Consumptive use (evapotranspiration) الاستهلاك المائي (التبخر النتح)

يعرف بأنه مجموع ضائعات الماء من التربة والنبات

وخلال فترة نمو النبات فان حركة مستمرة للماء من التربة الى الجذور ثم الى السيقان ثم الاوراق ومن الاوراق الى الجو .. وجد بأن حوالي ٢% فقط من الماء الممتص من قبل جذور النباتات تبقى في النبات والباقي يعود الى الجو عن طريق سيقان واوراق النبات وهذه العملية تدعى (بالنتح) اضافة الى ذلك فان قسم من الماء يتبخر الى الجو مباشرة من التربة المحيطة بالنبات.

وبسبب استهلاك الماء لاغراض النمو والتنفس قليل لا يتجاوز ٢% فان مصطلحي تبخر نتح (evapotranspiration) والاستهلاك المائي (consumptive use) هما مصطلحان مترادفان.

∴ الاستهلاك المائي : هو كمية المياه المستهلكة من قبل النبات لاغراض النمو والتبخر النتح

يختلف الاستهلاك المائي باختلاف النباتات وحتى لنفس النبات حيث تختلف قيمة الاستهلاك المائي على مراحل النمو وكذلك تختلف باليوم الواحد والاسبوع والشهر.

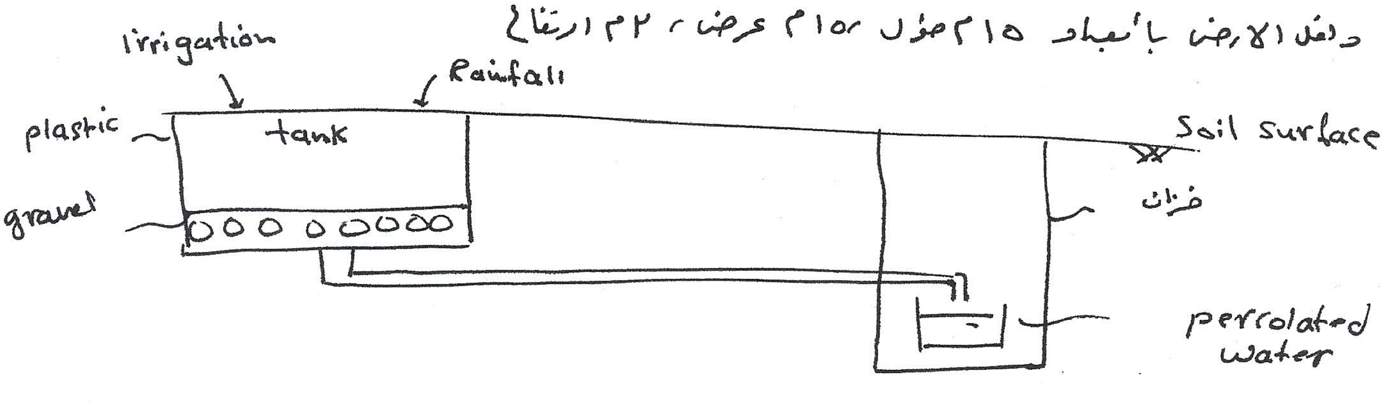
ان حساب الاستهلاك المائي يساعد في حساب متطلبات الري لمساحة مزروعة والتي تتغذى من قناة الري .. حيث بمعرفة كمية هذه المتطلبات يمكن معرفة سعة القناة الناقلة للمياه.

وحدات الاستهلاك المائي هي وحدات طول.

Methods of measuring consumptive use طرق قياس الاستهلاك المائي

١- Field plots : من خلال اخذ قطعة صغيرة من الحقل عبارة ٢x٢ م ومن ثم قياس (كمية الامطار الساقطة + كمية الماء المستخدم للري) - الضائعات السطحية = مقدار الاستهلاك المائي

٢- طريقة lysimeter : وهي طريقة حقلية ولكن يستخدم بها خزان مدفون داخل الارض بأبعاد ١٥م طول ، ١٥م عرض ، ٢م ارتفاع



Crop evapotranspiration ET = Rainfall + Irrigation − percolation

$$ET = ET_o * K$$

Where:

ET : Crop evapotranspiration (mm/day)

ET_o : Refrence evapotranspiration (mm/day) من الاحواض المكشوفة او النباتات الخضراء

K : Crop coefficient وتعتمد على نوعية النبات ومراحل نموه (معامل النبات)

٢- تقدير الاستهلاك المائي من النباتات الطبيعية باستخدام العلاقات الرياضية مثل:

1- Blaney - criddle method
2- Thornthwait method
3- penman method
4- Hargreaves, class A pan evaporation method

Blaney-Criddle Method

معامل الاستهلاك المائي الشهري

$$f = T\left(\frac{P}{100}\right) \quad \text{(in FPS وحدات بريطانية)}$$

f : monthly consumptive use factor.

T : The mean monthly temperature (°F)

P : The monthly percentage of day-time hours.

$$f = \frac{P}{40}[1.8T + 32] \quad \text{(S.I unit وحدات)}$$

T : monthly temperature (°C)

وجد بأن الاستهلاك المائي يتناسب مع معامل الاستهلاك المائي الشهري (f) بالعلاقة التالية:

$$C_u = K \cdot f$$

C_u : monthly consumptive use of water (cm)

K : monthly consumptive use coefficient

حساب الاستهلاك المائي لكل فصل نمو هو مجموع الاستهلاك المائي الشهري

$$C_{u\,total} = \sum C_u = \sum\left[\frac{Kp}{40}(1.8T + 32)\right]$$

$$t^\circ C = \frac{5}{9}(t^\circ F - 32)$$ للتحويل من F° الى C°

Ex/ Determine the seasonal consumptive use for wheat (deep)

month	Nov	Dec	Jan	Feb
mean monthly temperature °C	20	18	15	16
monthly percentage of day-time hr	7.75	7.88	7.94	7.36

take $K = 0.6$

Sol.

$$Cu = K \sum \frac{p}{40} (1.8T + 32)$$

$$= \frac{0.6}{40} \left[7.75(1.8*20+32) + 7.88(1.8*18+32) + 7.94(1.8*15+32) + 7.36(1.8*16+32) \right]$$

$$Cu = 29.26 \text{ cm}$$

Ex/ The monthly consumptive use values for rice are:

June (cm)	July (cm)	Aug. (cm)	Sep. (cm)	Oct. (cm)	Nov. (cm)
28.65	7.85	13.45	21.6	24.3	14.7

Determine the seasonal consumptive use, the average daily consumptive use, the average monthly consumptive use and the peak monthly consm. use

Sol.

Seasonal $Cu = \sum Cu$

$$= 28.65 + 7.85 + 13.45 + 21.6 + 24.3 + 14.7 = 110.55 \text{ cm}$$

Average monthly $Cu = 110.55 \div 6 = 18.43$ cm

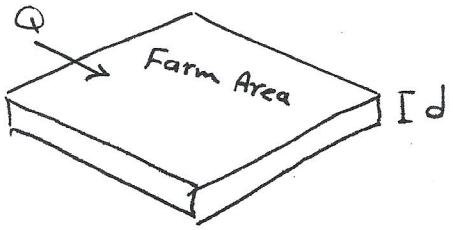
$\Rightarrow$ daily $Cu = 18.43/30 = 0.61$ cm

peak monthly $Cu = 28.65$ cm

Ex/ Using the data given in the first four colums, determine the grass net irrigation depth for each month take IE = 60%

Month ①	crop factor K ②	Pan evaporation ET (mm) ③	eff. rainfall ④	Cu (mm) (②×③) ⑤	$dg = \frac{dn}{IE}$ ⑥ $= \frac{⑤-④}{IE}$
Nov.	0.2	118	6	23.6	29.3
Dec.	0.36	96	16	34.5	30.93
Jan	0.75	90	20	67.5	79.17
Feb	0.9	105	15	94.5	132.5
Mar.	0.8	140	2	112.0	183.3

Relation between Discharge, Depth, Time and Area



Volume of water Applied = Q * T

Volume of water Applied = d x A

$\therefore Q \times T = d \times A$

$Q_n \times T = d_n A_n$

$Q_g \times T = d_g A_n$

Q : Discharge $(L^3/s)(L/T)$

T : Time of irrigation (T)

d_g, d_n : depth of water (gross, net) (L)

A : area of (Field, Farm) hactar $= 10^4 m^2$

$A_{net} = 0.88 A_{Total}$ Dunum $= 2500 m^2$

Example : Given Q = 50 l/sec. Find Q in L/min, L/hr m^3/sec, m^3/min, m^3/hr, m^3/day?

$1 m^3 = 1000$ lit

Sol. $Q = 50 \frac{l}{s} = 50 \frac{l}{s} \times \frac{60 s}{1 min} = 3000$ l/min

$Q = 50 \frac{l}{s} = 50 \frac{l}{s} * \frac{60 s}{1 min} \times \frac{60 min}{1 hr} = 100\,000$ L/hr

$Q = 50 \frac{l}{s} = 50 \frac{l}{s} \times \frac{1 m^3}{1000 lit} = 0.05 m^3/s$

$Q = 50 \frac{l}{s} = 50 \frac{l}{s} * \frac{1 m^3}{1000 lit} * \frac{60 s}{1 min} = 3 m^3/min$

$Q = 50 \frac{l}{s} = 50 \frac{l}{s} * \frac{1 m^3}{1000} * 60 * 60 = 180 m^3/hr$

$Q = 50 \frac{l}{s} = 50 \frac{l}{s} * \frac{1}{1000} * 60 * 60 * 24 = 4320 \frac{m^3}{day}$

Ex Storage tank takes 2 min to fill a 500 lit. What is the discharge in m^3/s?

Sol. $Q = \frac{Volume}{Time} = \frac{500 lit}{2 min} = 250$ l/min

$= 250 \frac{l}{min} * \frac{1 m^3}{1000} * \frac{1 min}{60 Sec} = 0.0042 m^3/s$

Ex Given a discharge of 5 $\frac{m^3}{s}$ diverted from irrigation source IE = 90%, CE = 85% and then applied to a farm of total area 1500 Dunum for a period of 24 hr. Find the gross and net depth applied to the farm.

Sol.

$$CE = \frac{Q_g}{Q_{total}}, \quad \frac{85}{100} = \frac{Q_g}{5} \Rightarrow Q_g = 4.25 \frac{m^3}{s}$$

$$Q_g * t = d_g * A_n$$

$$4.25 * 24 * 60 * 60 = d_g * 1500 * 2500 * 0.88$$

$$d_g = 0.111\ m = 111\ mm$$

$$IE = \frac{d_n}{d_g} * 100, \quad IE = \frac{90}{100} = \frac{d_n}{111} \Rightarrow d_n = 99.9\ mm$$

H.W1 Given $Q = 90 \frac{l}{s}$ applied to a farm of net area 100 Dunum once every week, C_u = 20 mm/day, farm losses = 10% of net depth. Find time of irrigation?

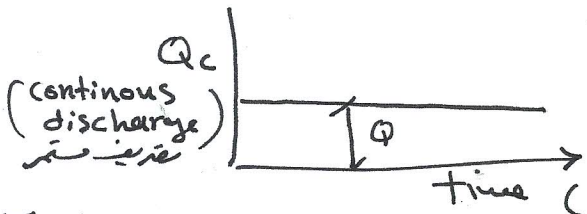
H.W2 150 $\frac{L}{s}$ of water applied to irrigate a total area of 250 Dunum. Water lost by runoff = 7 l/s, $C_u = 10 \frac{mm}{day}$ Find net depth of water stored in the soil after the end of 24 hr of irrigation time.

Continous and intermittent discharge

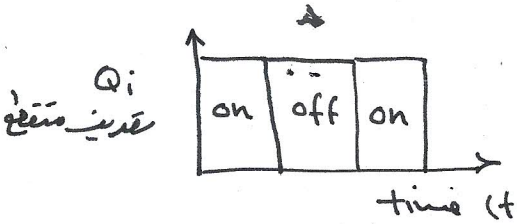
التشغيل المستمر والتشغيل المتناوب

Continous operation : the discharge is provided continously with time

(اضافه مستمره من دون انقطاع)



Intermittent Operation :- is the discharge applied for aperiod of time and swtt off another period of time and so on.



اضافه ثم توقف ثم اضافه وهكذا

$$Q_i t_i = Q_c t_c$$

يفضل التشغيل المتناوب على التشغيل المستمر وذلك للاسباب :

١- تنظيم توزيع المياه بين المناطق المختلفه

٢- القيام بأعمال الصيانه

Ex① 15 m^3/s of water applied for 15 hrs to irrigate a ~~not~~ area of 12500 Dunam, pan evaporation (C_w) = 6 $\frac{mm}{day}$ water is applied once every 3 days. Find IE, Continous discharge.

sol. $Q_g \cdot t = d_g \cdot A$ (التحويل الى m^2)

$15 \frac{m^3}{s} * 15 * 60 * 60 = d_g * 12500 * 2500$

$d_g = 0.026\ m = 26\ mm$

$IE = \frac{d_n}{d_g}$ where $d_n = S_{md}$ [$S_{md} = 6 \times 3 = 18mm$ (C_w day)]

$= \frac{18}{26} \times 100 = 69\%$

$Q_c \cdot t_c = Q_i t_i$

$Q_c \cdot 3 * 24 = 15 * 15 \Rightarrow Q_c = 3.13 \frac{m^3}{s}$

Ex② It is required to apply 3500000 m^3 of water every 10 days to irrigabe an area. Find the discharge in m^3/sec if water is applied for

a- one day every 10 days

b- 12 hrs between day and another

c- 3 days once every 10 days

d- 5 days every 10 days

e- Continously

Sol.

$T \propto \frac{1}{Q}$

a- $Q = \frac{U}{T} = \frac{3500000}{24*1*3600} = 40.5 \frac{m^3}{s}$

b- $Q = \frac{3500000}{2.5*3600*24} = 16.2 \frac{m^3}{s}$

c- $Q = \frac{3500000}{3*24*3600} = 13.5 \ m^3/s$

d- $Q = \frac{3500000}{5*24*3600} = 8.1 \ m^3/s$

C- $Q = \frac{3500000}{10*24*3600} = 4.05 \frac{m^3}{s}$

Ex It is required to apply a net depth of 120 mm to a total area of 60 ha the applied discharge is continously 180 L/sec. IE = 85% what must be the time of irrigation?

Sol.

$IE = \frac{Q_n}{Q_g} = 0.85 = \frac{Q_n}{180} \Rightarrow Q_n = 153 \ l/s$

$Q_n \cdot t = d_n \cdot A_n$ where A_n (net) $= 0.88 A_T$ (total)

$\frac{153}{1000} * 3600 * t = \frac{120}{1000} * 60 * 10000 * 0.88$

$t = 114.5$ hr

1 ha = $10^4 m^2$

Water Duty (W.D) المقنن المائي

Is defined as the continous discharge applied to irrigate a unit area. هو التصريف المستمر المضاف لسقي وحدة واحدة من المساحة ويمثل مقدار الاحتياج المائي لعملية الري

$$W.D = \frac{Q}{A}$$

where Q : Qg (gross discharge) or Qn (net discharge)

A : At , Ag (total area) or An (net area)

حيث ان $\frac{Q}{A}$ = سرعة : سعة جريان القناة
Flow capacity

$$W.D = \frac{Q_g}{A_n} \text{ or } \frac{Q_g}{A_g} \text{ or } \frac{Q_n}{A_n} \text{ or } \frac{Q_n}{A_g}$$

or

is an area irrigated by unit of continous discharge.

$$W.D = \frac{A}{Q} \text{ or } \frac{A_g}{Q_n} \text{ or } \frac{A_n}{Q_g} \text{ or } \frac{A_n}{Q_n}$$

$A_n = 0.88\,A_t$ وللتحويل $A_t = A_g$ حيث ان

water duty depend on :

1- Type of plant
2- type of soil
3- temperature
4- Salt concentration in the soil.

فوائد دراسة المقنن المائي هو توزيع اقتصادي لمياه الري المجهزة للحقل بدون ضياعات او هدر وذلك بتقييم الاستفادة الشهرية (علم محمة من المائي) للمحاصيل المختلفة على مدار نموها ضمن تعاير صدة الكمية مع احتياجات الغسل والتقليل الصحيحة

Ex① Given Cu = 12 mm/day time of continous irrigation = 1 day, IE = 95%, total area = 10 ha. Find water duty in total ha per applied discharge (m^3/s).

Sol.

$$d_n = \text{Smd} = 12\,\frac{mm}{day} * 1\,day = 12\,mm$$

$$Q_n \cdot t = d_n \cdot A \implies Q_n * 24 * 3600 * 1 = \frac{12}{1000} * 100000 * .88$$

$$Q_n = 0.0122\ m^3/s$$ تصريف صافي مستمر

$$IE = \frac{Q_n}{Q_g} = 0.95 \implies 0.95 = \frac{0.0122}{Q_g} \implies Q_g = 0.0126\ \frac{m^3}{s}$$

$$W.D = \frac{10}{0.0126} = 793.7\ \text{G ha/G m}^3\text{/sec or T ha/T m}^3\text{/s}$$

Ex ② Given a W.D = 2000 G Dunam/G m^3/sec , Ec or CE = 75% , Total area = 1000 Dunam. Find discharge at the head of the canal. (Q_{Total}).

Sol.

$$CE = \frac{Q_g}{Q_T} \times 100\% \qquad W.D = \frac{A_g}{Q_g} \Rightarrow 2000 = \frac{1000}{Q_g}$$

$$Q_g = 0.5 \ m^3/s$$

$$\frac{75}{100} = \frac{0.5}{Q_T}$$

$$\therefore Q_T = 0.67 \ m^3/s$$

Ex ③ Discharge is applied to Farm = 180 l/s once every week. Total area = 60 ha , F.C = 40% by vol. initial water content just before irrigation = 32 % by vol. RZ = 1m , Water losses = 20% of net depth. Find water duty in N.Dunam / G m^3/s .

1 ha = 4 Dunum

$$dn = smd = \frac{40-32}{100} * 1000 = 80 \ mm \quad [\text{before irrigation}]$$

$$dg = dn + \text{water losses} + \cancel{LR} - \cancel{\text{Rainfall}}$$

$$dg = 80 + \frac{20}{100} 80 = 96 \ mm$$

التصريف $Q = 180 \frac{l}{s}$ المعطى بالسؤال هو تصريف مستاوب لذا وجب تحويله الى تصريف مستمر لتعويضه من قانون W.D واستخراجه (W.D) .

Q_i : تصريف معطوبه لذا وجب استزافها

$$Q_i \cdot t_i = Q_c \cdot t_c \qquad Q_g \cdot t = dg \cdot A$$

$$180 * 88 = Q_c * 7 * 24 \qquad \frac{180}{1000} * 3600 \ t = \frac{96}{1000} * 60 * 10000$$

لتحويل L الى m^3

$$Q_c = 94.28 \ L/S \qquad t = 88 \ hr = 3.6 \ days$$

$$\therefore W.D = \frac{A}{Q} = \frac{60 * 4 * 0.88}{\frac{94.28 \ l/s}{1000 \ m^3/s}} = 2240 \ N \ Dunum/G \ m^3/s$$

H.W ① Given a W.D = 0.5 T L/S / G Dunum , CE = 90% , IE = 88%. Net area of farm = 2000 ha , Find Q_g (m^3/s)

H.W ② Given a W.D = 5.8 G l/s / G ha , total area = 600 ha a discharge is applied for 10 hrs every 7 days . Find Q_i (m^3/s).

Ex/ Given a soil of F.C = 35% , P.W.P = 15% R.Z = 1 m
AD = 50% , Cu = 8 mm/day , Find II (max)

Sol- $II_{max} = \frac{RAW = dn}{Cu}$

$dn = RAW = (F.C - P.W.P) * AD * R.Z$

$= \frac{100}{8} = 12.5$ days $= (0.35 - 0.15) * 0.5 * 1000$

$\approx$ 13 days $= 100$ mm

or $\approx$ 12 days

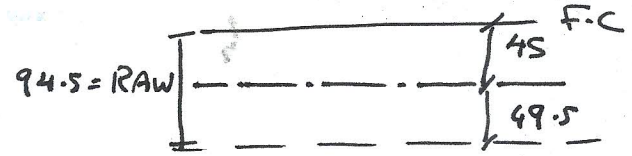
Ex/ Given a soil of F.C = 38% , PWP = 17 % R.Z = 90 cm
AD = 50% , Cu = 5 mm/day . On NOV. 6th (morning) soil moisture content = 33% , when would be the next irrigation ?

Sol- $dn = RAW = \frac{38-17}{100} * 90 * 10 * \frac{50}{100} = 94.5$ mm

Smd (on 6th of NOV.) $= (0.38 - 0.33) * 900 = 45$ mm

water to be consumed by plant $94.5 - 45 = 49.5$ mm

$\therefore II = \frac{49.5}{5} = 9$ days



بنبدأ نحسب ٩ ايام من يوم 6th لانه ذكر في السؤال صباحاً

اي بنبدأ اليوم وبالتالي بيكون موعد السقيه التالية في يوم 14th .

Ex/ Given a soil of F.C = 40% , PWP = 18 % , R.Z = 0.8 m
AD = 50% , Cu = 5 mm/day . Just before irrigation initial water content = 34% , Net depth was applied = 40 mm , 6 days after irrigation eff. rainfall = 30 mm when would be the next irrigation?

Sol- $RAW = \frac{40-18}{100} * 0.8 * 1000 * \frac{50}{100} = 88$ mm

Smd $= (0.40 - 0.34) * 0.8 * 1000 = 48$ mm before irrigation

Smd (after irrigation) $= 48 - 40 = 8$ mm

Smd (after 6 days from irrigation) $= 8 + 6 * 5 - 30 = 8$ mm

Water to be consumed by plant $= 88 - 8 = 80$ mm

$II = \frac{80}{5} = 16$ days from the rainfall

Ex Given a F.C = 40% , PWP = 20% , RZ = 900mm AD = 60%. if Cu = 3.5 mm/day for 1st 10 days of April , 3 mm/day for 2nd 10 days , 2.5 mm/day for 3rd 10 days of April , Cu = 2mm/day for May . If first of irrigation was done on 1st of April (morning) when would be the next of irrigation.

sol. $RAW = (0.4 - 0.2) * 900 * 0.6 = 108\ mm$

$Smd = 3.5 * 10 + 3 * 10 + 2.5 * 10 = 90\ mm$ For April

Water to be consumed by plants = 108 − 90 = 18 mm

$II = \frac{18}{2} = 9$ days from 1st of May

it means the next irrigation will be at 9 May.

Ex A Farm of total area 500 ha , AW = 400 mm/1m , R.Z = 0.9m F.C = 35% , AD = 60% , I.W.C in 1st of April = 120 mm. Cu in first 10 days of April = 3.5 mm/day , Cu in 2nd 10 days of April = 4.5 mm/day , Cu in 3rd 10 days of April = 5.5 mm/day

Find : ① The time till the next of irrigation ② For a net depth of applied water = 80 mm + $\frac{2}{3}$ of dn is water losses , total discharge at head of canal 10 m^3/s , CE = 92% , Find time of irrigation (hr). ③ Find W.D in T lps / N ha.

sol. ① $AW = \frac{400}{1000} = 40\%$ by vol.

$RAW = 0.4 * 0.6 * 900 = 216\ mm$

$Smd = F.C - I.W.C \Rightarrow Smd = 0.35 * 900 - 120 = 195\ mm$

Smd (after 10 days) = $195 + 10 * 3.5 = 230\ mm > 216\ mm$

∴ no. of days (II) = $\frac{216 - 195}{3.5} = 6$ days after the first of April

② $dn = 80\ mm$

$dg = 80 + \frac{2}{3} * 80 = 133\ mm$

$CE = 0.92 = \frac{Qg}{Qt} = \frac{Qg}{10} \Rightarrow Qg = 9.2\ m^3/s$

$Q_g * t = d_g * A$

$9.2 * t = 0.133 * 500 * 10000 * 0.88$

$\therefore t = 17.7\ hr$

$$W.D = \frac{10\ \frac{m^3}{s} * 10^3\ \frac{l}{m^3}}{500 * 0.88\ ha} = 22.7\ T\ l/s\ /\ N\ ha.$$

Ex

$A_t = 5000\ ha$, $AW = 600\ mm/0.8m$, $R.Z = 900\ mm$, $F.C = 25\%$ (by weight) , $AD = 50\%$, $As = 1.4$, soil moisture content in 15th of March = 315 mm , Cu is as follows :

6 mm/day from 15th to 20th of March
6.5 mm/day from 21th to 31th of March
7.5 mm/day from 1st to 30th of April
9.0 mm/day from 1sh to 31th of May

at 15th of April effec. rainfall = 30mm

at 31th of March $d_g = 108\ mm$, Find ① IE @ 31th of March ② Find time of next irrigation ③ Find $(Q_g)_i$ if time of irrig. = 2 days every 7 days.

Sol.

$F.C = 25\% * 1.4 = 35\%$ by vol.

I.W.C in March (15th) $= \frac{315}{900} = 35\%$.

$\therefore$ Smd (in 15th of March) = 0

Smd (in 20th of March) $= 6\ \frac{mm}{day} * 6\ days = 36\ mm$

Smd (in 31th of March before irrigation) $= 11\ days * 6.5\ \frac{mm}{day} + 36 = 107.5\ mm$

Smd (in 31th of March after irrigation) $= 107.5 - 107.5 = 0$ { water losses by deep percolation = 0.05mm }

$d_n = 107.5\ mm$ $IE = \frac{d_n}{d_g} = \frac{107.5}{108} * 100\% \simeq 100\%$.

$AW = \frac{600}{0.8} * \frac{mm}{1000mm} = 75\%$ by vol.

$RAW = 0.75 * 0.5 * 900 = 337.5\ mm$

Smd (in 30th of April) $= 30 * 7.5 - 30$ (rainfall) $= 195\ mm$

Smd (in 31th of May) = 195 + 31 day * 9 $\frac{mm}{day}$ = 474 >> RAW

$\therefore$ II = $\frac{RAW - Smd}{Cu}$ = $\frac{337.5 - 195}{9}$ = 15.8 $\approx$ 16 days from 30th of April

$Q * t = dg * An$

$Q * 2 * 24 * 3600 = \frac{108}{1000} * 5000 * 10^4 * 0.88$

$Q = 5.5 \frac{m^3}{s}$

Schedule of Irrigation and Water Budget

جدولة الري والموازنة المائية

الجدولة : هي عملية تنظيم الري وحساب كميات المياه المضافة خلال مدة معينة قد تكون سنة ، شهرين ، فصل زراعي وموازنتها مع استهلاك النبات + الفاقد في التربة .

هنالك طريقتين للجدولة :-

1- Constant net depth of irrigation and variable irrigation interval عمق ماء صافي مع فاصلة ري متغيرة

2- Variable net depth of irrigation and constant interval irrigation عمق ماء صافي متغير مع فاصلة ري ثابتة

Water Budget :

$$I + R = Cu + \text{Farm losses} + \text{water storage in R.Z}$$

where :

I : irrigation net depth (Σdn)

R : Rainfall ← effective

Cu : ΣCu

water storage in R.Z = المحتوى الرطوبي في نهاية الموازنة − المحتوى الرطوبي في بداية الموازنة

Ex: An irrigation project ① $q = 8.4\ m^3/s$, Net area = 6000 ha , I.W.C on 1st March = 27% (by vol.) , F.C = 36% p.w.p = 21% all by vol. AD = 40% , IE = 60% , $Cu = 4.8 \frac{mm}{day}$ R.Z = 600 mm Effective rainfall = 31 mm/month Schedule the irrigation using constant net depth and constant irrigation Interval.

* dn ثابتة وفاصلة اري متغيرة او طريقة ثانية dn متغير وفاصلة ثابتة

$$RAW = (0.36 - 0.21) * 0.4 * 600 = 36\ mm = dn$$

لجدول الحساب نطرح المطر مع Cu وكما يلي

$$Cu = 4.8 \frac{mm}{day} - \frac{31\ mm}{month} * \frac{1\ month}{31\ day} = 3.8\ mm/day$$

smd (before irrigation) $= \frac{36 - 27}{100} * 600 = 54$ mm

(A) constant dn

Date day–month	dn (mm)	smd (before irrg.) (mm)	smd after irrig. (mm)	note
1–3	36	54	54 − 36 = 18	water can be depleted (36 − 18 = 18 mm) [RAW − smd] no. of day = $\frac{18}{3.8}$ = 4.7 ≈ 5 days
6–3	36	18 + 5 * 3.8 = 37	37 − 36 = 1	II = $\frac{36-1}{3.8}$ = 9 days
15–3	36	1 + 9 * 3.8 = 36	36 − 36 = 0	II = $\frac{36-0}{3.8}$ = 10 days
25–3	36	0 + 10 * 3.8 = 38	38 − 36 = 2	36 − 2 = 34 , II = $\frac{34}{3.8}$ = 9 days نتوقف عندها لانه لا يمكن بأقل 9 days يتم التجاوز على الشهر الرابع

at 31–3 smd $= 2 + 7 * 3.8 = 29$ mm

I.W.C $= \left(\frac{36}{100} * 600\right) - 29 = 187$ mm

$I = \Sigma dn = 36 * 4 = 144$ mm

$\Sigma Cu = 3.8 * 31 = 118$ mm

I + R = Cu + soil moisture at the begining of budget + soil moisture at the end of budget (water storage in R.Z)

$144 = 118 + \left(\frac{-27}{100} * 600 + 187\right)$

$144 = 144$

(B) Constant II

$II_{max} = \frac{36}{3.8} = 9.5$ days , RAW = 36 mm
≈ 9 days or 10 days

$Cu = 3.8 \frac{mm}{day}$

II = 9 days , Smd on 1st of March = 54 mm

dn = smd = 54 mm [on 1st of March] (ري متكامل)

Date	dn mm	Smd before irrig. (mm)	Smd after irrig. (mm)
1-3	54	54	0
10-3	34	0 + 3.8*9	34 - 34 = 0
19-3	34	0 + 3.8*9	34 - 34 = 0
28-3	34	0 + 3.8*9	34 - 34 = 0

31-3 : Smd = 0 + 4 * 3.8 = 15 mm

water content = F.C - Smd

= (0.36 *600) _ 15 = 210 mm

Σdn = 54 + 3 * 34 = 156 mm

Σcu = 31 * 3.8 = 118 mm

156 = 118 + (210 - 162)

↑

0.27*600

EX :

Schedule the irrigation, calculate water budget for october and NOV. by two methods, F.C = 39%, p.w.p = 17% (all by vol.), AD = 40%, R.Z = 90cm, Soil moisture content on 1st of oct (morning) = 25% by vol., $Cu = 5 \frac{mm}{day}$ in Oct., $Cu = 3.5 \frac{mm}{day}$ in NOV.

Sol.

1- Constant dn

dn = RAW = (0.39 - 0.17) * 0.4 * 900 = 79.2 ≈ 80 mm

Smd (1st of Oct morning) = (0.39 - 0.25) * 900 = 126 mm

date	dn (mm)	Smd (mm) before irrig.	Smd (mm) after irrig.	II
1-10	80	126	126-80=46	$\frac{80-46}{5}=6.8\approx 7$ days
8-10	80	46+7*5=81	81-80=1	$\frac{80-1}{5}=15.8\approx 16$ days
24-10	80	1+16*5=81	81-80=1	16 days
31-10	—	1+8*5=41	—	$\frac{80-41}{3.5}=11.1\approx 11$ days
12-11	80	41+11*3.5=79.5 ≈80	80-80=0	$\frac{80}{3.5}=22.8\approx 23$ days
30-11	—	0+19*3.5=66.5 ≈67		

I.w.C at 31 Nov. $=(0.39*900)-67=284$ mm

$I=\Sigma dn = 80*4=320$

$\Sigma Cu = 31*5+30*3.5=260$

$I+R = Cu+$ water storage in R.Z

$320=260+[284-(0.25*900)]$

$320\approx 319$ O.K

2- Constant II

$$II_{max}=\frac{RAW}{Cu}=\frac{80}{5}=16 \text{ days for oct.}, \quad \frac{80}{3.5}=23 \text{ days for Nov.}$$

Choose II = 16 days [دائماً نأخذ القيمة الأصغر]

Date	dn	Smd (before irrig.)	Smd (after irrig.)
1-10	126	126	0
17-10	80	0+16*5=80	0
31-10	—	0+15*5=75	—
2-11	79	75+1*3.5=79	0
18-11	56	0+16*3.5=56	0
31-11	—	0+13*3.5=46	—

I.w.c [at 30 NOV.] = [0.39*900] - 46 = 305 mm

$I = \Sigma dn = 126 + 80 + 79 + 56 = 341$

$\Sigma Cu = 31*5 + 30*3.5 = 260$

$341 = 260 + [305 - (0.25*900)]$

$341 \cong 340$ ∴ o.k

H.W

Given aproject of total area = 50 Dunme, net discharge = 0.05 $\frac{m^3}{s}$, F.C = 40%, p.w.p = 22% [all by Vol.] R.Z = 1m, AD = 50%, Cu = 5 $\frac{mm}{day}$ for May, Cu = 7 $\frac{mm}{day}$ for June, Cu = 8 mm/day for July, Cu = 10 $\frac{mm}{day}$ for Augest.

First Complete irrigation was done at 10th of May (morning) Schedule the irrigation starting from 1st of June to End of Augest by using Constant dn method.