It Does not Matter How Much Water My Soil Holds - The Osmotic Discussion

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Water ON TARGET ON TIME

David McKechnie

CPAg, CIAg, CPSS

North Ryde NSW

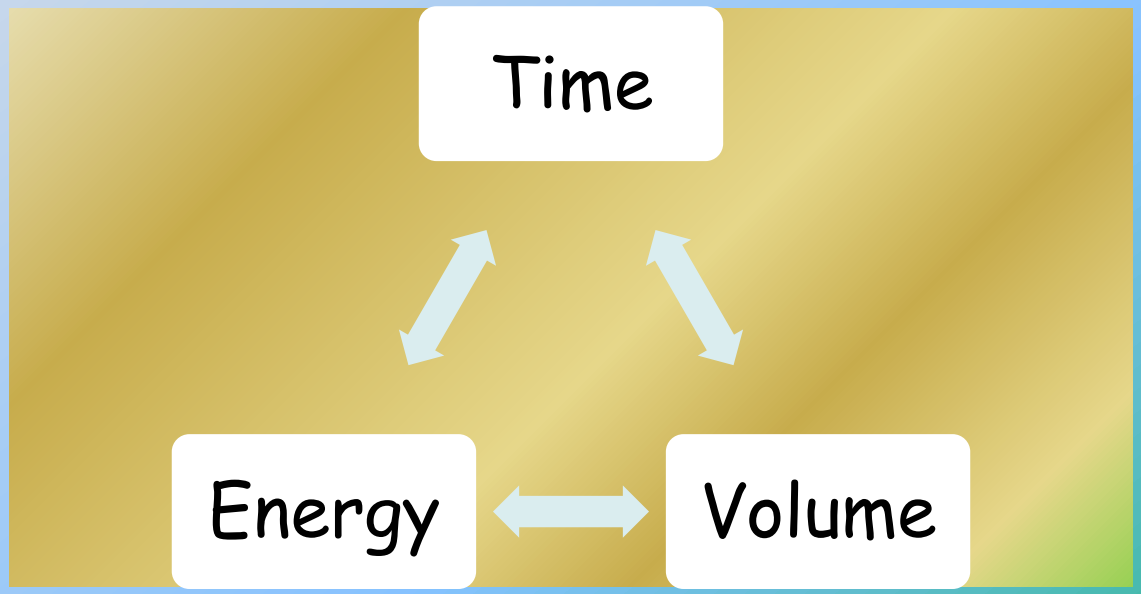
www.davidmckechnie.com

Generally –
Water in the Soil can be measured in three ways

- Volume
- Time
- Energy

Various units for each

Irrigation Is scheduled by one, or more methods



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Cover 3 Points

Soil Water Holding Capacity (SWHC)

Soil Texture to ??????

Comments on EC and the SWHC

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Definition of Terms SWHC

- AW FC – PWP
- FC Volume or energy of water after saturation after 24 hours Drainage and others
  - PWP The point a plant can not recover from (- 1500 kpa) and others

Other Terms for SWHC

- AW = FC –PWP

- EW + DUL – DLL
  - EW Effective Water
  - DUL Drained Upper Limit
  - DLL /LL Drained Lower Limit

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Volume to Energy SWHC

- FC / DUL
  - Measured 24 hrs. to 2 days after rainfall or irrigation
    - -10kpa -33kpa -100kpa
- PWP / DLL
  - The stage a plant cannot obtain useful water
    - -1500kpa

Suction			Matrix Potential	Equivalent as cylindrical pore diameter	relative humidity	freezing point depression
(m)	(bar)	(pF)	(J kg-1 or kPa)		(%)	(K)
0.01	0.001	0	-0.1	3 mm	100	
0.1	0.01	1	-1	300*u*m	100	
1	0.1	2	-10	30*u*m	99.99	
10	1	3	-100	3*u*m	99.93	0.08
100	10	4	-1,000	300nm	99.28	0.8
1,000	100	5	-10,000	30nm	93	8
10,000	1,000	6	-100,000		48.4	
100,000	10,000	7	-1,000,000		0.07	

- kPa is commonly used for potential , but is a unit of pressure. (energy)
- **Table 1.** Units of soil suction and its equivalents (From Hanks 1992 pp 25)

As % of AW Removed from Soil	Sand / Sandy Loam	Loam	Clay / Clay Loams
Saturated (Above FC)	Free water appears on squeezing	Free Water CAN be squeezed out	Soil is sticky
At FC	No Free water - Leave mark on hand	Soil Stickily - able to roll into "worms"	As per loam
0-25	Forms weak ball - breaks easily	Soil is coherent and pliable - Unable to form worms	Form ribbon in fingers - has slick feeling
25-50	Appears Dry - Ball will not hold together	Soil Coherent - Forms Ball under pressure	Forms Ball - just fingers out
50-75	Appears Dry - Will not form Ball	Forms Crumbly ball under pressure	Will Form Ball - Not Ribbon
75-100 to PWP	Soil is dry and loose - Falls though fingers	Crumbly - Small Crumbs will Powder	As for Loam

From Reid 1990. The Manual of Australian Agriculture. 5th Ed. pg 735.

An Energy Equation

$$\psi_W = \psi_M + \psi_S + \psi_P$$

ψ_W is the water potential

ψ_M is the matrix potential

ψ_S is the solute or osmotic potential

ψ_P is the pressure potential.

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Plant Water Use
General Points

- 40 %
- 30%
- 20%
- 10%

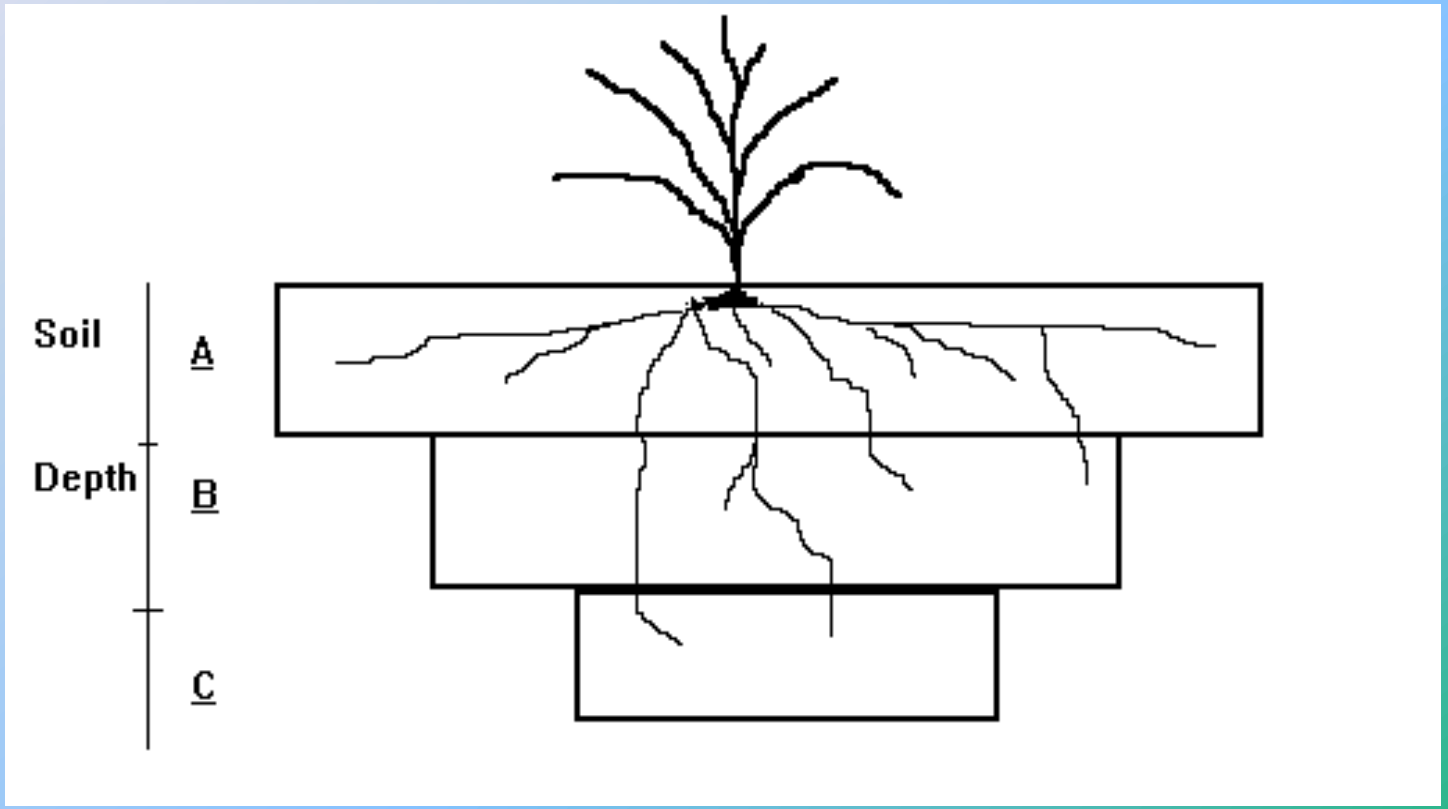

Diagram 1. Plant roots and water uptake over soil depth
Generalisation

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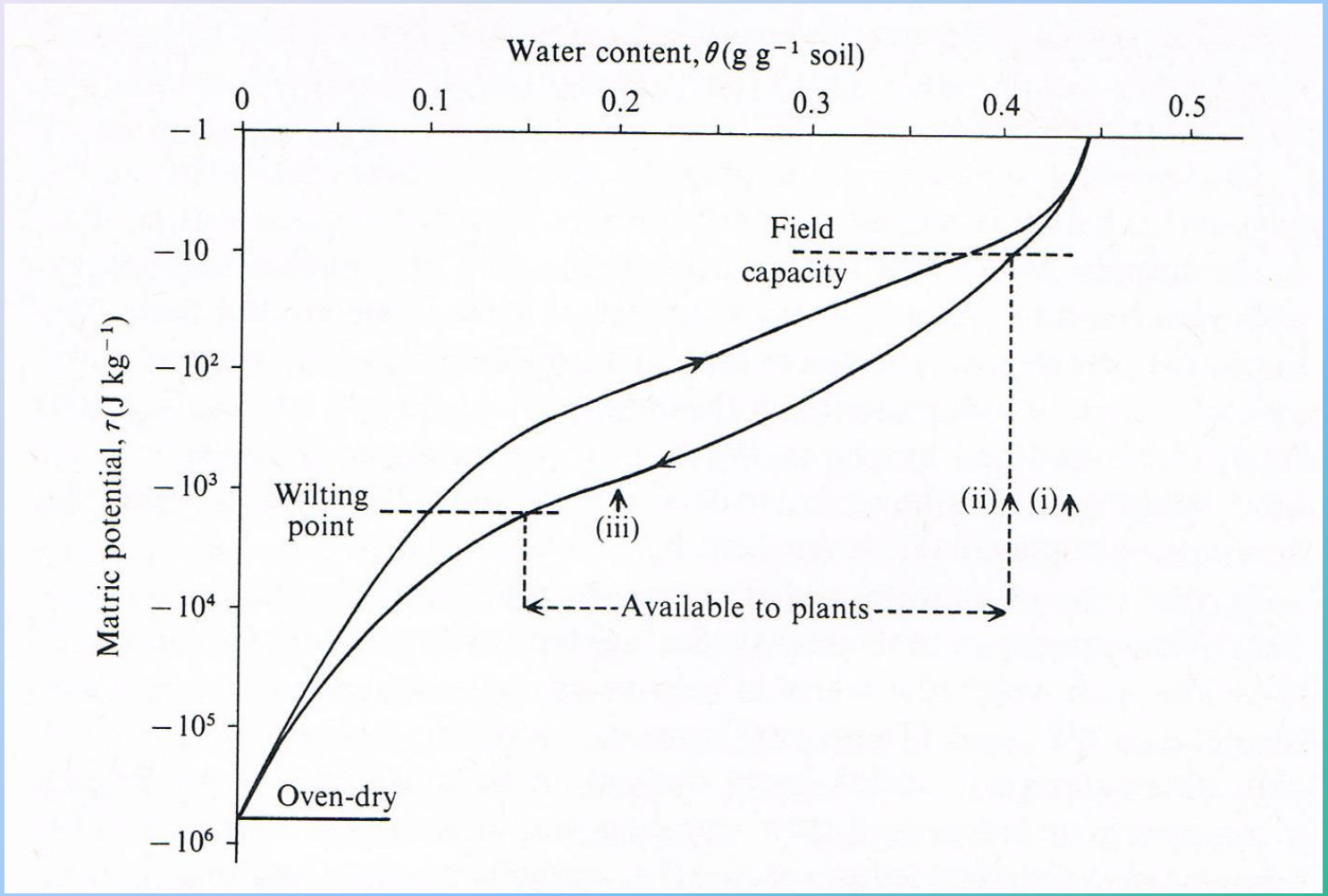

•**Graph 1.** Matrix Potential vs Moisture. Note Hysteretic effect. (From Milthorpe & Moorby 1975 Pg 16).

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SALINITY AFFECTS

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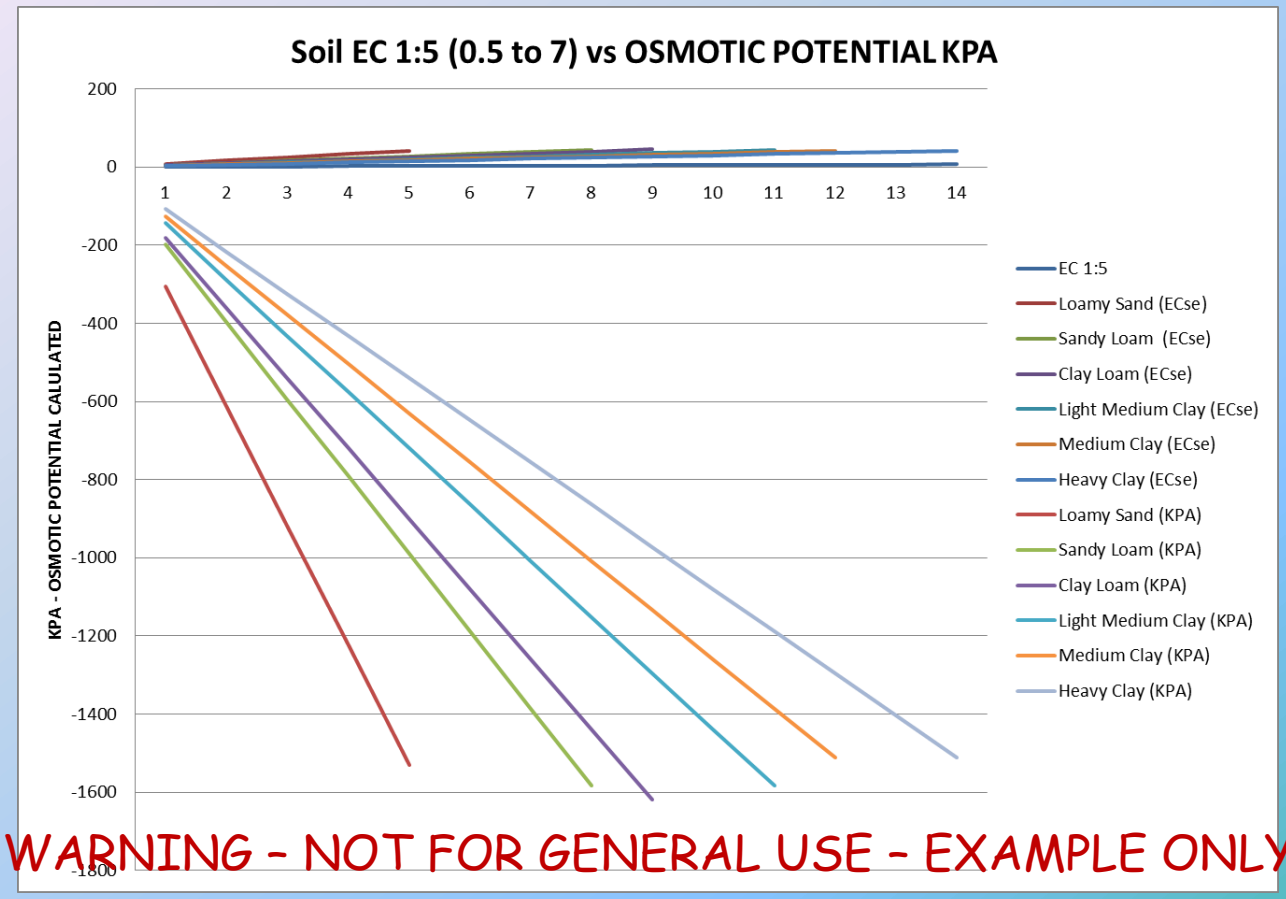
Electrical Conductivity
Osmotic Potential

- Various EC terms - ECse, ECw, EC1:5, ECa, ECp, ECe, etc..
- EC to ppm conversation range 1EC =540 to 740ppm
- EC has been converted to Osmotic Potential – Formula needs to be confirmed for different applications, soils, etc..



WARNING – NOT FOR GENERAL USE – EXAMPLE ONLY

EC 1:5	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
Loamy Sand (ECse)	8.5	17	25.5	34	42.5									
Sandy Loam (ECse)	5.5	11	16.5	22	27.5	33	38.5	44						
Clay Loam (ECse)	5	10	15	20	25	30	35	40	45					
Light Medium Clay (ECse)	4	8	12	16	20	24	28	32	36	40	44			
Medium Clay (ECse)	3.5	7	10.5	14	17.5	21	24.5	28	31.5	35	38.5	42		
Heavy Clay (ECse)	3	6	9	12	15	18	21	24	27	30	33	36	39	42

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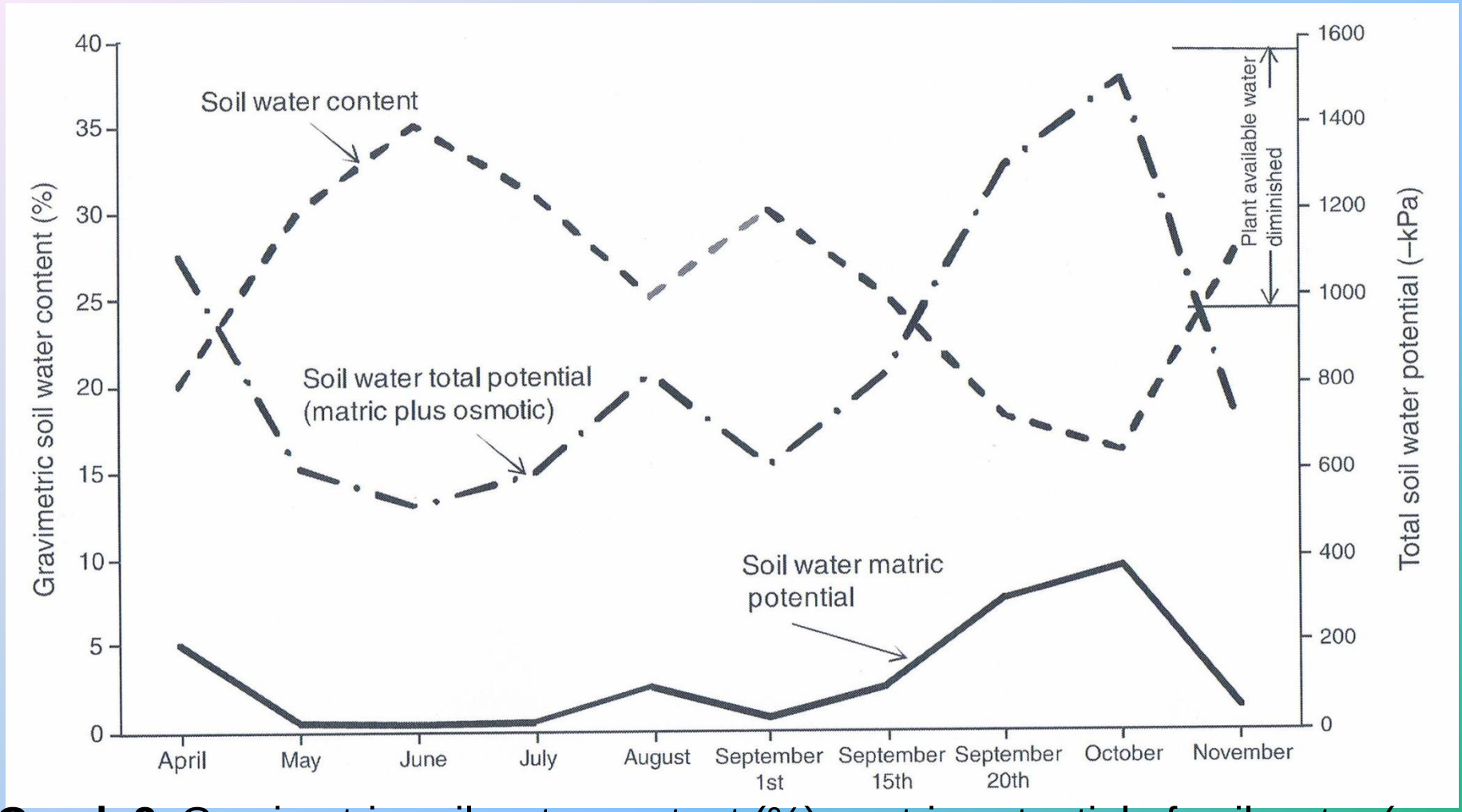

•**Graph 2.** Gravimetric soil water content (%), matrix potential of soil water (-kpa) and total soil water potential of a clay loam layer (20-60cm with an EC1:5 of 1 dSm-1 during a wheat growing season. From Rengasamy 2010.

Summary

- It does Matter How Much Water the Soils Holds
- **BUT** Consideration Needs to be made for soil characteristics
- With different water sources used – EC / Osmotic Potential should be taken into account to the availability of water to the plants from the soil

Further REFERENCES:

Hanks, R. J. 1992. Applied Soil Physics, Soil and Water Applications. Second Edition. Springer-Verlag New York Inc.

Milthorpe, F. L. & Moorby, J. 1975. An Introduction to crop Physiology. Cambridge University Press.

Reid, R. L. Editor. 1990. The Manual of Australian Agriculture. 5th Edition.

Rengasamy, P. 2010. Soil processes affecting crop production in salt-affected soils. *Functional Plant Biology.* 37. 613–620.

K-sat slower than K-unsat –Why?

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