Irrigation Requirement for Different Crops

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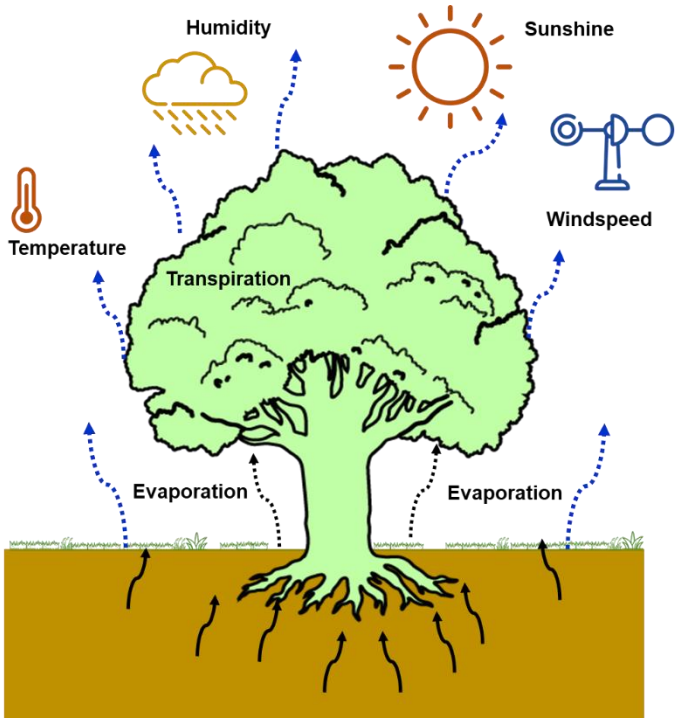
"Someday men will learn to irrigate and spread fertilizer instead of praying for fertility."
— Warren Eyster, The Goblins of Eros

Concept

Plants absorb soil water through roots and conduct it to leaves through the stem. This movement occurs in liquid form. In leaves, water turns into vapor and escapes into the atmosphere through the open stomata. The process depends mainly on availability of soil water and conditions of the atmosphere around the plant. Further, soil water gets evaporated from the soil surface. In crop fields, transpiration and evaporation go on simultaneously changing with time after rain or irrigation. Owing to variable crop structures, root systems, nature of soils and soil conditions, and the energy status of water in plant and soil, variable quantity of soil water escapes into the atmosphere as evapotranspiration. It is therefore necessary to estimate the evapotranspiration and water requirement of crops for making efficient use of water and increasing crop production.



Irrigation

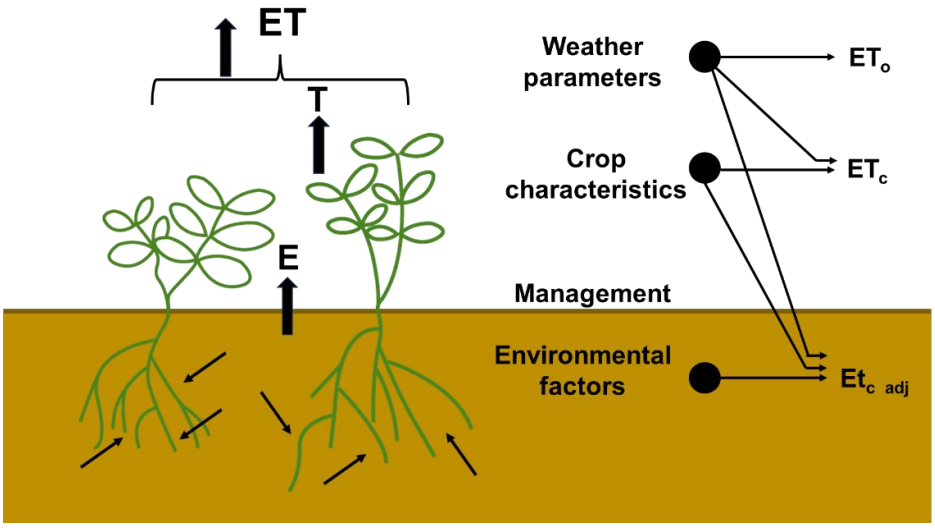
Water is an essential element for survival. Crops require water for their growth and development. Irrigation is the process of applying water to the crops artificially to fulfil their water requirements. Nutrients may also be provided to the crops through irrigation. The various sources of water for irrigation are wells, ponds, lakes, canals, tube-wells and even dams. Irrigation offers moisture required for growth and development, germination and other

related functions. The frequency, rate, amount and time of irrigation are different for different crops and also vary according to the types of soil and seasons.

Water Requirements of Crops

It is defined as, "The quantity of water required by a crop in a given period of time for normal growth under field conditions." It includes evaporation and other unavoidable wastes. Usually, water requirement for crop is expressed in water depth per unit area.

Irrigation Water Need = Crop water need — available precipitation
Evapotranspiration involves reference crop evapotranspiration (ETo) and crop evapotranspiration under standard conditions (ETc) and various management and environmental conditions (ETc adj).



Irrigation Crop Water Requirement

Water Requirement of Crops

The water requirement of a crop refers to the amount of water required to raise a successful crop in a given period. It comprises the water lost as evaporation from crop field, water transpired and metabolically used by crop plants, water lost during application which is economically unavoidable and the water used for special operations such as land preparation, puddling of soil, salt leaching and so on. The water requirement is usually expressed as the surface depth of water (i.e. mm or cm). Water requirement may be formulated as:

$$WR = E + T + IP + W_m + W_u + W_s$$

or,

$$WR = ET + W_m + W_u + W_s$$

or,

$$WR = CU + W_u + W_s$$

Where,

WR = Water requirement of crop
E = Evaporation from crop field
T = Transpiration by crop plants
IP = Intercepted precipitation by the crop that gets evaporated
W_m = Water metabolically used by crop plants to make their body weight
W_u = Economically unavoidable water losses during application
W_s = Water applied for special operations
ET = Evapotranspiration from crop field
CU = Consumptive use of water by the crop

Crop water needs in peak period of various field crops as compared to standard grass

-30%	-10%	Same as standard grass	+ 10%	+20%
Citrus	Cucumber	Carrot	Barley	Rice
Olive	Radish	Crucifers	Bean	Sugarcane
Grape	Squash	Onion	Maize	
		Peanut	Flax	
		Tea	Cotton	
		Grass	Lentil	
		Cacao	Millet	
		Coffee	Oat	
			Pea	
			Potato	
			Safflower	
			Sorghum	
			Soybean	
			Sugarbeet	
			Sunflower	
			Tobacco	
			Wheat	

Water requirements of crops in surface irrigation methods

Crop	Water Requirement (mm)
Rice	900-2500
Wheat	450-650
Sorghum	450-650
Maize	500-800
Sugarcane	1500-2500
Groundnut	500-700
Cotton	700-1300
Soybean	450-700
Tobacco	400-600
Potato	500-700
Onion	350-550
Sunflower	350-500
Castor	500
Bean	300-500
Pea	350-500
Finger millet	400-450

Necessities of determining water requirement

Determination of water requirement is essential to (i) decide the possible cropping pattern in a farm or in an area, (ii) make effective use of available water supplies during any season, (iii) plan and design an irrigation project, (iv) plan water resource development in an area, (v) assess the irrigation requirement of the area and (vi) management of water supply from sources.

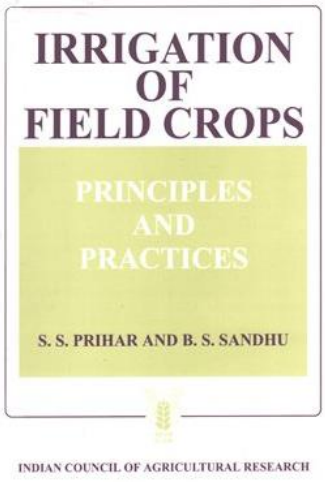
Determination of timing of irrigation

- Different crops require specific soil moisture levels for optimal yield and quality.
- Most plants efficiently absorb water when soil moisture is near field capacity (−0.33 bar).
- As moisture levels decrease from field capacity, due to evapotranspiration and other losses, soil moisture tension increases, hindering crops' ability to extract necessary moisture for optimal growth.
- With decreasing moisture, crops begin to wilt, initially slowing and then completely halting growth.
- Some crops, when rehydrated through irrigation or rainfall, can recover and show minimal permanent damage. However, other crops suffer permanent damage despite rehydration. Some are typically drought-resistant varieties, such as sorghum, pearl millet, finger millet, and cotton. For crops like maize and wheat, irrigation at 25% depletion of available moisture can enhance yields. It's crucial to prevent moisture stress between irrigations, a challenge particularly in light-textured soils like sandy or sandy loamy.
- Irrigation should be timed when soil moisture is sufficient to meet both the crop's transpiration and the atmosphere's evaporation demands.
- Understanding the moisture available in the crop's root zone and the evapotranspiration needs helps in determining the right irrigation timing.
- Various methods are used to decide when to irrigate, based on soil, plant, and atmospheric conditions, combinations of these factors, and critical crop growth stages.

Moisture sensitive stages of important crops

Crop	Important moisture sensitive stages
Rice, pearl millet, finger millet	Panicle initiation, flowering
Wheat	Crown root initiation, jointing, milking
Sorghum	Seedling, flowering
Maize	Silking, tasselling
Groundnut	Flowering, pegging, early pod formation
Mungbean, blackgram, fieldpea	Flowering, pod formation
Sugarcane	Formative stage
Sesame	Blooming to maturity stage
Sunflower	Two weeks before and after flowering
Safflower	Rosette to flowering
Soybean	Blooming, seed formation
Cotton	Flowering, boll development
Tobacco	Transplanting to full blooming
Potato	Tuber formation to tuber maturity
Onion	Bulb formation to maturity

Suggested Readings:



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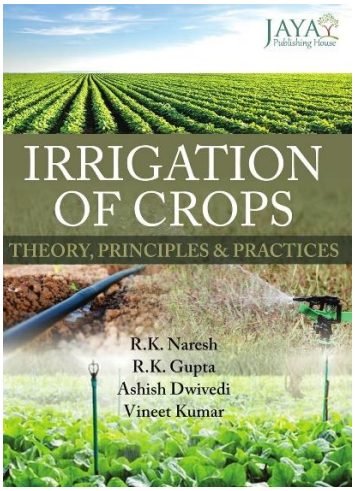

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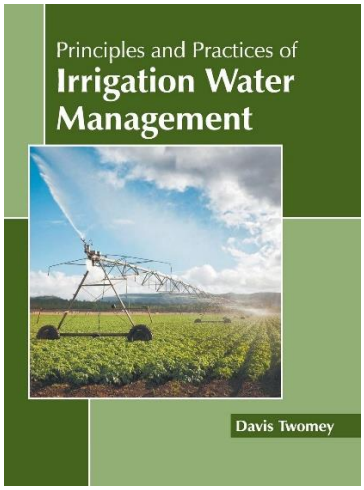

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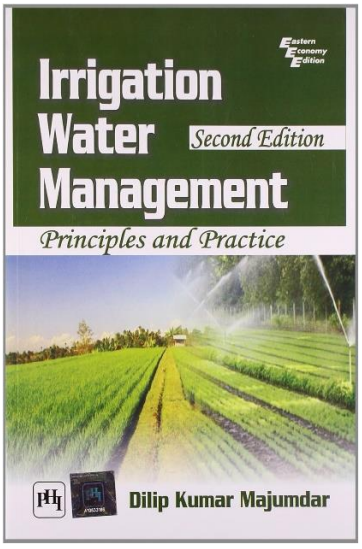

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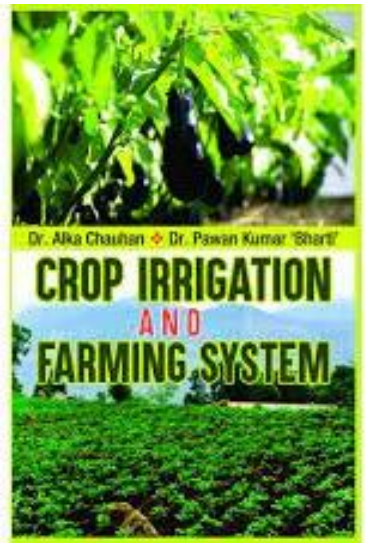

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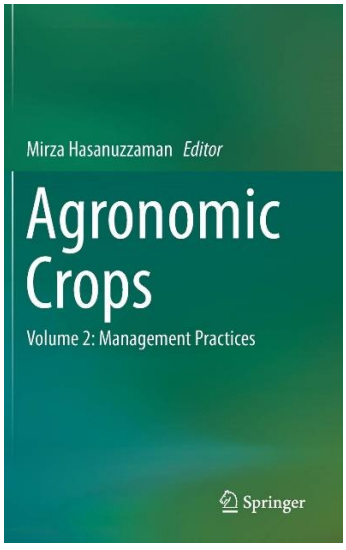

Agronomic Crops Vol. 2

By Mirza Hasanuzzaman (eds, 2019)

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