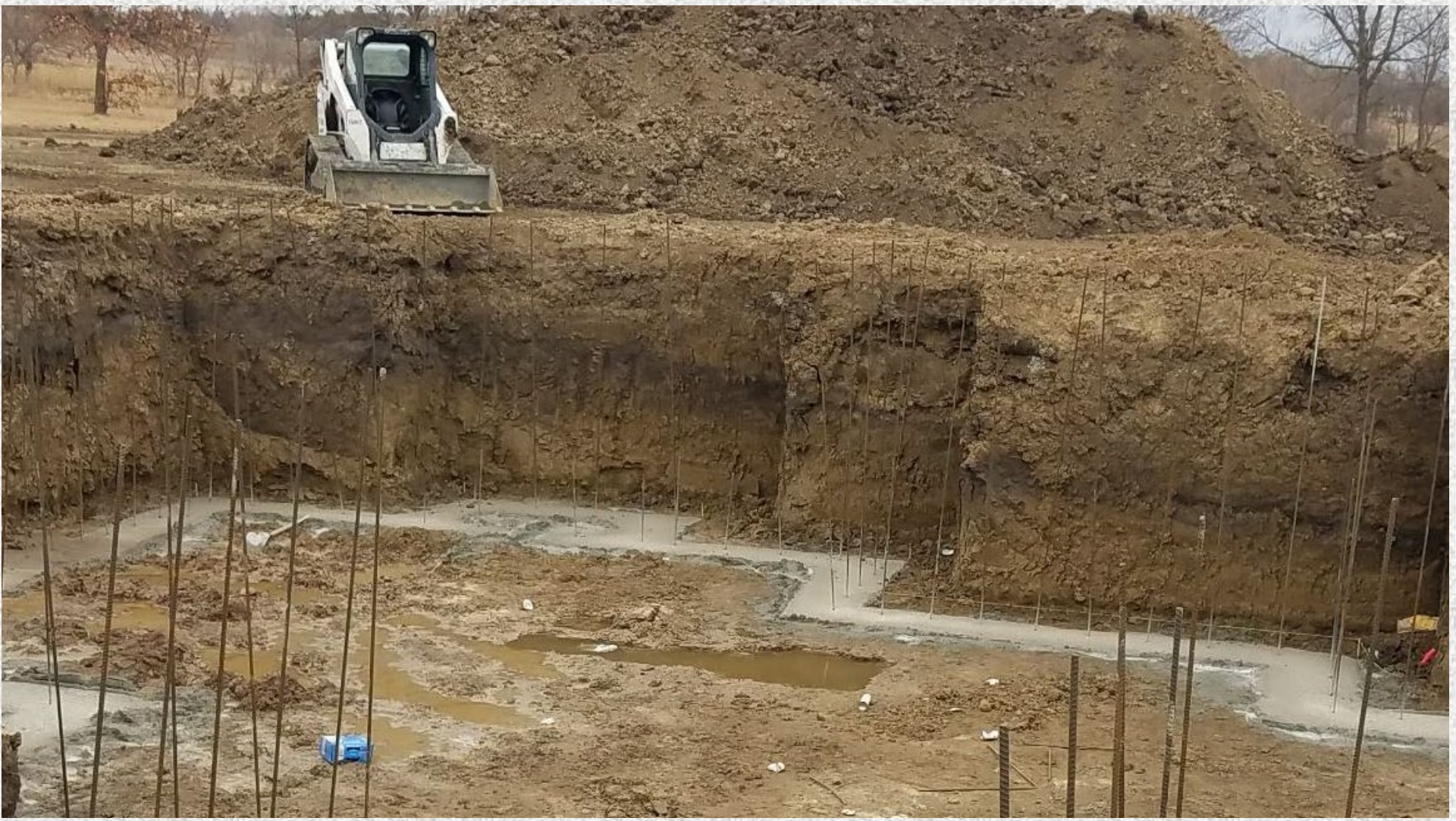
- Web Soil Survey 3.4.0 has been released! View Web Soil Survey release history
- Sign up for e-mail updates via GovDelivery

I Want Help With...

Type here to search

64°F Cloudy

7:29 AM
6/6/2022



Kentucky Bluegrass Allowable Depletion

12-inch root zone

Soil Texture	Available Water In Root Zone	Allowable Depletion 50 % of Available Water (maximum amount to apply)
Fine sand	1.0 in.	0.5 in.
Loamy fine sand	1.3 in.	0.7 in.
Silt loam	2.2 in.	1.1 in.
Silty clay loam	1.6 in.	0.8 in.
Clay loam	1.4 in.	0.7 in.

Kentucky Bluegrass Irrigation Frequency

12-inch root zone

Soil Texture	Available Water In Root Zone	Allowable Depletion 50 % of Available Water (maximum amount to apply)	Maximum Irrigation Frequency @ ET = 0.2 in/d Assuming No Rain
Fine sand	1.0 in.	0.5 in.	2-3 days
Loamy fine sand	1.3 in.	0.7 in.	3-4 days
Silt loam	2.2 in.	1.1 in.	5-6 days
Silty clay loam	1.6 in.	0.8 in.	4 days
Clay loam	1.4 in.	0.7 in.	3-4 days

Tall Fescue Allowable Depletion

24-inch root zone

Soil Texture	Available Water In Root Zone	Allowable Depletion 50 % of Available Water (maximum amount to apply)
Fine sand	2.0 in.	1.0 in.
Loamy fine sand	2.6 in.	1.3 in.
Silt loam	4.4 in.	2.2 in.
Silty clay loam	3.2 in.	1.6 in.
Clay loam	2.8 in.	1.4 in.

Tall Fescue Irrigation Frequency

24-inch root zone

Soil Texture	Available Water In Root Zone	Allowable Depletion 50 % of Available Water (maximum amount to apply)	Maximum Irrigation Frequency @ ET = 0.21 in/d Assuming No Rain
Fine sand	2.0 in.	1.0 in.	5 days
Loamy fine sand	2.6 in.	1.3 in.	6 days
Silt loam	4.4 in.	2.2 in.	10 days
Silty clay loam	3.2 in.	1.6 in.	8 days
Clay loam	2.8 in.	1.4 in.	7 days


Questions

How to Determine Water Application Amounts or How Much Did I Apply?

How to Determine Water Application Amounts

1. Precipitation rates provided by designer/installer for each station/zone
2. Estimate based on type of sprinkler head
3. Measure with rain gauges
4. Calculate based on water meter

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Approximate Precipitation Rate Based on Sprinkler Type

- ***Spray heads, 8-12 ft. radius:*** *2 in/hr*

- ***Rotators with 30-40 ft. radius:*** *0.5 in/hr*

Product Catalog

RESIDENTIAL & COMMERCIAL IRRIGATION | *Built on Innovation*®

VOLUME 39

Hunter®






hunterindustries.com

RAIN BIRD®

Landscape Irrigation Products Catalog

Hideaway HOA • La Quinta, CA

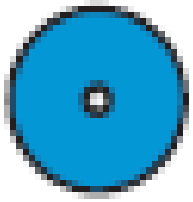





The Intelligent Use of Water.™

10 Series MPR

15° Trajectory

Nozzle	Pressure psi	Radius ft.	Flow gpm	Precip In/h	Precip In/h
10F 	15	7	1.16	2.28	2.63
	20	8	1.30	1.96	2.26
	25	9	1.44	1.71	1.98
	30	10	1.58	1.52	1.75
10H 	15	7	0.58	2.28	2.63
	20	8	0.65	1.96	2.26
	25	9	0.72	1.71	1.98
	30	10	0.79	1.52	1.75
10Q 	15	7	0.29	2.28	2.63
	20	8	0.33	1.96	2.26
	25	9	0.36	1.71	1.98
	30	10	0.39	1.52	1.75

5000 Series Std. Angle Rain Curtain™ Nozzle Performance

Pressure psi	Nozzle	Radius ft.	Flow gpm	Precip ■ In/h	Precip ▲ In/h
45	1.5	35	1.54	0.24	0.28
	2.0	37	2.07	0.29	0.34
	2.5	37	2.51	0.35	0.41
	3.0	39	3.09	0.37	0.43
	4.0	42	4.01	0.44	0.51
	5.0	43	5.09	0.48	0.56
	6.0	44	6.01	0.59	0.69
	8.0	44	8.03	0.92	1.06

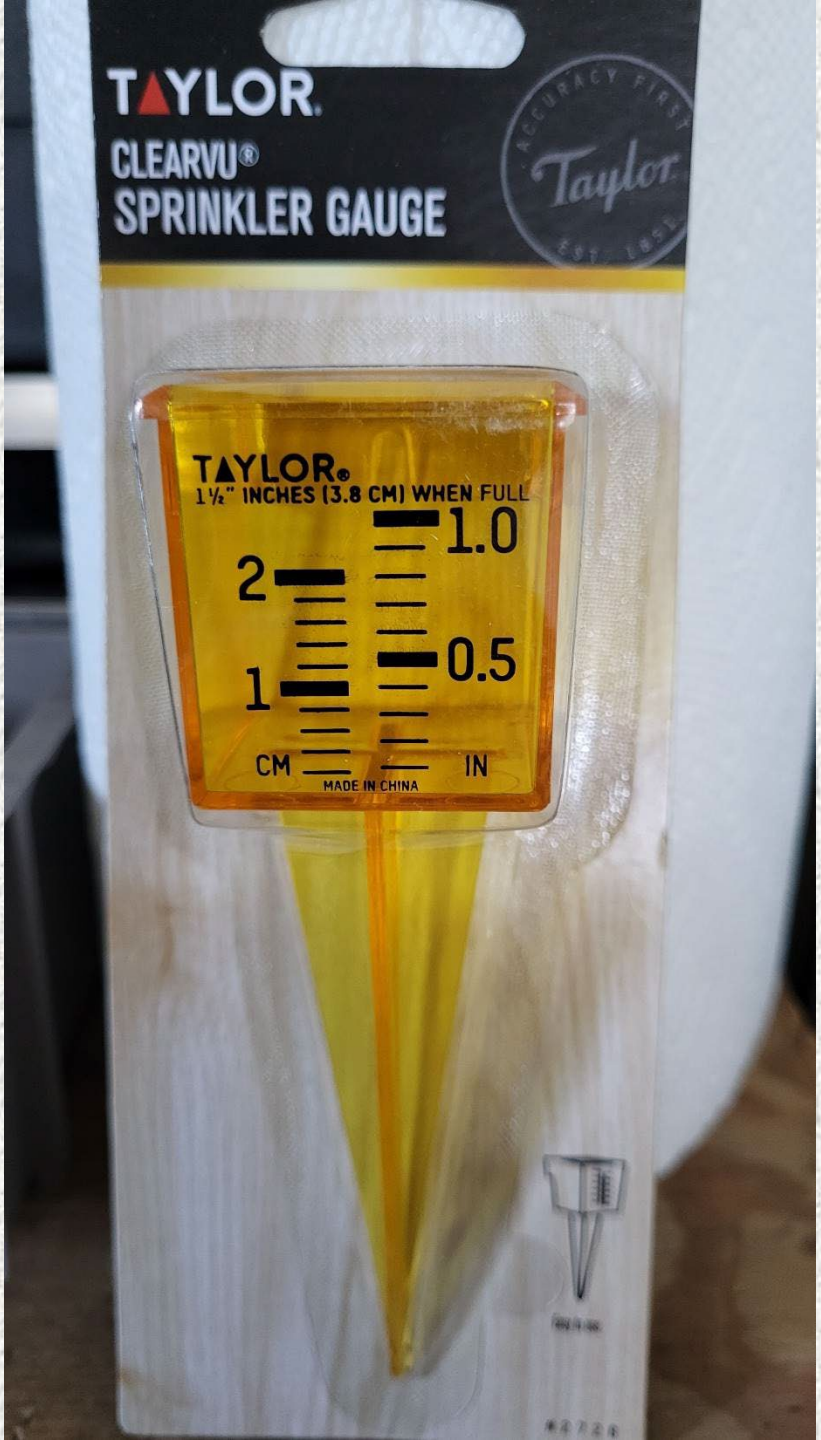
Precipitation rates based on half-circle operation

■ *Square spacing based on 50% diameter of throw*

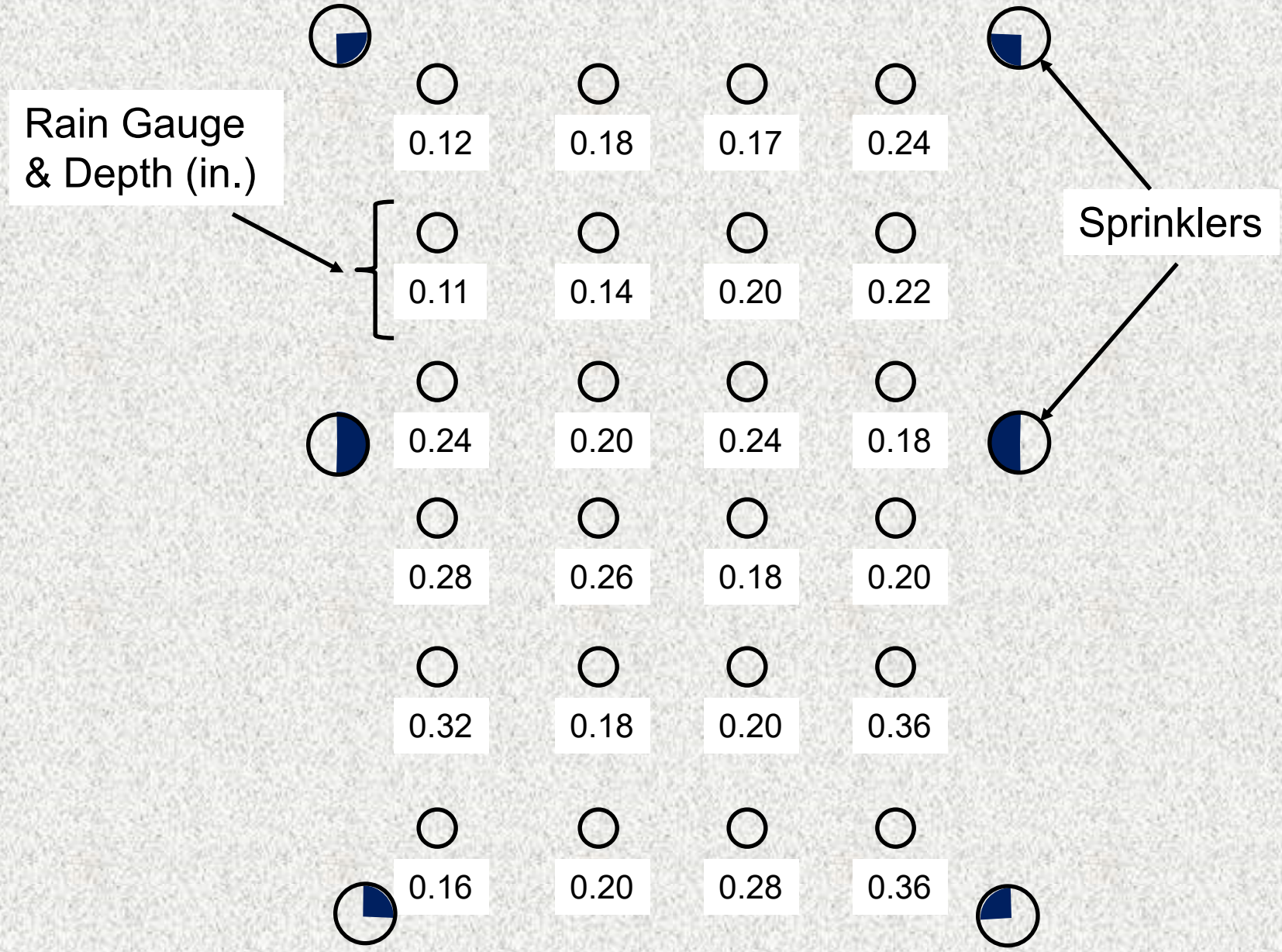
▲ *Triangular spacing based on 50% diameter of throw*

How to Determine Water Application Amounts

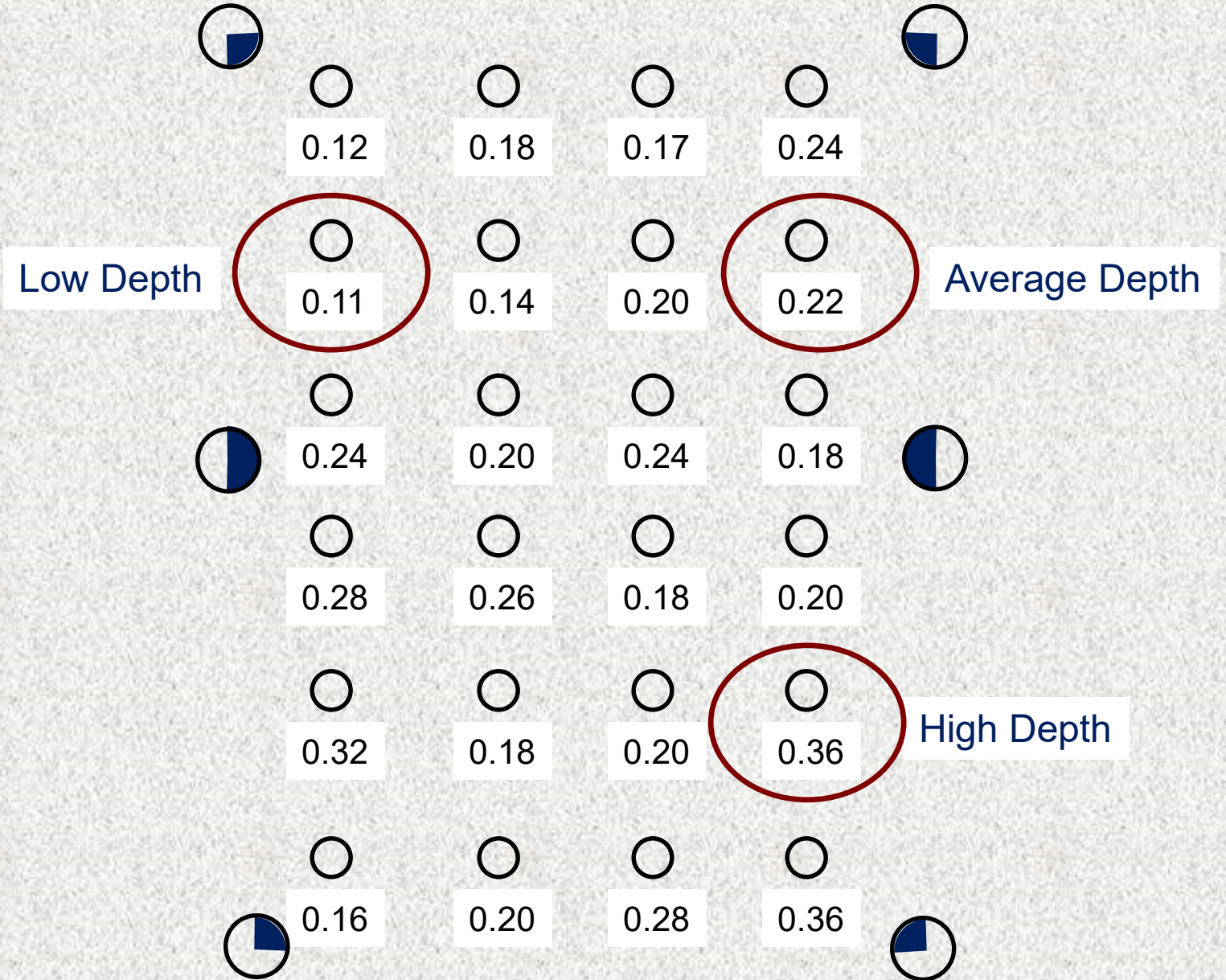
1. Precipitation rates provided by designer/installer for each station/zone
2. Estimate based on type of sprinkler head
3. **Measure with rain gauges**
4. Calculate based on water meter


TAYLOR
CLEARVU®
SPRINKLER GAUGE
ACCURACY FIRST
Taylor
EST. 1856
TAYLOR
1½" INCHES (3.8 CM) WHEN FULL
2
1
1.0
0.5
CM
IN
MADE IN CHINA

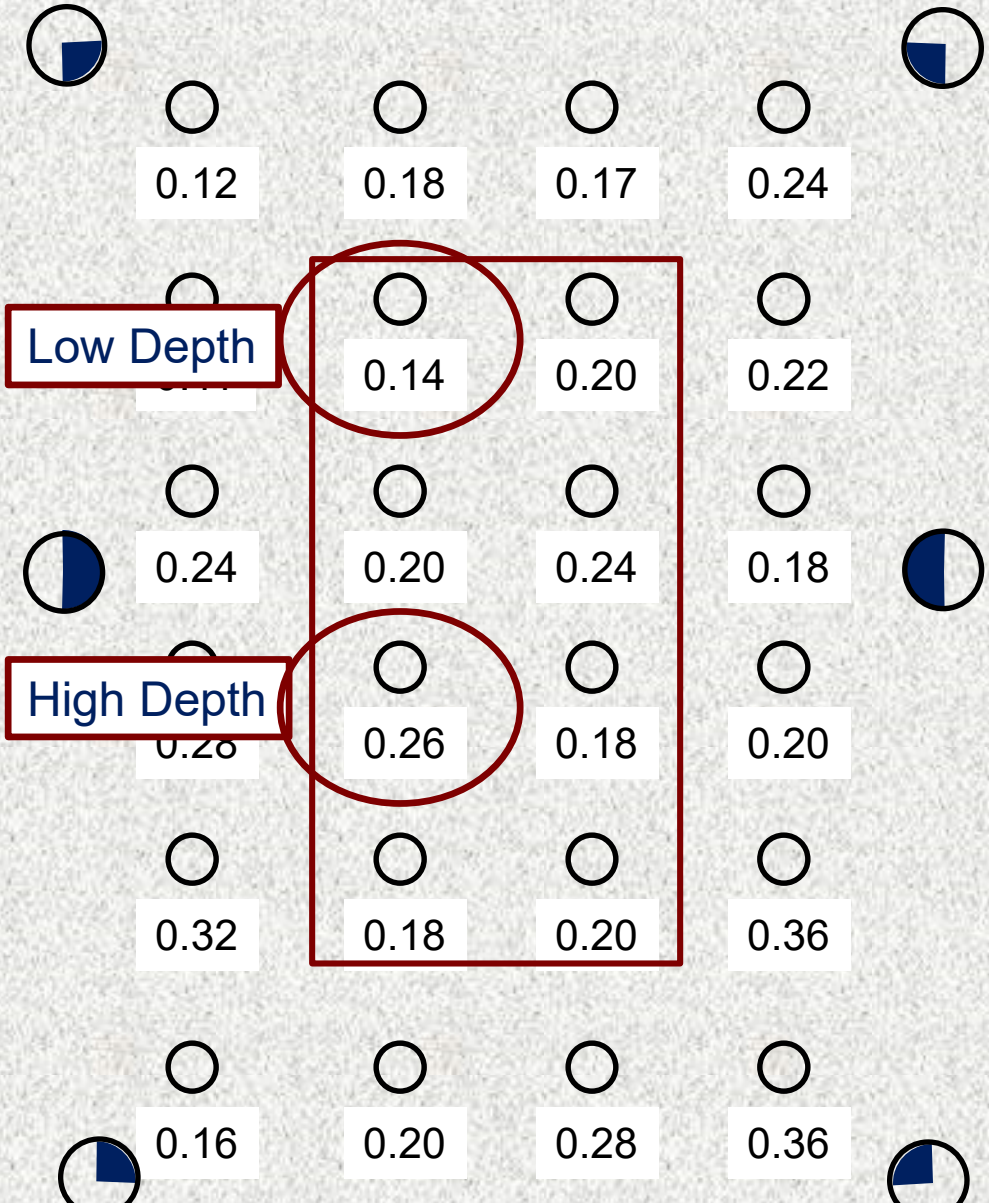

TAYLOR®
1½" INCHES (3.8 CM)
1.0
2
0.5
1


Rain Gauge
& Depth (in.)
Sprinklers
0.12
0.18
0.17
0.24
0.11
0.14
0.20
0.22
0.24
0.20
0.24
0.18
0.28
0.26
0.18
0.20
0.32
0.18
0.20
0.36
0.16
0.20
0.28
0.36

Average Depth = 0.22 in.



Interior Gauges



So how many gauges do I need?

- my analysis revealed that **3** gauges would average within about 20% of the real amount

- place them in the interior region

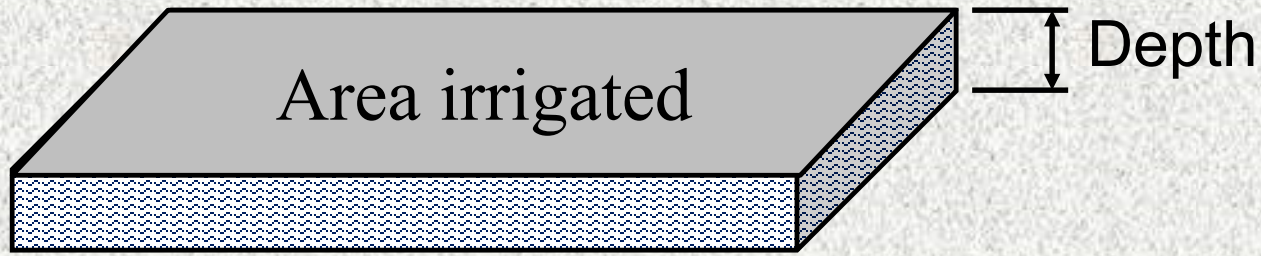
How to Determine Water Application Amounts

1. Precipitation rates provided by designer/installer for each station/zone
2. Estimate based on type of sprinkler head
3. Measure with rain gauges
4. Calculate based on water meter


03 21271825
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1104
Model
35
62584-021
3/4"
Cubic Feet
19795

Calculate based on water meter

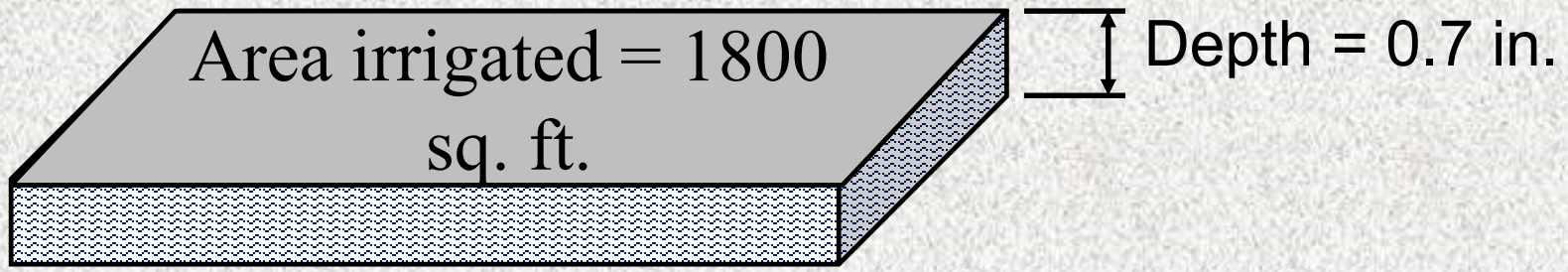
$$Depth = \frac{Volume\ applied}{Area\ irrigated}$$




Example:
Station waters 30’ x 60’ area = 1800 square ft

Example

$$Depth = \frac{Volume\ applied}{Area\ irrigated}$$



Volume on meter **after** watering station (zone) =2084.51 cubic feet
Volume on meter **before** watering station (zone) =1979.51 cubic feet
Volume applied = 2054.51 – 1979.51 = **105 cubic feet**

$$Depth = \frac{105\ cubic\ feet}{1800\ sq.ft.}$$ = 0.058 ft. x 12 in./ft = **0.7 in.**

Questions

Setting the Controller to Match Needs

- *Watering, how often and how much*
- *Seasonal adjust*
- *Rainfall shutoffs*

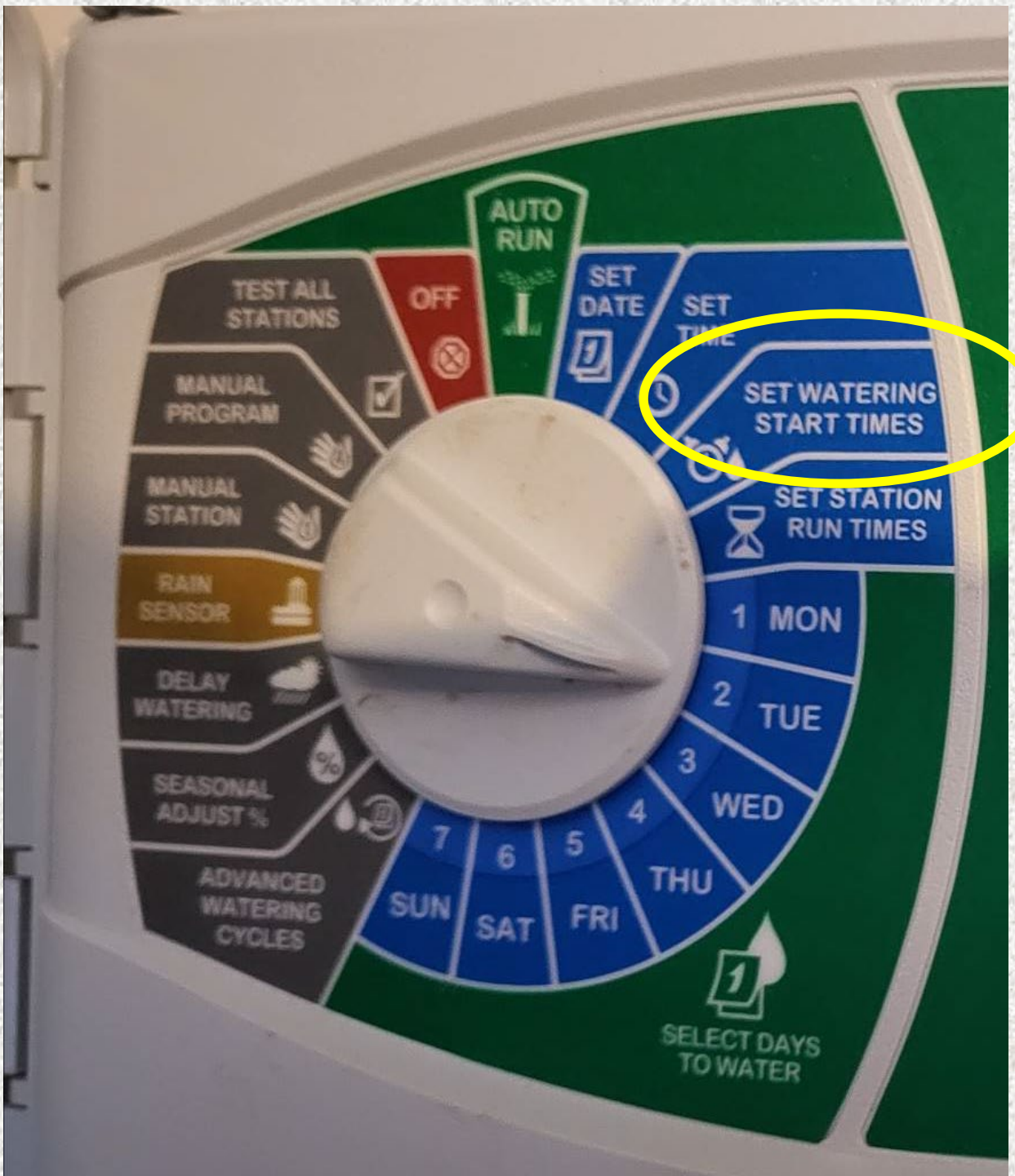
Setting the Controller to Match Needs

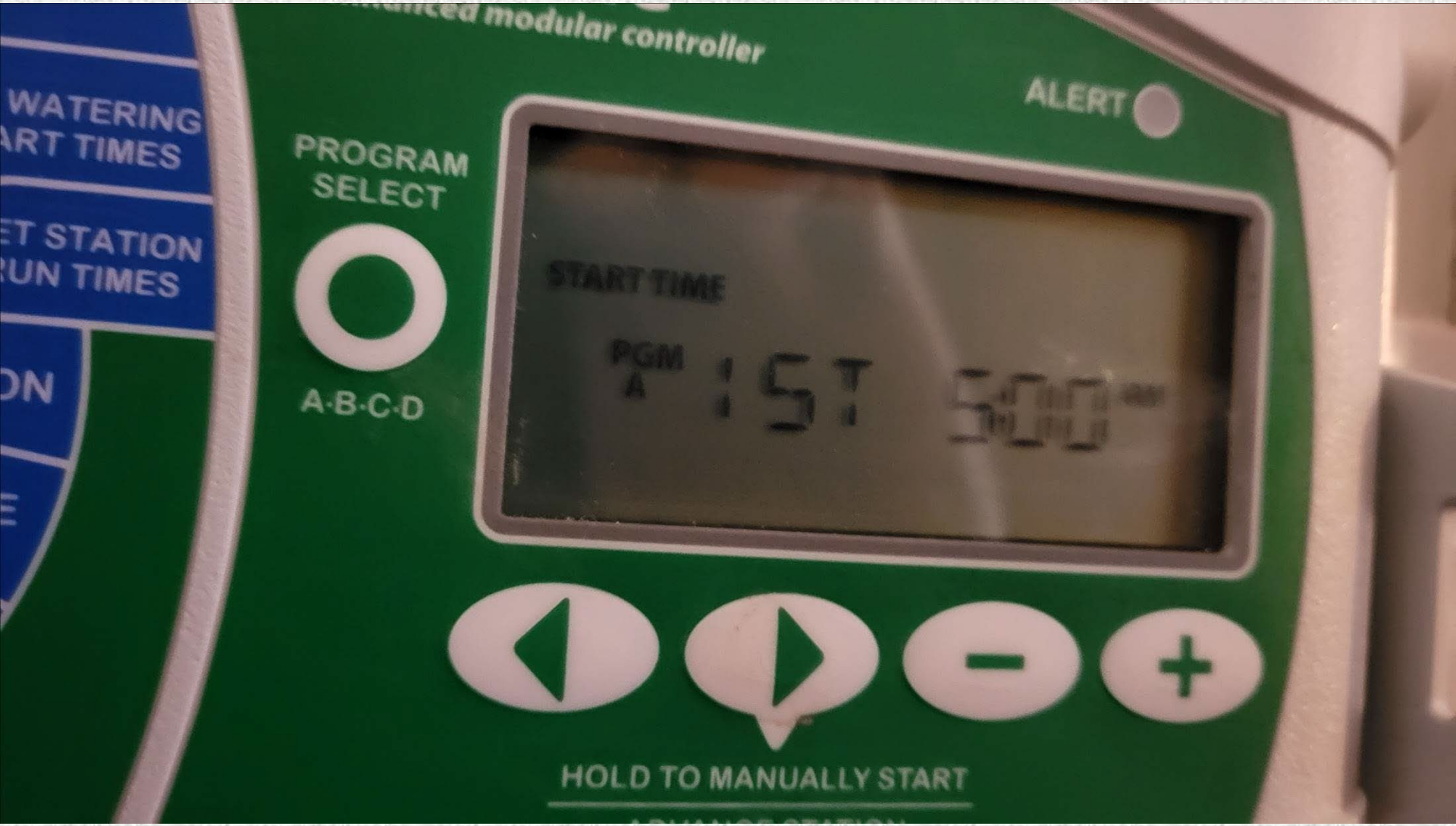
- *Watering, how often and how much*
- *Seasonal adjust*
- *Rainfall shutoffs*

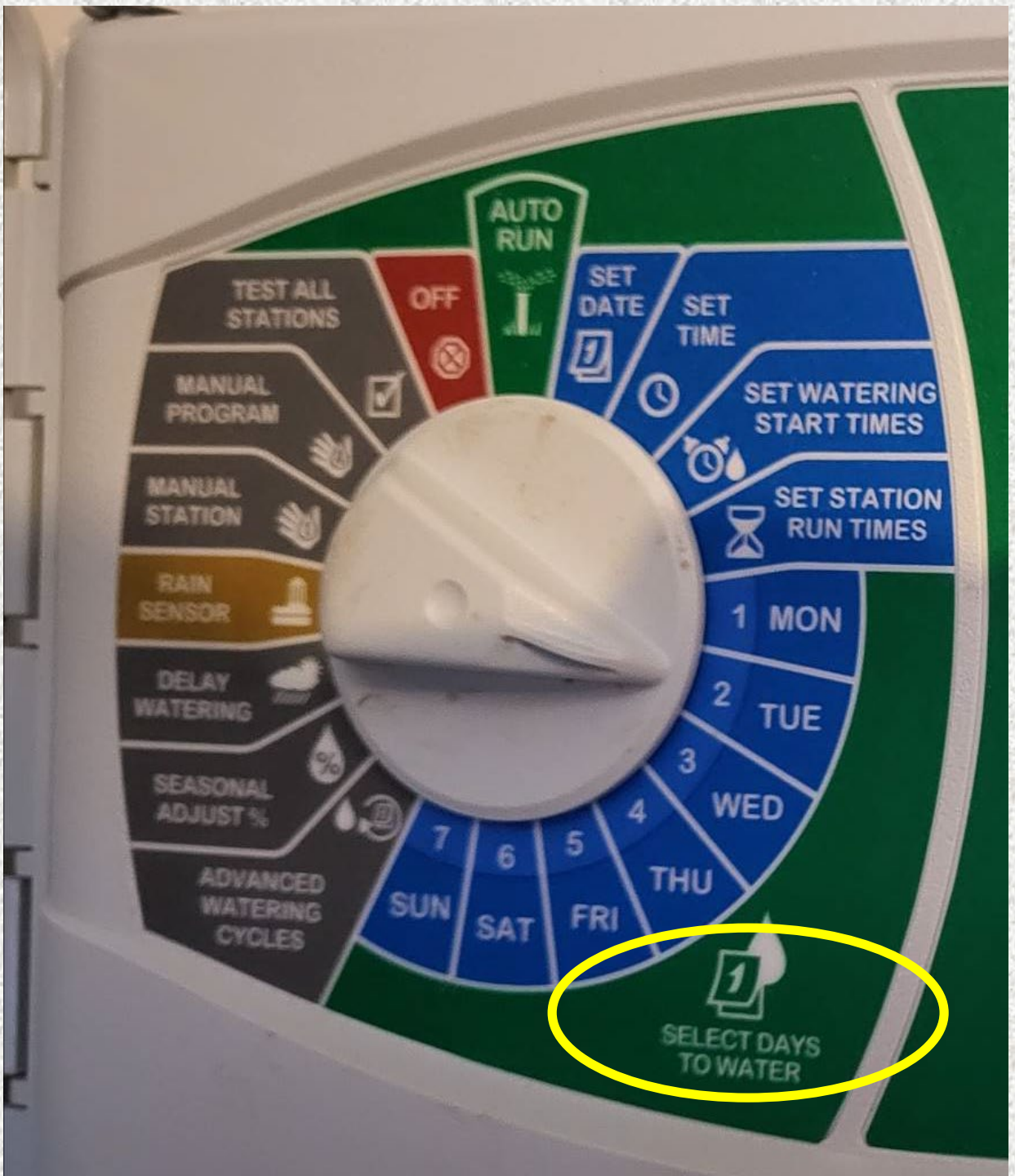
Kentucky Bluegrass Irrigation Frequency

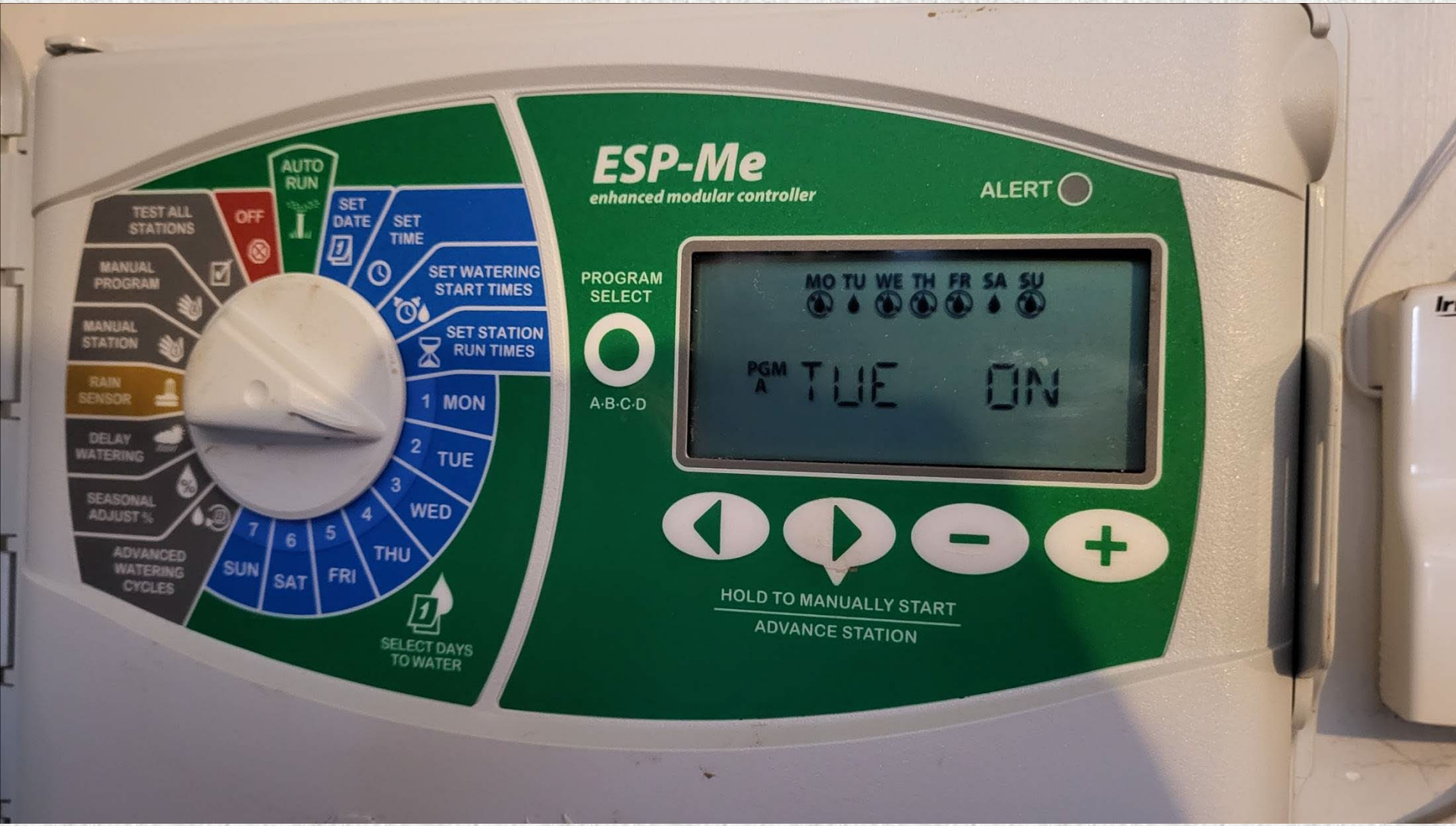
12-inch root zone

Soil Texture	Available Water In Root Zone	Allowable Depletion 50 % of Available Water (maximum amount to apply)	Maximum Irrigation Frequency @ ET = 0.2 in/d Assuming No Rain
Fine sand	1.0 in.	0.5 in.	2-3 days
Loamy fine sand	1.3 in.	0.7 in.	3-4 days
Silt loam	2.2 in.	1.1 in.	5-6 days
Silty clay loam	1.6 in.	0.8 in.	4 days
Clay loam	1.4 in.	0.7 in.	3-4 days


AUTO RUN
OFF
SET DATE
SET TIME
SET WATERING START TIMES
SET STATION RUN TIMES
TEST ALL STATIONS
MANUAL PROGRAM
MANUAL STATION
RAIN SENSOR
DELAY WATERING
SEASONAL ADJUST %
ADVANCED WATERING CYCLES
1 MON
2 TUE
3 WED
4 THU
5 FRI
6 SAT
7 SUN
SELECT DAYS TO WATER

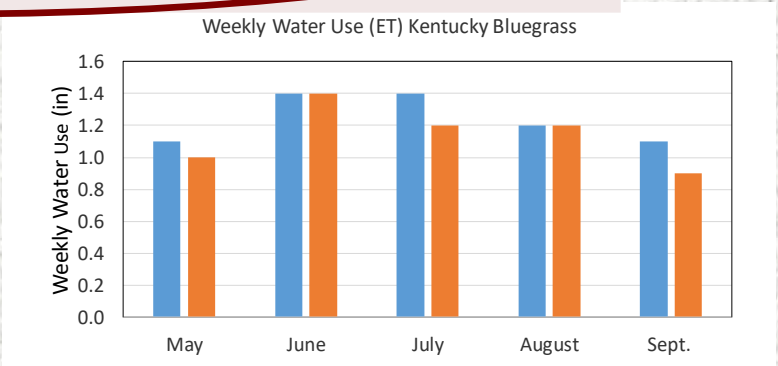

modular controller
ALERT
PROGRAM SELECT
A·B·C·D
START TIME
PGM A
1ST
HOLD TO MANUALLY START

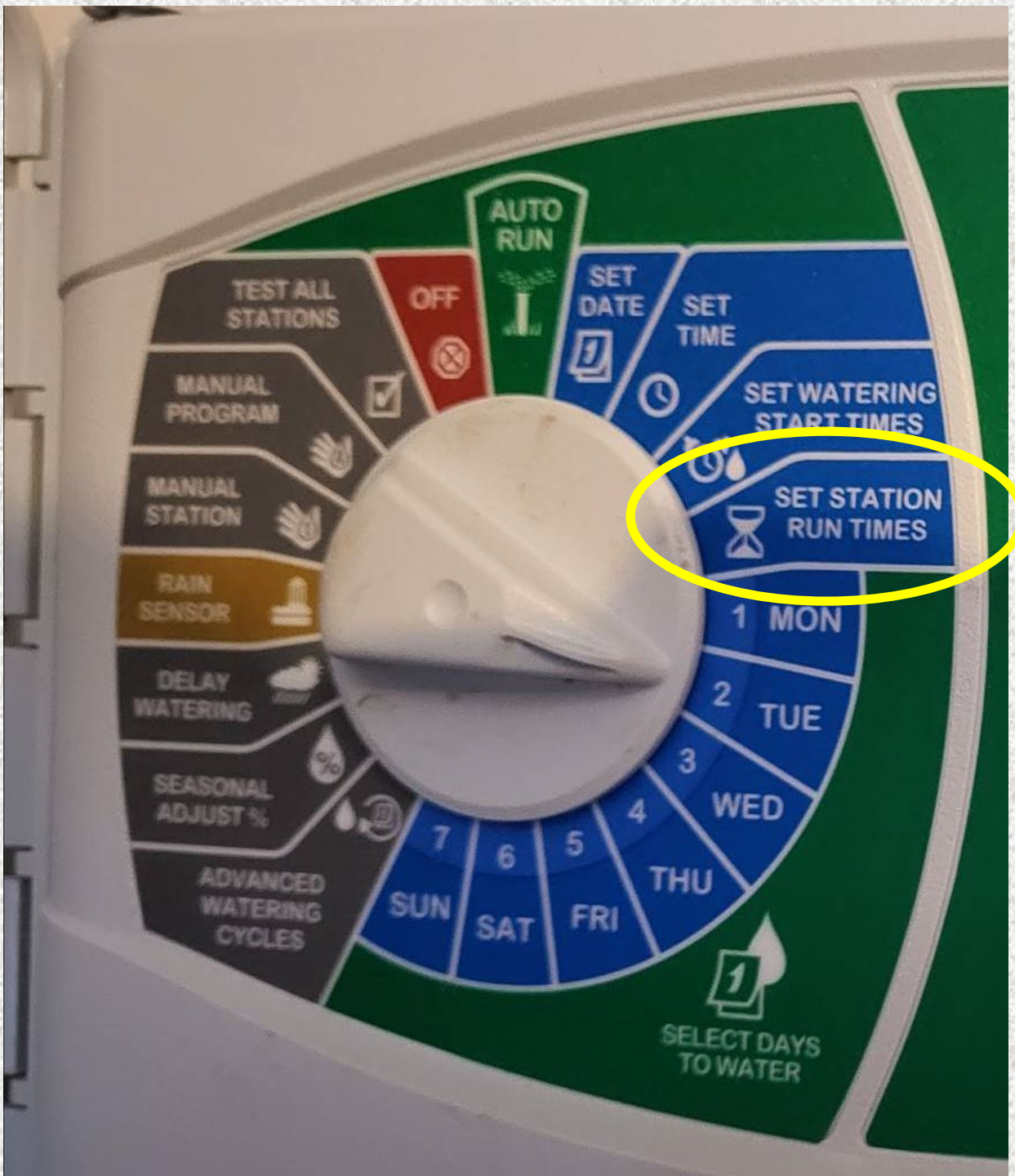

AUTO RUN
OFF
TEST ALL STATIONS
MANUAL PROGRAM
MANUAL STATION
RAIN SENSOR
DELAY WATERING
SEASONAL ADJUST %
ADVANCED WATERING CYCLES
SET DATE
SET TIME
SET WATERING START TIMES
SET STATION RUN TIMES
1 MON
2 TUE
3 WED
4 THU
5 FRI
6 SAT
7 SUN
SELECT DAYS TO WATER

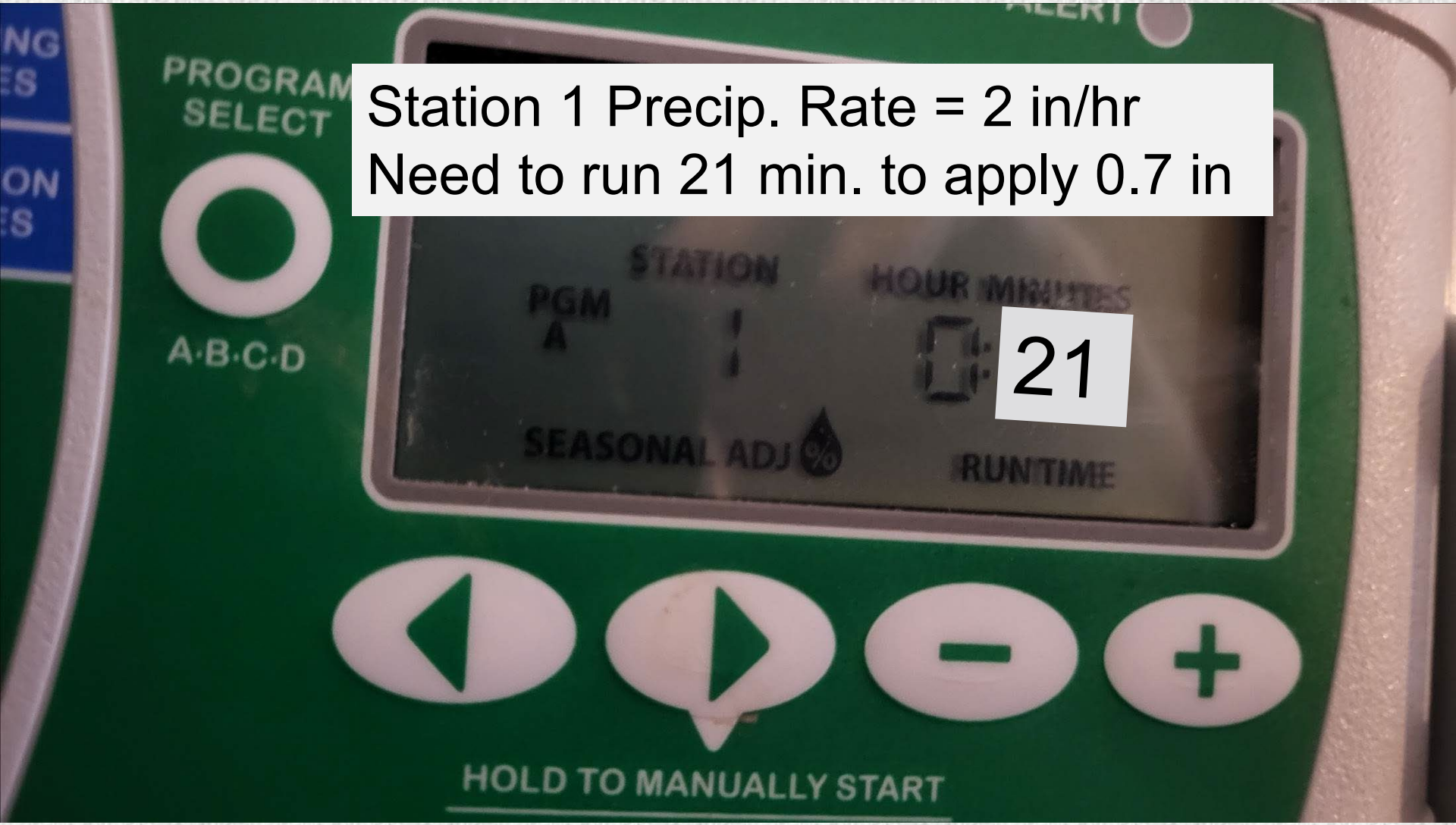

ESP-Me
enhanced modular controller
ALERT
AUTO RUN
OFF
SET DATE
SET TIME
SET WATERING START TIMES
SET STATION RUN TIMES
1 MON
2 TUE
3 WED
4 THU
5 FRI
6 SAT
7 SUN
SELECT DAYS TO WATER
TEST ALL STATIONS
MANUAL PROGRAM
MANUAL STATION
RAIN SENSOR
DELAY WATERING
SEASONAL ADJUST %
ADVANCED WATERING CYCLES
PROGRAM SELECT
A·B·C·D
MO TU WE TH FR SA SU
PGM A TUE ON
HOLD TO MANUALLY START
ADVANCE STATION

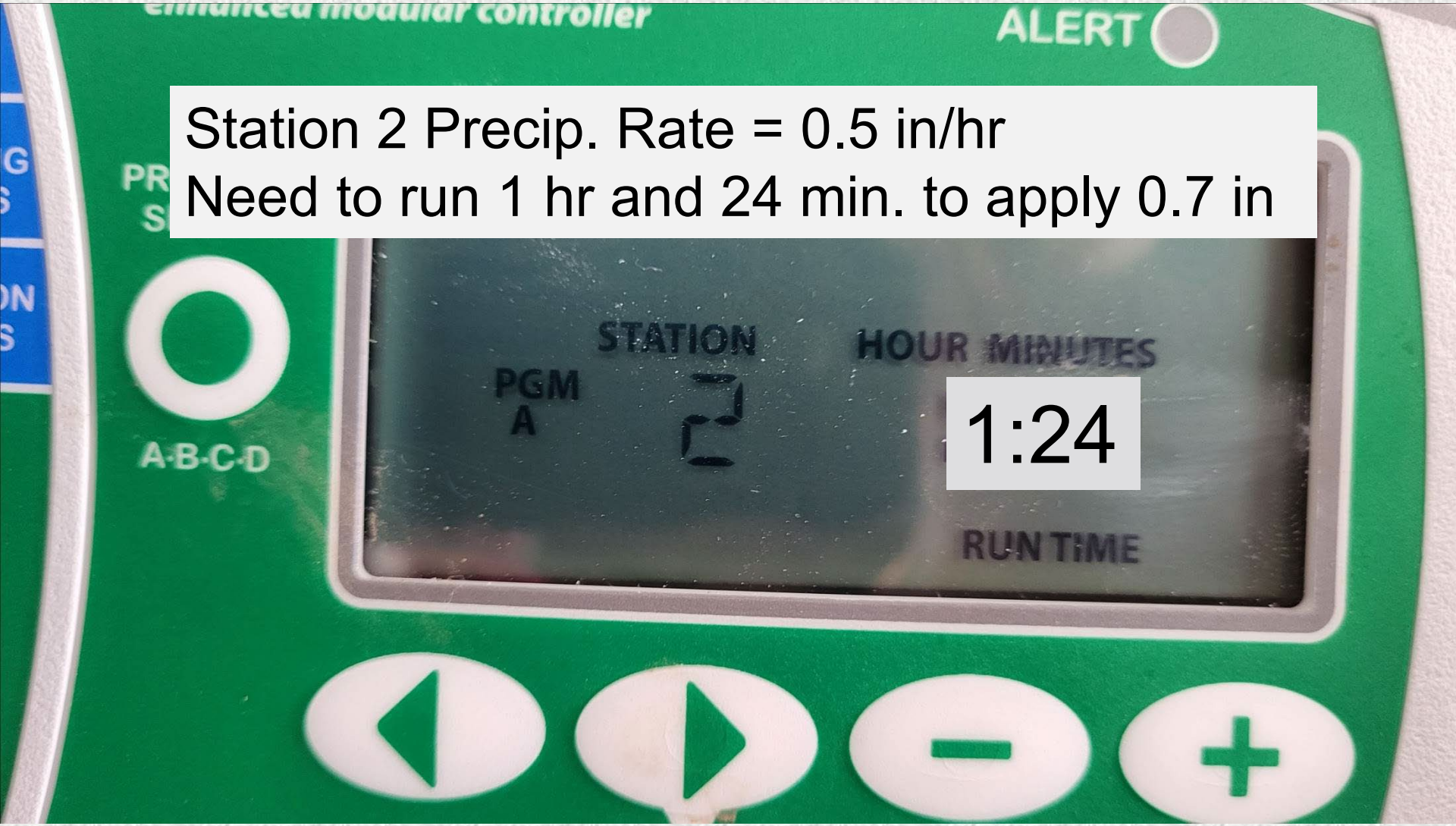
Irrigation Needed During Highest Water Use Periods If It Doesn't Rain

	Kentucky Bluegrass
Weekly	1.4 in.
Daily	0.2 in.
Every other day	0.4 in.
Twice per week	0.7 in.



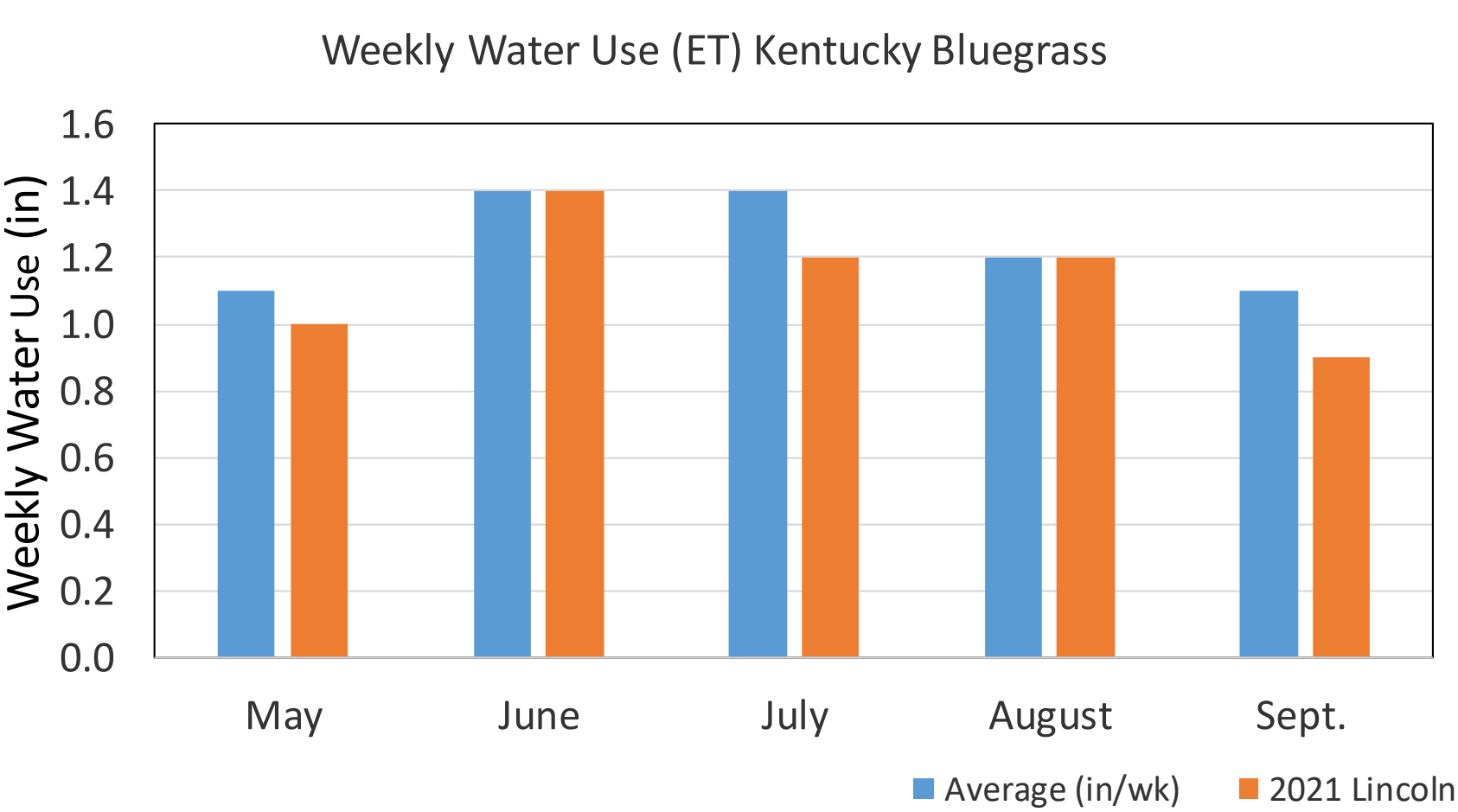

AUTO RUN
SET DATE
SET TIME
SET WATERING START TIMES
SET STATION RUN TIMES
OFF
TEST ALL STATIONS
MANUAL PROGRAM
MANUAL STATION
RAIN SENSOR
DELAY WATERING
SEASONAL ADJUST %
ADVANCED WATERING CYCLES
1 MON
2 TUE
3 WED
4 THU
5 FRI
6 SAT
7 SUN
SELECT DAYS TO WATER


Station 1 Precip. Rate = 2 in/hr
Need to run 21 min. to apply 0.7 in
PROGRAM SELECT
A·B·C·D
STATION
PGM
A
1
HOUR MINUTES
0:21
SEASONAL ADJ
RUNTIME
HOLD TO MANUALLY START


Station 2 Precip. Rate = 0.5 in/hr
Need to run 1 hr and 24 min. to apply 0.7 in
ALERT
PGM
A
STATION
2
HOUR MINUTES
1:24
RUN TIME
A·B·C·D

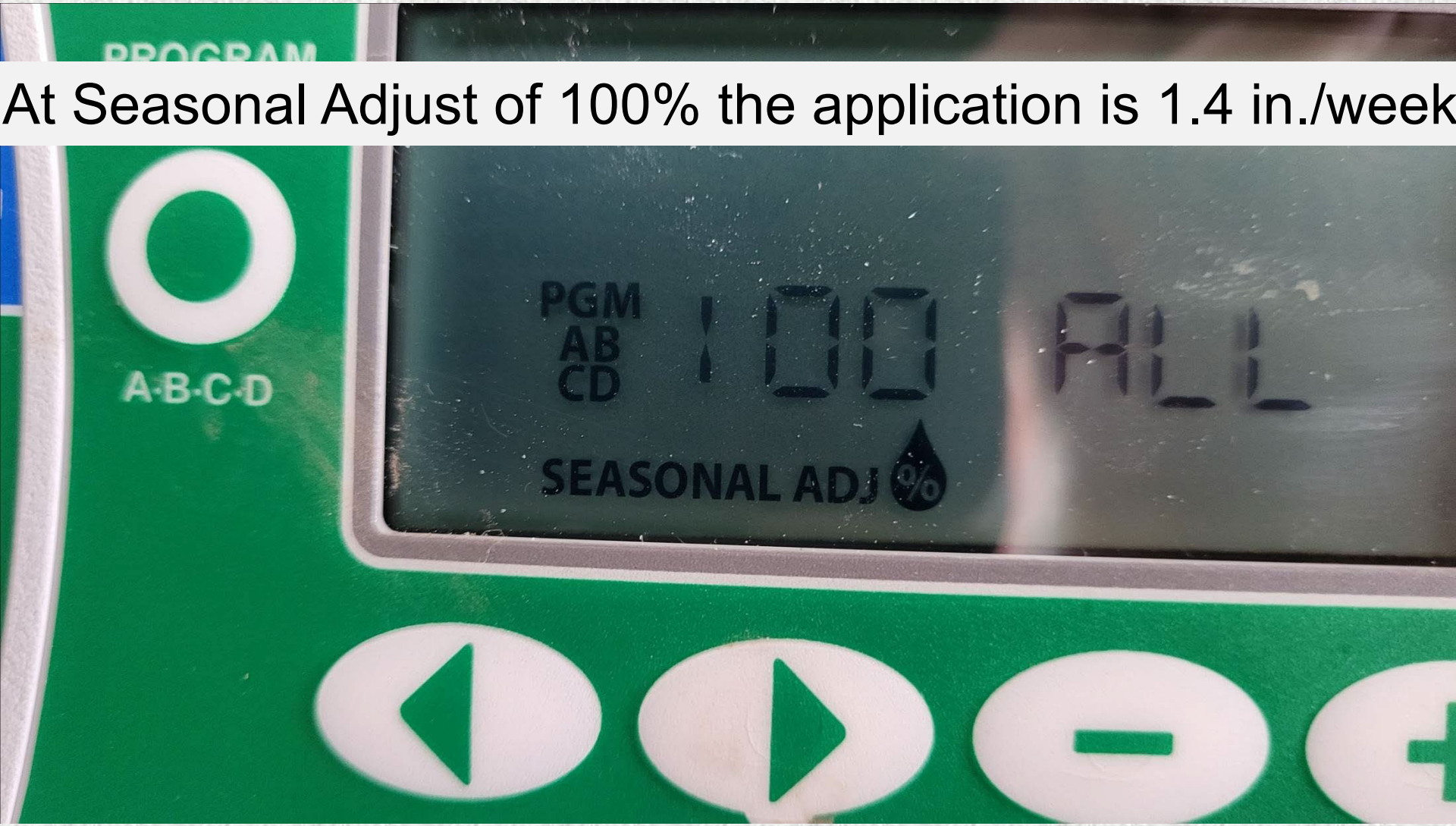
Setting the Controller to Match Needs

- *Watering, how often and how much*
- ***Seasonal adjust***
- *Rainfall shutoffs*

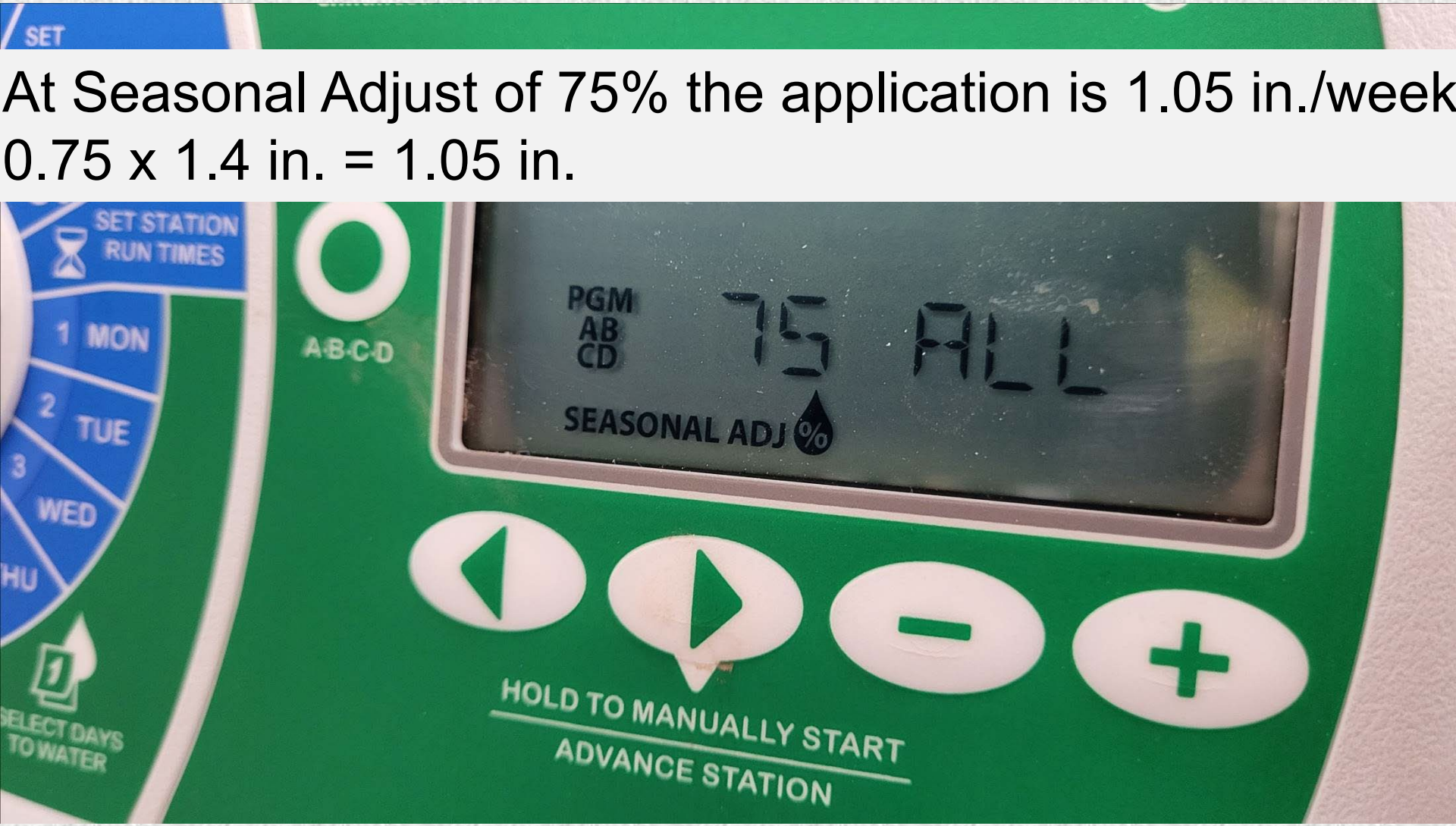

Weekly Water Use (ET) Kentucky Bluegrass
Weekly Water Use (in)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
May
June
July
August
Sept.
Average (in/wk)
2021 Lincoln


TEST ALL STATIONS
OFF
AUTO RUN
SET DATE
SET TIME
SET WATERING START TIMES
SET STATION RUN TIMES
MANUAL PROGRAM
MANUAL STATION
RAIN SENSOR
DELAY WATERING
SEASONAL ADJUST %
ADVANCED WATERING CYCLES
1 MON
2 TUE
3 WED
4 THU
5 FRI
6 SAT
7 SUN
PROGRAM SELECT
A·B·C·D

At Seasonal Adjust of 100% the application is 1.4 in./week



At Seasonal Adjust of 75% the application is 1.05 in./week
0.75 x 1.4 in. = 1.05 in.



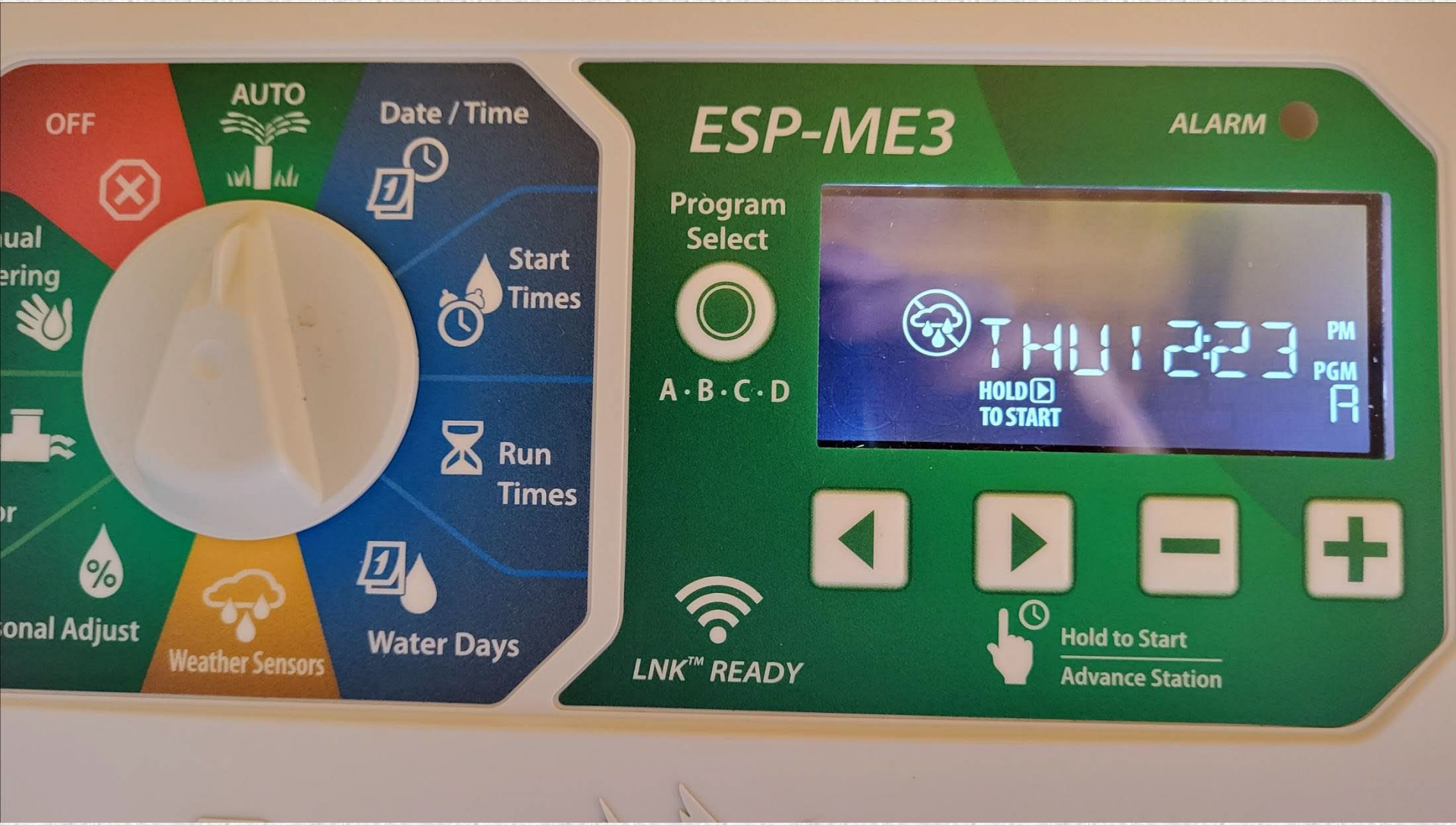
Setting the Controller to Match Needs

- *Watering, how often and how much*
- *Seasonal adjust*
- ***Rainfall shutoffs***


Lmitrol


Irritrol


1/2"
1/4"


OFF
AUTO
Date / Time
Start Times
Run Times
Water Days
Weather Sensors
%
onal Adjust
ESP-ME3
ALARM
Program Select
A · B · C · D
THU 12:23 PM
HOLD TO START
PGM A
LNK™ READY
Hold to Start
Advance Station

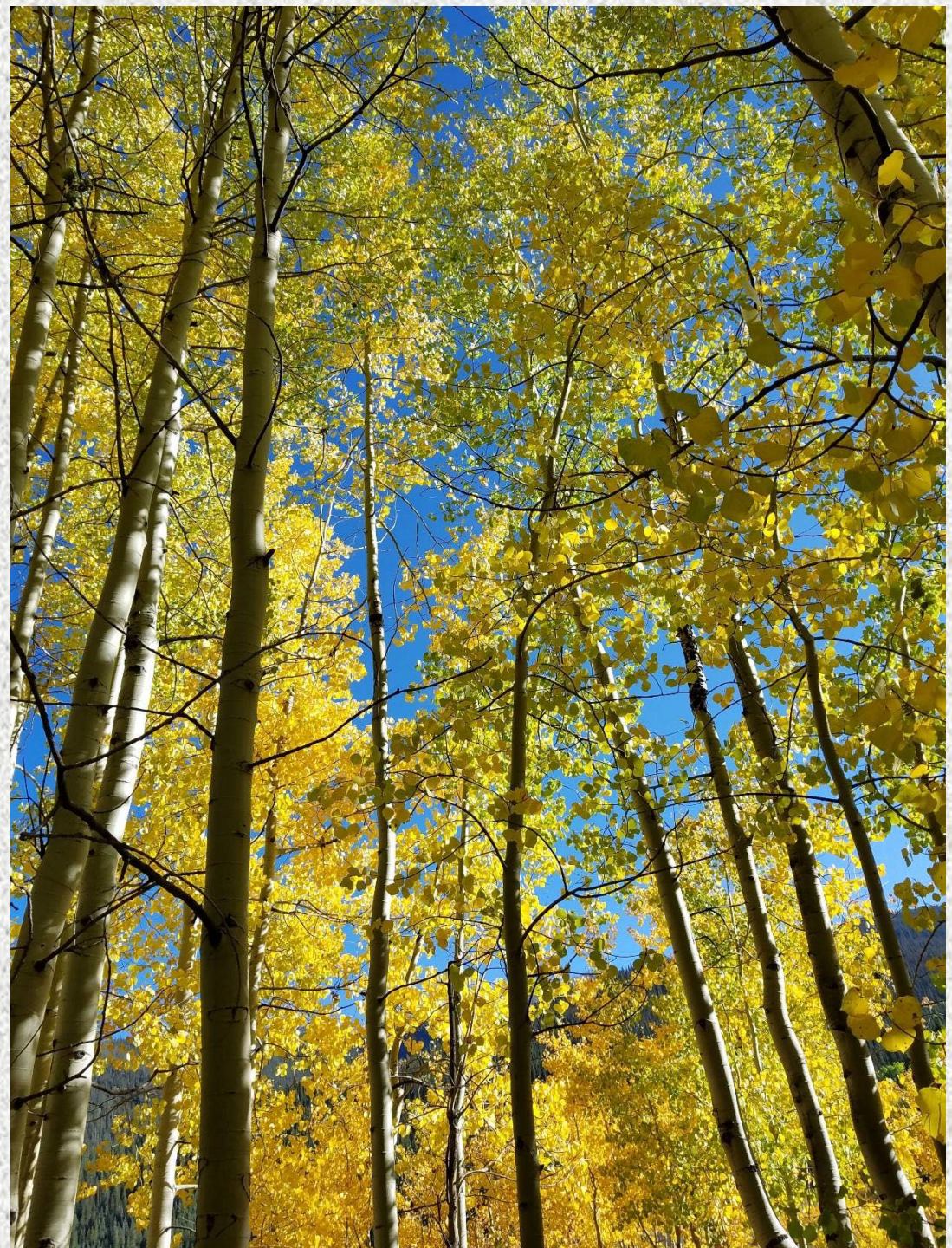

CRAFTSMAN

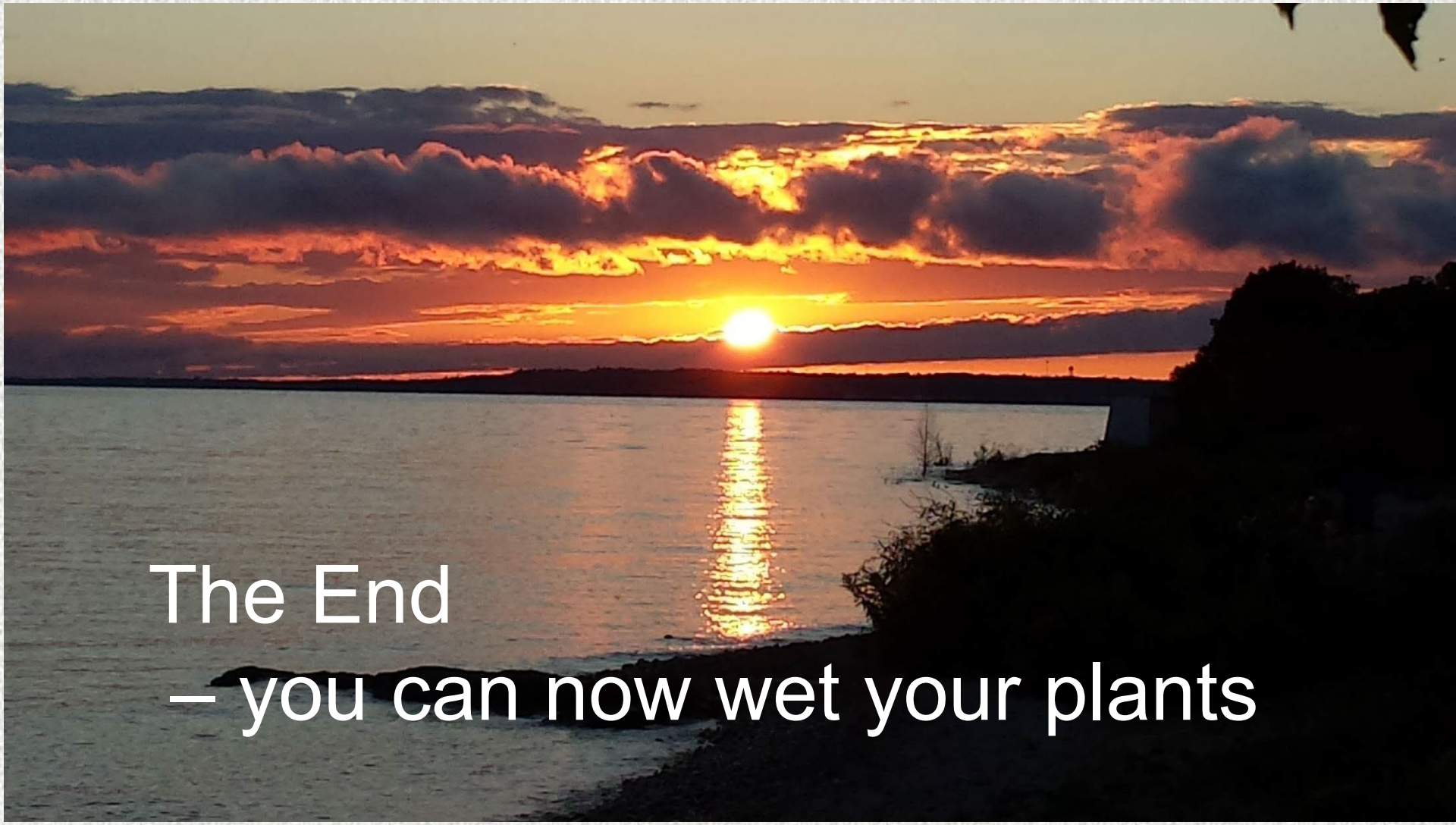

1 2 3 4 5 6 7 8 9 10
DRY
MOIST
WET
MOISTURE
METER

Thinking of the Soil Moisture Reservoir Like a Checking Account - 2021 Data

	Deposits to Root Zone	Withdrawals from Root Zone
Effective Rainfall	9.8 in.	-
Irrigation	14.3 in.	-
Evapotranspiration	-	23.7 in
Total, May 1 – September 21	24.1 in.	23.7 in.

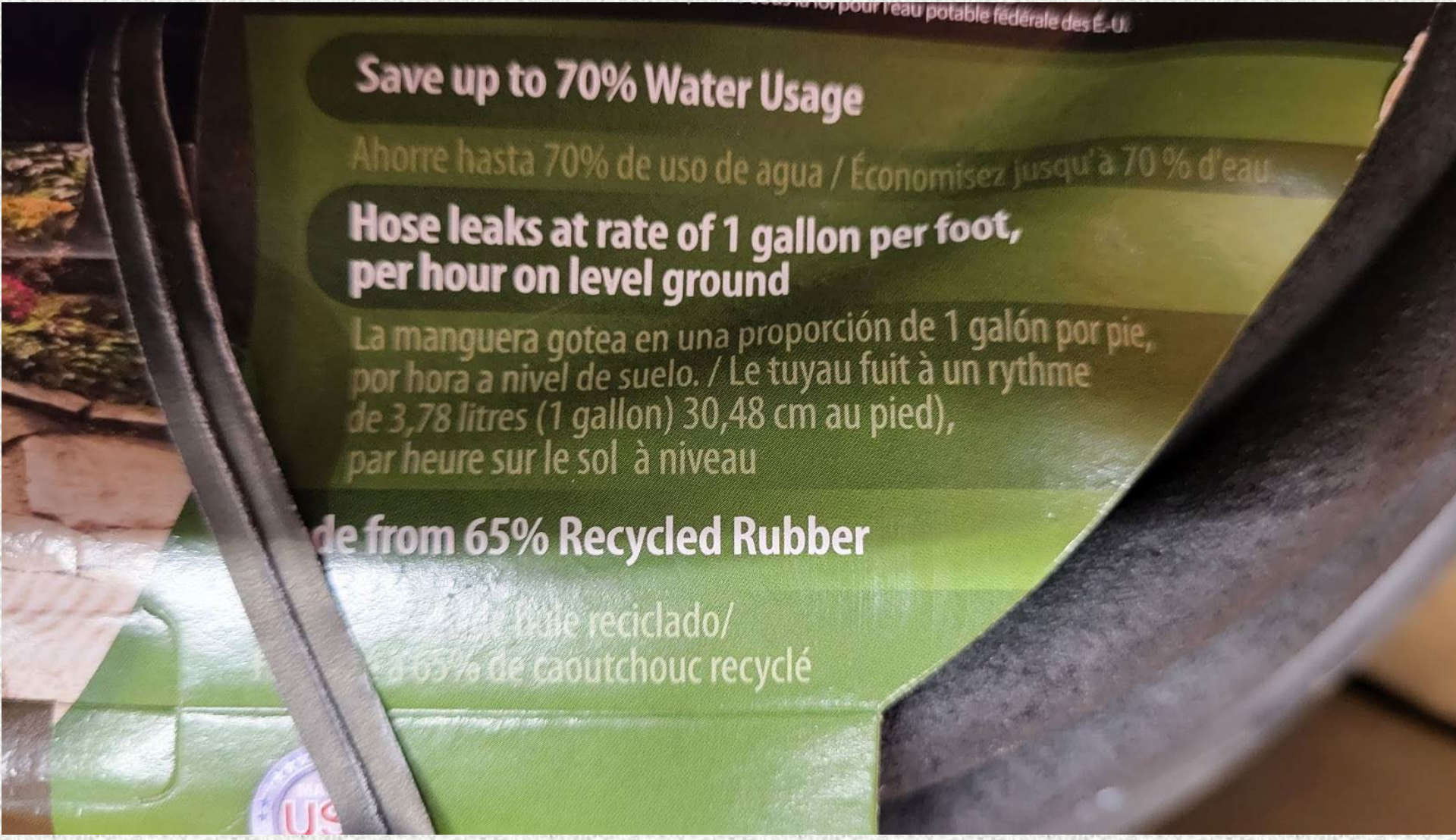
Questions




The End
– you can now wet your plants


OMEGA
bar
psi


OMEGA
bar
psi


Save up to 70% Water Usage
Ahorre hasta 70% de uso de agua / Économisez jusqu'à 70 % d'eau
Hose leaks at rate of 1 gallon per foot,
per hour on level ground
La manguera gotea en una proporción de 1 galón por pie,
por hora a nivel de suelo. / Le tuyau fuit à un rythme
de 3,78 litres (1 gallon) 30,48 cm au pied),
par heure sur le sol à niveau
de from 65% Recycled Rubber
reciclado/
de caoutchouc recyclé