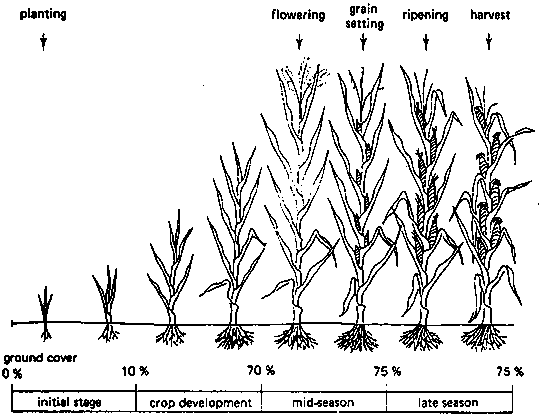
Crop Water Requirement

**PLANT WATER DEMAND/REQUIREMENT**

* The relationship between the reference grass crop and the crop actually grown is given by the crop factor, Kc.
* **The crop factor, Kc, mainly depends on:** 
  + the type of crop  
    · the growth stage of the crop  
    · the climate

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**Crop ET**

* + ETc = Crop evapotranspiration (mm/day)
  + ETo = Reference crop evapotranspiration (mm/day)
  + Kc = Crop coefficient

**How to Calculate Daily irrigation Requirement**

**(a). Daily Crop Water Requirement   
 (Row/Field Crop)**

**Crop Water Requirement, mm/day**

**ETc = (ETo X Kc)**

**ETo** = Reference Evapotranspiration rate in mm/day

* Kc = Crop Factor

**(b). Daily Crop Water Requirement   
 (Orchard)**

**Crop Water Requirement, mm/day**

**ETc = (ETo X Kc x Cp)**

**ETo** = Reference Evapotranspiration rate in mm/day

* Kc = Crop Factor
* Cp = Canopy factor

**Factors affecting Etc**

1. Climatic Factors
2. Soil Water Factors
3. Irrigation Method
4. Cultural Practices

**Irrigation Requirements**

IRn = ETc - (Pe + Ge + Wb) + LRmm

Where:

* + IRn = Net irrigation requirement (mm)
  + ETc = Crop evapotranspiration (mm)
  + Pe = Effective dependable rainfall (mm)
  + Ge = Groundwater contribution from water table (mm)
  + Wb = Water stored in the soil at the beginning of each period (mm)
  + LRmm = Leaching requirement (mm)

**IRRIGATION SCHEDULING**

* How to Apply
  + Flood, Bed & Furrow, Sprinkler, Drip, Center pivot.
* When one should apply water.
  + Rate of water use by the crop.
  + Total available moisture.
* How Much water should be applied during irrigation.
  + The soil available moisture storage capacity.
  + The amount of available water depleted from the soil profile by crop water use.

**Poor Irrigation Management**

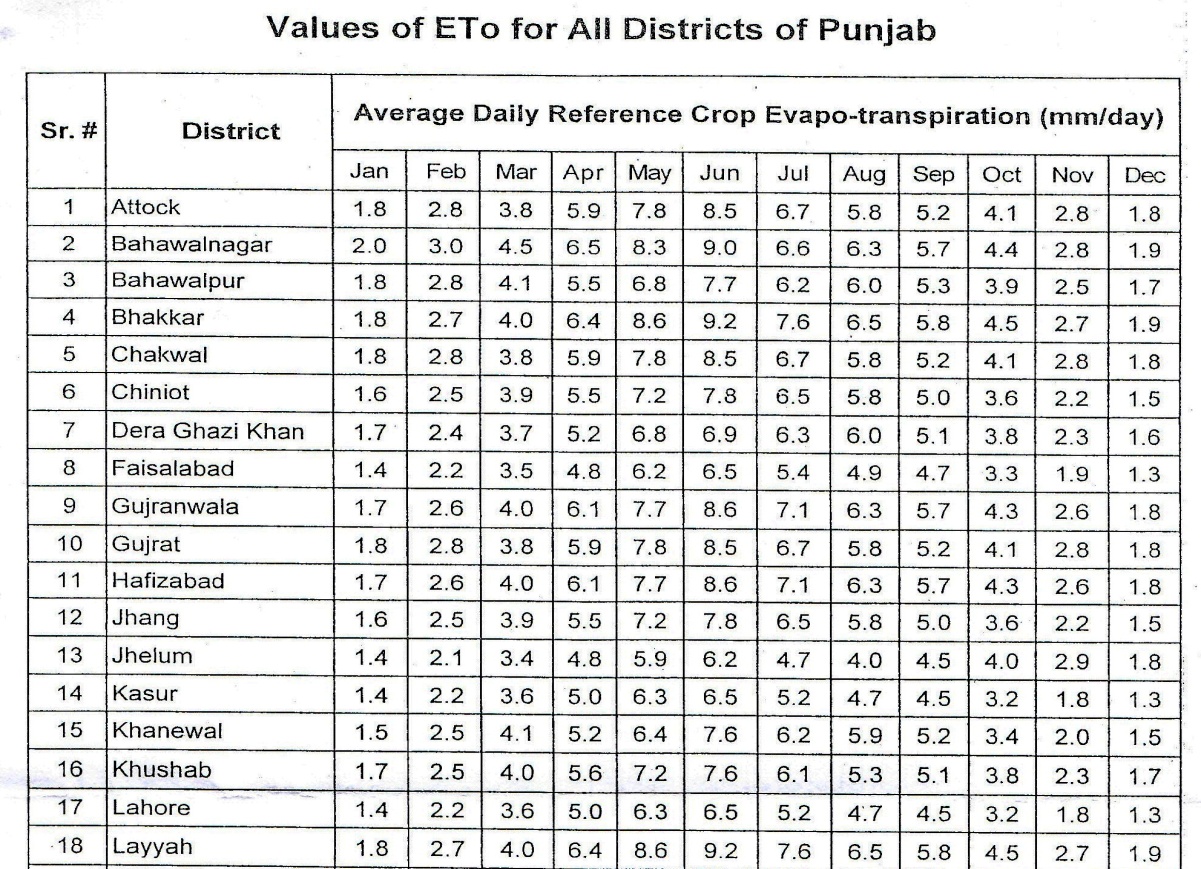
* Over and Under Irrigation.
* Reduce Crop Yield.
* Degrade Crop Quality.
* Enhance the field environment for disease/Insect/weeds epidemic.
* Increase Pumping Cost.
* Leach soluble nutrients from root zone

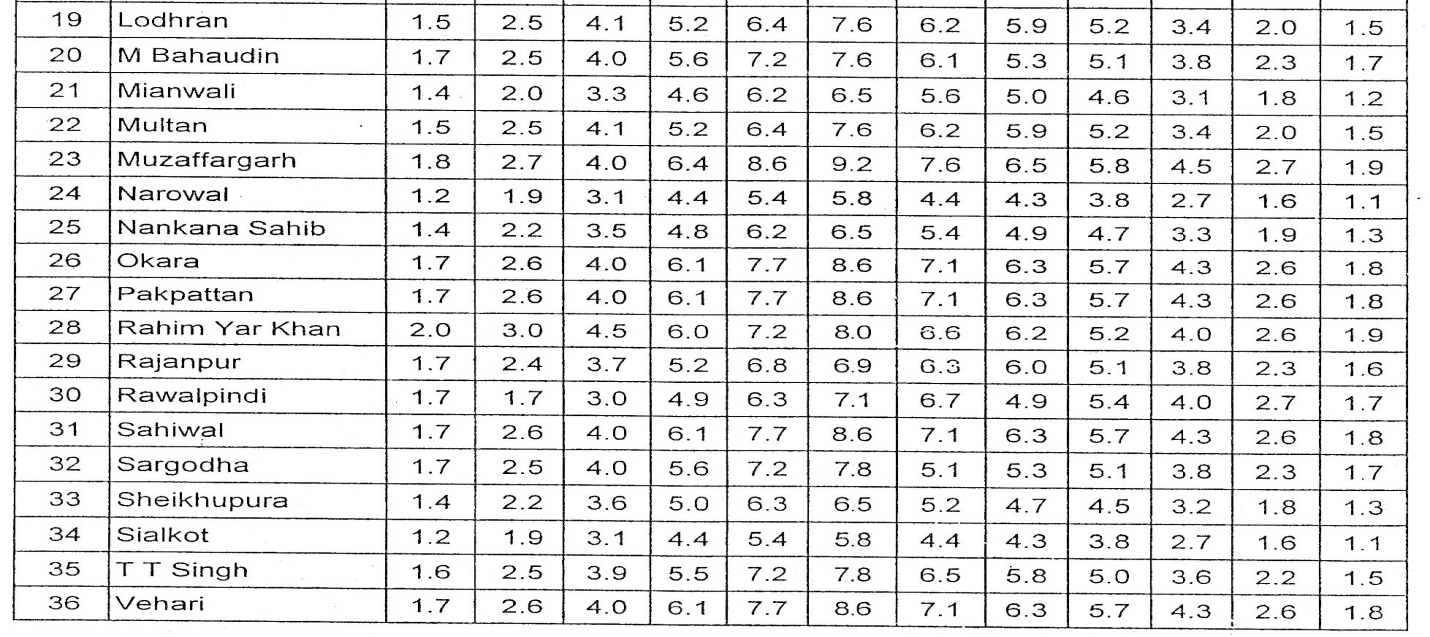
**WHY SCHEDULING**

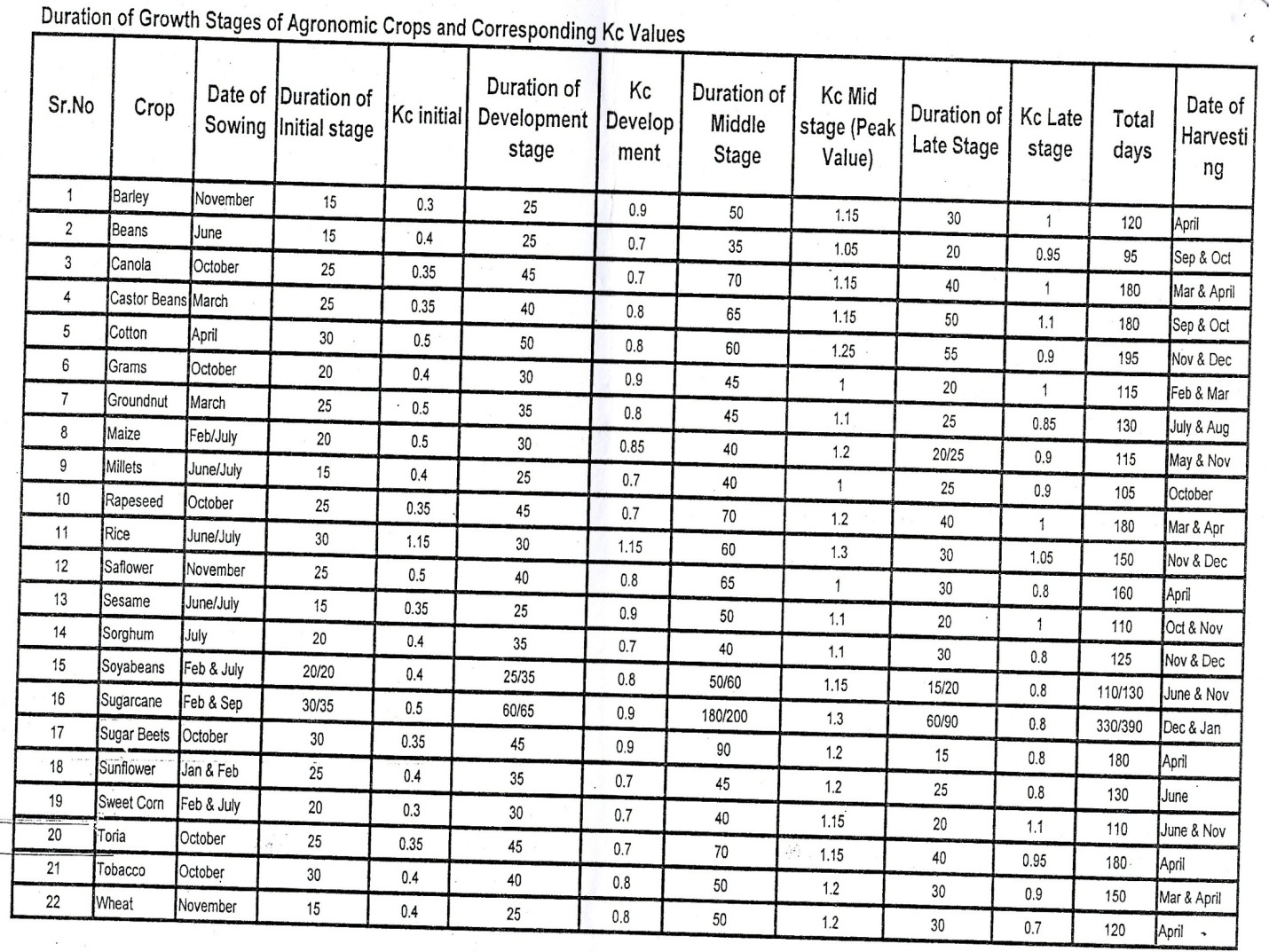
* Each soil has different moisture holding capacity.
* Plants differ in their abilities to withdraw water from soil.
* Plants differ in their water use rate.
* Water quality (salinity) may influence water availability to plants.
* Irrigation System may have inherent characteristics to restrict frequency, rate or duration of water application.
* Certain irrigation Practices may be needed for reasons other than meeting evapo-transpiration requirements such as:
  + - * frost control,
      * softening of soil crust,
      * softening of clods
      * incorporation of herbicides in the soil
      * Nutrient application
* External factor Such as:
  + - * labour scheduling,
* availability of water,

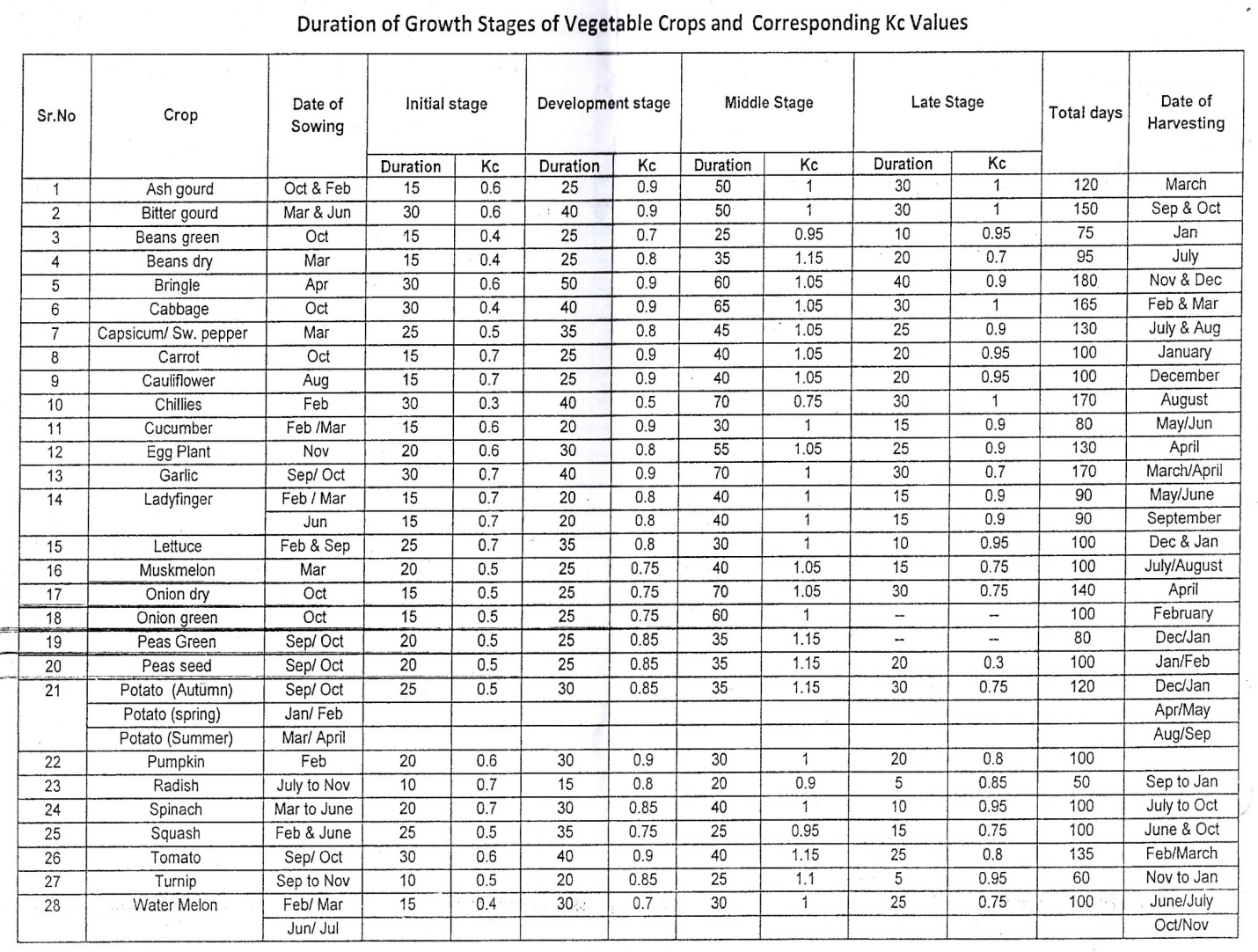
**FACTORS EFFECTING IRRIGATION SCHEDULING**

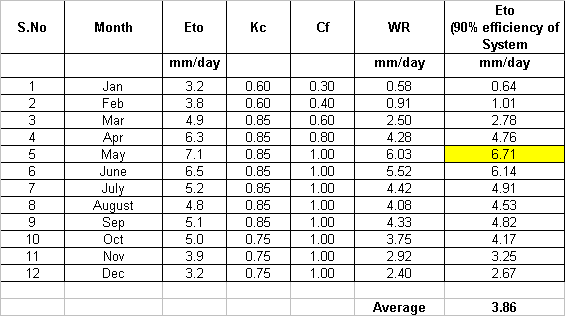
* Availability of water in the soil
* Water needs of crop
* How water is needed by the crop/plants
* Rainfall
* Output of irrigation system



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**PHYSICAL PROPERTIES OF SOILS**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Soil Texture** | **Field Capacity (Fc)** | **Permanent Wilting Point (PWP)** | **Available Moisture (AW)=Water Holding Capacity=Fc-PWP** | |  | **AW% by volume =Asg x % by weight** | |
|  | ***% by volume cm/m*** | ***% by volume cm/m*** | ***% by volume cm/m*** | ***% by volume inch/foot*** |  | **mm/m** | **inch/foot** |
| Sandy | **15** | **7** | **8** | **1.00** |  | **82.5** | **0.99** |
| **(10-20)**  **Range** | **(3-10)** | **(7-10)** | **0.8-1.2** |  |
| loam | **21** | **9** | **12** | **1.40** |  | **120.0** | **1.44** |
| **(15-27)** | **(6-12)** | **(9-15)** | **1.1-1.80** |  |
| Loam | **31** | **14** | **17** | **2.00** |  | **168.0** | **2.02** |
| **(25-36)** | **(11-17)** | **(14-19)** | **1.7-2.3** |  |
| Clay loam | **36** | **18** | **19** | **2.30** |  | **189.0** | **2.27** |
| **(31-42)** | **(15-20)** | **(17-22)** | **2.0-2.6** |  |
| Silty clay | **40** | **20** | **21** | **2.5** |  | **208.0** | **2.50** |
| **(35-46)** | **(17-22)** | **(18-23)** | **2.2-2.8** |  |
| Clay | **44** | **21** | **23** | **2.7** |  | **225.0** | **2.70** |
| **(39-49)** | **(19-24)** | **(20-25)** | **2.4-3.0** |  |
| ***Source: Principles of Farm Irrigation System Design by Larry G. James 1988*** | | | | | | | |

**Available Soil Water Holding Capacity (AW)**

|  |  |  |  |
| --- | --- | --- | --- |
| Soil Texture | Available Moisture (AW)/WHC mm/m  Range Average | | Inch/Foot |
| 1. Very coarse texture-very coarse sand | 33-62 | **42** | **0.50** |
| 2. Coarse texture-coarse, fine and loamy sands | 62-104 | **83** | **1.00** |
| 3.Moderately coarse textured-sandy loams | 104-145 | **125** | **1.50** |
| 4.Medium texture-very fine sandy loam, loam, silt loam | 125-192 | **167** | **2.00** |
| 5.Moderately fine texure-clay loams, silty-clay loam, sandy clay loam | 145-208 | **183** | **2.20** |
| 6.Fine texture-sandy clay, silty clay, clay | 133-208 | **192** | **2.30** |
| 7.Peat, muck | 167-250 | **208** | **2.50** |
| Note: 1 mm/m = 0.012 inch/foot | | |  |
| ***Source: Sprinkle and Trickle Irrigation by Jack Kelle***r | | | |

**Average Rooting Depth (Rd)**

|  |  |  |  |
| --- | --- | --- | --- |
| **CATEGORY** | **CROP** | **mm** | **Foot** |
| **Shallow root depth-<500 mm** | **Cabbage** | **400** | **2** |
| **Cauliflower** | **400** | **2** |
| **Garlic** | **400** | **2** |
| **Ginger** | **500** | **2** |
| **Onion** | **400** | **2** |
| **Rice** | **300** | **1** |
| **Spinach** | **400** | **2** |
| **Turmeric** | **500** | **2** |
| **Medium root Depth -500 to 1000 mm** | **Banana** | **700** | **3** |
| **Bitter gourd** | **600** | **2** |
| **Carrot** | **500** | **2** |
| **Chickpea** | **600** | **2** |
| **Chilli** | **700** | **3** |
| **Coriander** | **600** | **2** |
| **Groundnut** | **600** | **2** |
| **Lentil** | **600** | **2** |
| **Mustard** | **600** | **2** |
| **Papaya** | **600** | **2** |
| **Pointed gourd** | **900** | **4** |
| **Potato** | **500** | **2** |
| **Radish** | **500** | **2** |
| **Sesbania** | **600** | **2** |
| **Soybean** | **700** | **3** |
| **Tomato** | **1000** | **4** |
| **Turnip** | **500** | **2** |

Average Rooting Depth (Rd)

|  |  |  |  |
| --- | --- | --- | --- |
| **CATEGORY** | **CROP** | **mm** | **Foot** |
| **Deep root -1000 mm and above** | **Bottle gourd** | **1200** | **5** |
| **Citrus** | **1100** | **4** |
| **Cotton** | **1200** | **5** |
| **Cucumber** | **1200** | **5** |
| **Egg plant (Brinjal)** | **1000** | **4** |
| **Fruit Trees** | **1500** | **6** |
| **Grapes** | **1200** | **5** |
| **Lady's finger (Okra)** | **1000** | **4** |
| **Maize** | **1300** | **5** |
| **Pumpkin** | **1200** | **5** |
| **Sugarcane** | **1500** | **6** |
| **Sweet potato** | **1200** | **5** |
| **Watermelon** | **1200** | **5** |
| **Wheat** | **1200** | **5** |

Maximum Allowable Depletion (MAD)%

|  |  |  |
| --- | --- | --- |
| CROP TYPE | CROP | MAD (%) |
| CEREALS | Wheat | 50 |
| Maize | 50 |
| Rice | 80-100 |
| OIL SEEDS | Mustard | 50 |
| Groundnut | 50 |
| Soybean | 50 |
| GOURDS | Pumpkin | 50 |
| Watermelon | 50 |
| Bittle gourd | 50 |
| Cucumber | 50 |
| Bottle gourd | 50 |
| ROOTAND TUBER CROPS | Radish | 50 |
| Potato | 70 |
| Sweet potato | 50 |
| Carrot | 50 |
| VEGETABLES | Tomato | 65 |
| Egg plant | 65 |
| Cauliflower | 65 |
| Spinach | 65 |
| SPICES | Chilli | 60 |
| Coriander | 65 |
| Garlic | 70 |
| Garlic | 50 |
| Onion | 70 |
| Turmeric | 50 |
| FRUIT | Banana | 65 |
| Papaya | 50 |
| SUGAR CROPS | Sugarcane | 70 50 |

**Flood Irrigation**

**Sprinkler Irrigation**

**Drip Irrigation**

**HOW MUCH DEPTH OF WATER T BE APPLIED (MM) FOR FULL IRRIGATION**

**Maximum Irrigation Depth to be applied for FULL IRRIGATION**

Id= TAW x MAD(%)

Id = Maximum net depth of water to be applied per irrigation, mm (in.)

This is the same as RAW

AW = (FC) – (PWP) or figures of AW are available

TAW = AW x Rd

MAD = Management Allowable Deficit of the soil

For example if Aw= 125 mm/m, Rd=1.2 m, MAD= 50% then

TAW = 125 x 1.2 = 150 mm

Id = 150 x 50/100 = 75 mm= RAW

**Maximum Irrigation Interval**

Ii = \_\_\_\_\_\_\_\_\_\_\_\_Id\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Peak Daily Crop Water Requirement

**Where**

Ii = Irrigation interval or frequency (days)

Id = Net depth of water application per irrigation to meet Water Requirement

ETc = Daily crop water requirement

For example if Peak ETc is 9.77 mm/day, then irrigation interval = **75/9.77 = about 8 days**

**Exercise-1**

*For the following data of ETo, given in mm/day.*

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

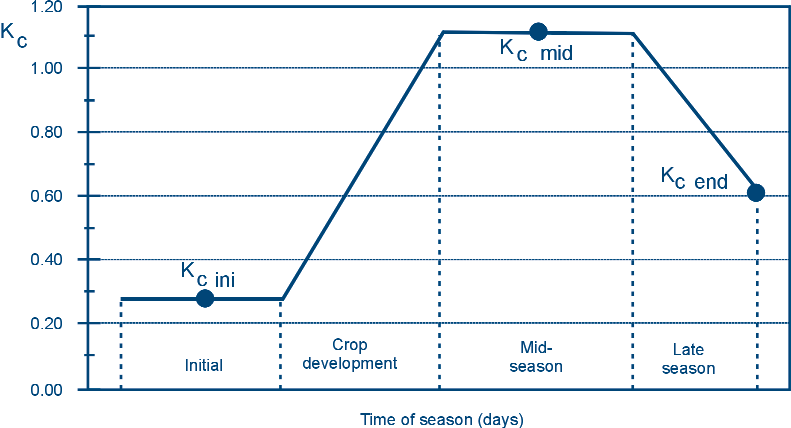
4.3 4.1 4.2 3.9 3.3 2.9 3.2 4.2 5.5 6.2 4.9 4.3

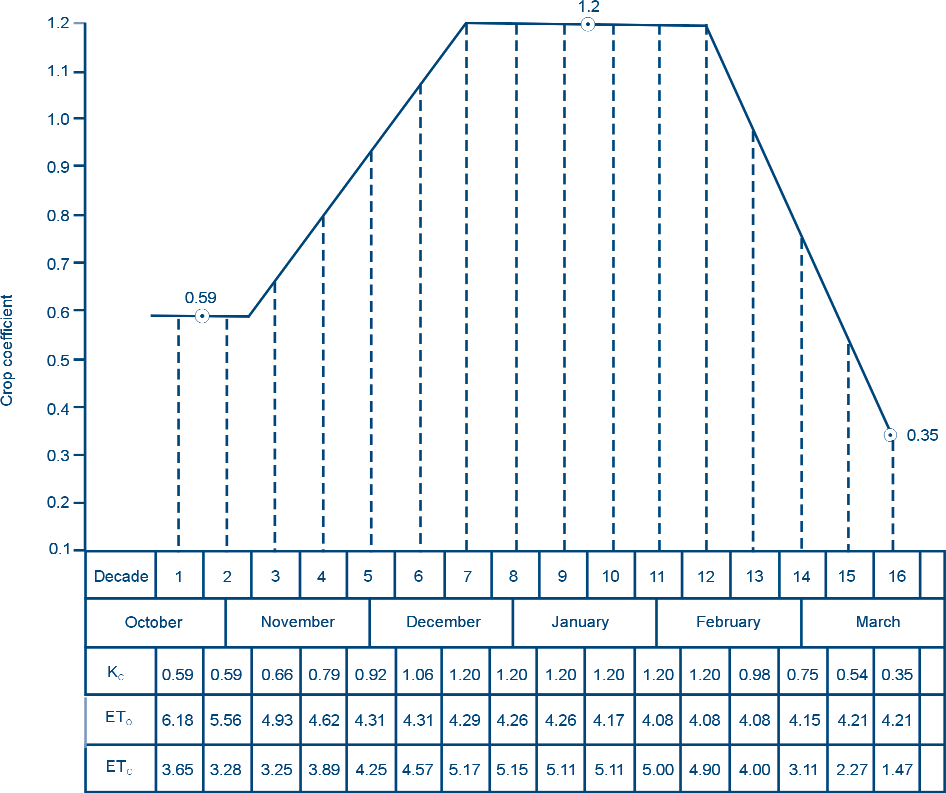
*Kc ini = 0.59, Kc mid = 1.20, Kc end = 0.35*

*Estimate the crop evapotranspiration for a maize crop planted on 15 October on the project site. The soils are heavy textured.*

**The first step is to establish the length of the growth stages:**

* Based on local experience, the duration of the initial stage is expected to be 20 days for a maize crop planted on 15 October, because of the favorable weather conditions. The development stage, also from local experience, will be 45 days and the mid-season stage will be 50 days. The late season stage is expected to last 39 days.
* Therefore the crop will finish around the 15th of March.
* *The Kc curve for maize can now be drawn, for initial planning purposes, where Kc ini , Kc mid, and Kc end are 0.59, 1.2 and 0.35 respectively, and the four lengths of growth stages are 20, 45, 50 and 39 days.*
* *Using the ETo figures and the Kc values, the crop evapotranspiration ETc for maize can be calculated. For a decade within one month, the daily ETo within the month is multiplied with the corresponding Kc to derive the ETc.*
* *For the first full decade in October ETc = 6.2 x 0.59 = 3.7 mm/day.*
* *For a decade that falls in two months, the weighted average of daily ETo from each month is multiplied by the corresponding Kc. For example, the ETc of decade 2 (end of October and early November) is calculated as follows:*
* *ETo in October = 6.2 mm/day and ETo in November = 4.9 mm/day.*
* *The planting date being 15 October means that decade 2 has 5 days in October and 5 days in November. The weighted ETo would be: (5/10) x 6.2+ (5/10) x 4.9 = 5.6 mm/day. This proportional ETo would then be multiplied by the corresponding Kc.*





Exercise-2

*Maiz has to be grown on July 21st at Agriculture Farm IUB, District Bahawalpur.*

*Estimate the crop water requirement (mm/day) for whole of the growing period (at 10 day interval).*