Modeling Deficit Irrigation Water Requirement For Maize in Mosul Region

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Abstract

A computerized model with (Microsoft QuickBasic version 1.1) was proposed for simulating the effect of deficit irrigation for maize crop during spring and autumn seasons in Mosul region. The simulation is based on 16 years of climatological data for the period (1985-2000) for Mosul meteorological station , which includes daily maximum and minimum temperatures , maximum and minimum relative humidity , wind speed at 2m height , and sunshine hours , which is used to calculate daily reference evapotranspiration with Penman-Monteith equation .The model predicts yield reduction by changing irrigation depth for three different irrigation methods (sprinkler , furrow and drip) .The rainfall is divided into three classes which represent three regions (wet ,semi- arid and arid).

أستلم في 2004/3/9 **قبل في 2004/12/2**

[illegible]

[illegible] .(1996 [illegible])

[illegible] Martin et al (1999) [illegible]

[illegible] Snyder et al (2002) [illegible]

[illegible] 21 [illegible] (2001) [illegible] 2000 [illegible] (2002) [illegible] (2001 [illegible]) [illegible] A [illegible] (75 [illegible] 80 [illegible] 90 [illegible] 100) [illegible] %4 [illegible] %7 [illegible] %6 [illegible] .%11

[illegible]

[illegible]

[illegible] (Kcb) [illegible]

[illegible]

[illegible] (ETc) [illegible] (ETc$_{adj}$) [illegible] (FAO,1998) [illegible]

$$ETc_{adj} = (Ks * Kcb + Ke)ETo \text{ -- } (1)$$

:[illegible]

[illegible] :ETc_{adj}

[illegible] : Ks

. [illegible] : Kcb

. [illegible] : Ke

[illegible] Ks [illegible] (Kcb) [illegible] ETo [illegible] ETc [illegible] Kcb [illegible] . (0-1.4) [illegible] Kcb [illegible] Kc [illegible] Kcb [illegible] (2) [illegible] (FAO,1998) [illegible] (2) :

$$Kcb_i = Kcb_{prev} + \left[\frac{i - \Sigma(L_{prev})}{L_{stage}}\right]\left[Kcb_{next} - Kcb_{prev}\right] \text{ -------------------- } (2)$$

:[illegible]

[illegible] : i

i [illegible] : Kcb_i

[illegible] : Kcb_{prev}

([illegible]) [illegible] : L_{stage}

([illegible]) [illegible] : $\Sigma (L_{prev})$

[illegible] Kcb [illegible] (1)[illegible]

.% 45 [illegible] 2([illegible]) [illegible]

.(**FAO, 1998**) [illegible] (**Kcb**) [illegible] **(1)** [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.15	1.15	⟵	0.15	[illegible]

0.5	1.15	←	0.15	ƕĭžĭƥƢǁƐ

(2) Ɨ!ƥǴžǆ!ƒ Ɣƪơ ǴőƱƤ ƥƒƥƨƙ ←

ƗùŏƤǴǉǆ!ƒ ƻĂƧùǓ!ƒ Ɣƪùơ (Kcb) Ŏƪǵƪǖƒ ýĂƮơǆ!ƒ ýǆǴžǆ Ɨǆŏl! ƠŏơƮƙ ƗőǁǆƸ ǷƒƧƞǊ ǅƙ ǅǍ

: (FAO ,1998) ƗŏǃǴƙ!ƒ Ɨ!ƥǴžǆ!ƒ Ɣƪơ ƗŏǯǴǌǉ!ƒĂ ƗƱƪĂƙǆ!ƒ Ăǆǉ!ƒ ƗǁơƧǆ! ýƮĂǆ!ƒ ƗǀƱǉǆ!

$$Kcb = Kcb_{(\text{جدول }1)} + \left[0.04\left(U2-2\right) - 0.004\left(RH_{min} - 45\right)\right]\left(\frac{h}{3}\right)^{0.3} \text{ --------(3)}$$

:ǈǊ ƦǴ

U2 : ýƥùžǆ ƗƸƧùƪ ƟǴùŏƧ!ƒ ǏùǁƸ ƳǴùƘƙƨƒ ǅ 2 ǅǄƤ ýǘùǁƧǆ!ƒ ƗùƙƪĂƙǆ!ƒ ƗƱùǉ ǅǍ ƗùǌŏǯǴǌǉ!ƒ ǈǘùǆ

ƒ!ǉǆĂ (ǅ / ǴǍ)

RH_{min} : ýƥžǆ ƗƕĂƱƧ!ƒ ăƧƺƮ!ƒ ýǖƤ ƗǁơƧǆ!ƒ ƗƱƪĂƙǆ!ƒ ǅǍ ƗǌǯǴǌǉ!ƒ (%)

h : ƳǴǘùùùƘƙƧƒ ýĂƮǘùùùơǆ!ƒ ýǖǘùùùƤ ƗǘùùùǁơƧǆ!ƒ ƗǘùùùƱƪĂƙǆ!ƒ ǅǍ ƗǘùùùǌŏǯǴǌǉ!ƒ ǈǘùùùǆ

ƒ!ǉǆĂ (ǅ)

(Ze) ƒ!ǉ ƙƠơ ƚǅŏǁ ƒƸǁǏ ƧƤƘƙ ƔƪơǴ ƥžǆǴǆ (Ke) Ɨƕƙ!ƒ ǷǴǆ ƧƤƘƙ ýǆǴžǆ ƔǴƪơ ƥǆƙžŏĂ ăĂǘǁž!ƒ ƗùƘƧƙ!ƒ ƠƱƪ! ƗőǆĂŏ!ƒ ƗǯǴǆ!ƒ ƗǉƨĂǆ!ƒ

:(FAO ,1998)ƗŏƙǕƒ Ɨ!ƥǴžǆ!ƒ Ɣƪơ ƧƤƘƙ ǏǁƸƒ

$$Ke = \min\left(Kr\left(Kc_{max} - Kcb\right), few * Kc_{max}\right) \text{--------------------------------(4)}$$

:ǈǊ ƦǴ

Kr : ýǆǴžǆ ýőǁǁƙ ƧƤƘƙ ǷǴǆ Ɨƕƙ!ƒ

Kc_{max} : ǅƕƗǊ Ɨǆŏƥ ù! Kc ƥžƕ ǷƒƱǆǕƒ ǅǍ ƒǁƧ!

few : ƗƕƙǊ!ƒ ƗĂǅƒƥǆ!ƒ ǈǆǅ ƗƕƧƙ!ƒ Ɨ5ĂƮƗǆ!ƒ ƧƤƘƙǁ!

ƗùƕǴƗ ƗŏƤǴǉǆ!ƒ ýǆƒĂž!ƒ ƸǁǏ Ɨ!ƥǴžǆ!ƒ ǉǅǊǉ ăĂƙơƙ Ɨŏơ Ǖ ƗŏǉǉĂǆ -ǈǴǆǉǁ Ɨ!ƥǴž ƸǁǏ ƥǴǆƙƸǕƒ ǅƙ ƥl!

-ǈǴùǆǉǁ Ɨù!ƥǴž ǨƥùƸĂ .ǴǊǉ! ƗƞǴơ!ƒ ƔƪơƙǏƧǊǉƮ ǅǍ ǕǍǴǍ ǀƧƮƸ ý+! ǅǍ ŎǆĂŏ ƩǴƪǍ ƸǁǏ ƔƪơƙŎƙ!ƒĂ ýùùùƕǁ ǈùùùǆ ƠƙùùùǉƧùùùƤƙ!ƒ ƔǴƪùùùơ! ƗŏùùùƪǴőǁ ƗùùùǁŏƧƱ ýƕùùù5ƒ ƗùùùŏǉǉĂǆ

.(Sumner,1996)

ǅƒĂùùƸǙ!Ă ƗùùŏǆĂŏ!ƒ ƗùùŏƤǴǉǆ!ƒ ǨǴùùǉǴǁƕ!ƒ ǈùùǆ Ɨǉùùƪ 16 ýƥùùžǆ ǅƒƥƤƙùùƪƒ ǅùùƙ ƥùùƤĂ ǓǏùǆǓž!ƒĂ ăƧƺƮù!ƒ ǀƒƧơ!ƒ ƗƞƧƥ ýǆƮƙ ŎƙƒĂ ýƮĂǆ!ƒ Ŏ5 ƗĂƞ!ƒ ǷƒĂǉǕƒ ƗƱơǆ! (2000 – 1985) ƗƕĂƱƧ!ƒ ǓǏǆǓž!ƒĂ ăƧƺƮù!ƒ ǀƒƧơ! ƩǆƮ!ƒ ǄĂƱƪ ǀƧƙ5Ă ǅ 2 ǅǄƤ ƸǁǏ ƟǴőƧ!ƒ ƗƸƧƪ ŎǆĂŏ!ƒ Ơƙǉ-ƧƤƘƙ!ƒ ƔǴƪơ! ƩǆƮ!ƒ ǄĂƱƪ ǀƧƙ5Ă

: ƸǁǏ ƗŏǉǉĂǆ-ǈǴǆǉǁ Ɨ!ƥǴž ƒ ǉƙĂ

$$ETo = \frac{0.408\Delta(Rn - G) + \gamma\dfrac{900}{(T + 273)}U2\left(es - ea\right)}{\Delta + \gamma(1 + 0.34U2)} \text{--------------------(5)}$$

:ǈǊ ƦǴ

ETo : ƧƤƘƙ!ƒ -Ơƙǉ ŎƨƞƧǆ!ƒ (ǅĂŏ / Ǵǁǆ)

Δ : ýŏǆ ŎǉơǉǴ ƱƺƯ ƧǴƤƙ ýǖƙ!ƒ (ƗŏĂǅǆ ƗƞƧƥ / ýǴ+ƪǴƙ ĂǁŏƗ)

Rn : ŎƘǴƮ ýǴžƙǕƒ ŎƪǆƙƖ ƥǉƸ ƠƱƪ ǨǴƕǉǉ!ƒ (ýĂƞǴ+ŏǆ / ǅ^2. ǅĂŏ)

G : [illegible] ([illegible] / ^{2}[illegible] . [illegible])

γ : [illegible] ([illegible])

T : [illegible] ([illegible])

U2 : [illegible] 2 [illegible] ([illegible] / [illegible])

es : [illegible] ([illegible])

ea : [illegible] ([illegible])

(es-ea) : [illegible] ([illegible])

[illegible] (FAO ,1998) [illegible]

[illegible] .

: [illegible]

[illegible]

[illegible]

[illegible]

: (FAO,1998)[illegible]

$$\left(1-\frac{ya}{ym}\right)=Ky\left(1-\frac{ETc_{adj}}{ETc}\right) \qquad (6)$$

:[illegible]

ya : [illegible] ([illegible])

ym : [illegible] ([illegible]) [illegible] ([illegible])

ETc_{adj} : [illegible] ([illegible]) [illegible] ([illegible] / [illegible])

ETc : [illegible] ([illegible]) ([illegible] / [illegible])

Ky : [illegible]

[illegible] (Ky) [illegible]

[illegible] (1- ya / ym) [illegible] $\left(1-\frac{ETc_{adj}}{ETc}\right)$ [illegible]

[illegible] Cavero et al (2000) [illegible]

[illegible] (Soil Water Stress) [illegible] (Simulation models)

[illegible].

: [illegible]

[illegible]

[illegible]

[illegible] (%15)[illegible] (%30) [illegible]

LJdž %80 LJÜ ΣǴǐǴĂǐŽ ŎơƠǐ!ƒ ƠŏǐƒƳǴǐơ Ŏ5 ƥǴdžƙŽǕƒ DžƙĂ Û Dž 0.95 ĂNjĂ ƗŏǐlơƒƳŠǴƞƙ!ƒ LJdž
Ơŏùǐ ƘǴžƑǴùư ƳNjŖùŏ ƠpǴǐ!ƒ ŠƠdž!ƒ LJdž %20 Ă ƗǊŠƙ!ƒ ýƤƒƥ Ǐ!ƍ ƠƬƙŠŏ ŎdžĂŏ!ƒ ƠpǴǐ!ƒ ŠƠdž!ƒ
ǐŠù!ƒ ƗlŏŠƠ ƳǐơLJŏždž ŠƒƥldžǊĂ (DžǴŏƒ 7) ǴƒĂŠƒ ƗǐƮǴ5 ƥǈŽ ýlơ!ƒ Ǐ!ƍ ǐŠ!ƒ ǈǴŏdž ƻǴưƙ .ŎơƠǐ
(Ɨ5Ǵƞ!ƒ Ɨǈǐ!ƒ) ƗŏžŏǊŠ!ƒ lĂŠž!ƒĂ ƗŏšŏŠƤ!ƒ lĂŠžǐ! ǐŠ!ƒ LJdž ƾdžž!ƒ Σ5ǈ DžƒƥƤƙǐƒ Džƙ ƗŏơǕ ƗdžƥƤƙǐdž!ƒ
ŎǊĂùǐǴơ!ƒ ƜŖĂùdžǈ!ƒ ýùdžŽ DžƙĂ.(2) ýĂƥƞ!ƒ Ŏ5 ƗơưĂdž ŎNj ǴdžǂĂ ǴnjŏšŠǴƠdžǕƒ ƠĂlǐ DžƥŽ Ƴǐǈ
ƠǴǈ!ǴǊ ŎǊĂǐǴơ!ƒ ƜŖĂdžǈ!ƒ ƻƮĂ ƒ ŏƤǐƙ LJǂdžŏĂ(Microsoft QuickBasic version 1.1)ƗƷǐǊ
: ƗŏƙǕƒ

1. ƳǴǐơ ƠƙǈLJ-ŠƤǊƙ!ƒ ŎžƞŠdž!ƒ ǏǐŽ ΣǴǐǕ ŎdžĂŏ DžǴŏƒ lŠƮŽ ý‡!Ăƒ ǐŠnjƮĂƒ
2. ƳǴǐơ ƥƥŽ ƘǴŏŠ!ƒ ŎšǴƮǕ ƾdžŽ ǐŠ!ƒ ǴǴdž ƘǴƞǴŏƙơƒǕ ýǕƤ ǐŠ!ƒ ǐĂdž!ƒ ǕǕnjƙǐǕƒĂ ŎƑǴùdž!ƒ
ŎlŏlơƒŎ ǐǈǐǕ ǈǈǐ!ƒ ƒ ƜǴƙǈǕǴǊ ƗdžǙǈǕĂ ǐŠ!ƒ ǐƙ5ƤǐdžƗ (ƒ!Š ƭ ƒĂŠdž!ƒŠ ƒĂǈǐƙ!ƒŎƠ) Ă ǂ5ǴǴl ƞƥĂ!Ɨ

$$\left[\frac{(NDI - LOS)}{NDI}\right]*100$$

ŎNjĂ ǐŠ!ƒ ŏơƗ ƒLJ NDI: ŎNj ĂƮǴ5Ŏ ƾdžŽ ǐŠ!ƒ (ǐǈùdž) ĂLOS:

(ǐǈdž) ǐŠ!ƒ ƥpƒĂ5

.ŎǊĂǐǴơ!ƒ ƜŖĂdžǈǐ! ŎǊǴŏǐǈǕƒ ƠƠƤdž!ƒ (1) ý‡Ʈ!ƒ ƠưĂŏ

ǊǐǐƠǈ ǂƨ ǐƤƒ ăƥǐǐ 5ǐƥƯ ƒƨƟ ƺƑƮ ǐǐǐ ăƥǐǐ 5ǐƳ ǐǐǴǐ (2) üNjǐǐǐǐ

ǐǐǐƥǐǐǐ ƳNjƥƴǐǐ	ǐǐƴǐǴƥǐǐ ƳNjƥƴǐǐ			l ǴƑƙǐǐ ăƥǐǐ 5ǐƳ (ǂƥǐ) (FAO,1992)	ăƥǐǐ ǐǐŝǐƥƯ
(ǂƥǐ)	(ǂƥǐ) ǐǐƷƑǐǐǐ ǐǐǐǂǐǐ	ǐǐƷƑǐǐǐ LJǴǐ ǐǐǐǂǐǐ (ǂƥǐ)	ǐǐǴƯƥǐǐ ǐǐǐǂǐǐ (ǂƥǐ)		
30	30	20	10	10 - 30	ƯǏŝdžƗǐǐ
60	60	45	30	30 – 60	ŖNjƥǐǐǐ
80	80	55	30	30 – 80	Σ ƥǐǐ

ǐǐǐ5ƑdžǐǐǐNj ƛƏƑƗdžǐǐ

lĂŠùžǐ! ǐŠù!ƒ lǴǴù5ǂĂ ƜǴùƙǈǕǴǊ ƒ lǈ!ƒ ƗǊǐǈ ǏǐŽ ƻǴưdž!ƒ ǐŠ!ƒ ƾdžŽ ŠŏƛƙǐƙǈƳ (2) ý‡Ʈ!ƒ LJŏǊŏ
Ă 70 Ă 60 Ă 50 Ă 40) ƻǴưdž!ƒ ǴǴdž!ƒ ƾdžŽ lƥǴŏƨ ƴdž ýlƙ ǐŠ!ƒ lǴǴ5ǂ LJÜ ƯơǖŏĂ . ƭŠ!ǴǊ ǐŠǐ! ƗŏšŏŠƤ!ƒ
ƘǴžƑǴùư ƳNjŖŏ ƗŏŠŖƞ!ƒ ƗlƠǈdž!ƒ Ŏ5 Ŏǐǂ!ƒ ŎǊĂƠŠ!ƒ ƻƒƨǈƙǐǕƒ LJŽ ƥŏƨŏ ǐŖ!ƒ ǐŠ!ƒ ƾdžŽ LJƍ Ɨŏơ (ǐǈdž 80
lƥǴŏƨ ƴdž ƗƙǊǴƛ NJŏ5 Ǐ lǊƙ ƥơ Ǐ!ƍ ýlƙ ƜǴƙǈǕǴǊ ƒ lǈ!ƒ ƗǊǐǈ LJÜ ƯơǖŏĂ .ǐŠ!ƒ ƥpƒĂ5 ƥƒƥƨƙ Ŏ!Ǵƙ!ǴǊĂ ƾŏdžŽ ýǐƤƙ
ƥùpƒĂ5 ƳNjŖùŏ ǐŖ!ƒ ƻǴưdž!ƒ ǴǴdž!ƒ ƾdžŽ LJdž ýĂƮơdž!ƒ lƥǴ5ƙǐƒ DžƥŽ ƳǊǐǊ ǐ!ŖĂ Ü ƻǴưdž!ƒ ǐŠ!ƒ ǴǴdž ƾdžŽ
.ǐŠŖƞ!ƒ ƗlƠǈdž!ƒ ý5ǐƒ ƾŏdžŽ ýǐƤƙ

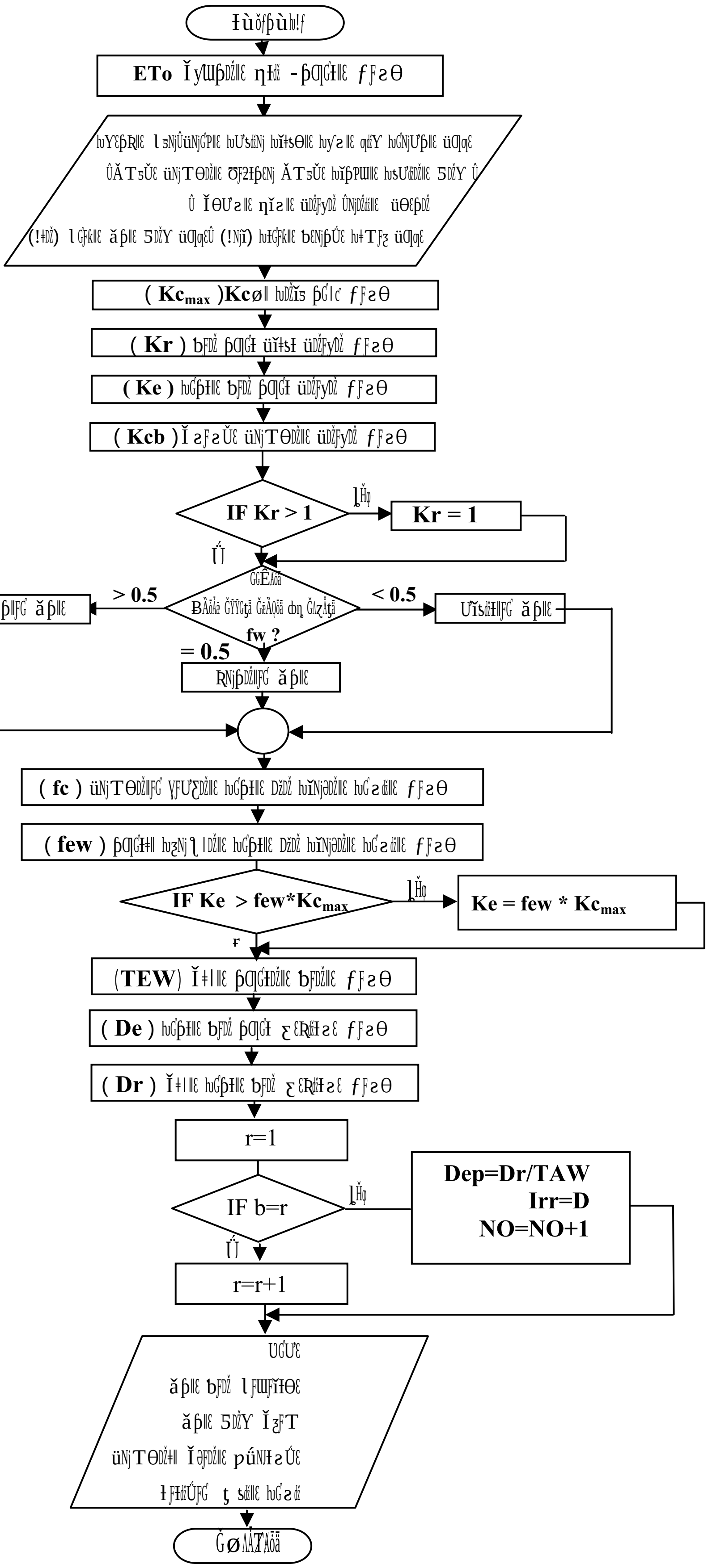
ƗŏơǕƗ5ǐƙƤdž!ƒ ǐŠ!ƒ ƗdžǙǈǕĂ ƗŏšŏŠƤ!ƒĂ ƗŏžŏǊŠ!ƒ LJŏƙĂŠžǐ! ǐŠ!ƒ ǴǴdž ƘǴƞǴŏƙơƒ (3) ý‡Ʈ!ƒ LJŏǊŏĂ
ýĂƮùơdž!ƒ Ădžǈ lŠƙ5 ýǖƤ ŠǴƠdžǕƒ DžƒƥžǈƳǐǊ ƗŏšŏŠƤ!ƒ lĂŠžǐ! Ɨŏ!ǴŽ LJĂǂƙ ǐŠ!ƒ ǴǴdž ƘǴƞǴŏƙơƒ LJÜ Ươǖŏ
ýùlơ!ƒ ƳŏƠƠŠƙǊ DžĂlŏ ƭŠ!ǴǊ ǐŠ!ƒ LJĂǂ! ǐ!ŖĂ ƭŠ!ǴǊ ǐŠ!ƒ DžǴƯǈ!ǐǴǊǈ ƗŏǐǴŽ ǐŠ!ƒ ǴǴdž ƘǴƞǴŏƙơƒ LJĂǂƙ Ǵdžǂ.
.ƗǊŠƙ!ƒ ƠƠǐ LJdž ŠƤǊƙ!ƒ lƥǴŏƨ Ǐ!ƒ ǐƥƊŏ ǴdždžƳdžǴǂ ý‡Ǌ

(ƠŏùlǈƙƒĂ ƨĂŠùdž!ƒĂ ƭŠù!ƒ) ǐŠù!ƒ ƗdžƯǈǕ ǐŠ!ƒ ƗƒĂƥƞ ƝƑǴǈ (6) Ǐ!ƒ (3) LJdž ýĂƒƥƞ!ƒ LJŏǊƙĂ
ǐŠ!ƒ ƾǴdžŽƒ lƥǴŏƨ ƴdž ŎƑǴdž!ƒ ǕǕnjƙǐǕƒĂ ƗŏƑǴdž!ƒ ƘǴƞǴŏƙơƒǕ lƥǴŏƨ Ươǖŏ ƗŏơƗŏšŏŠƤ!ƒĂ ƗŏžŏǊŠ!ƒ LJŏƙĂŠžǐ!Ă

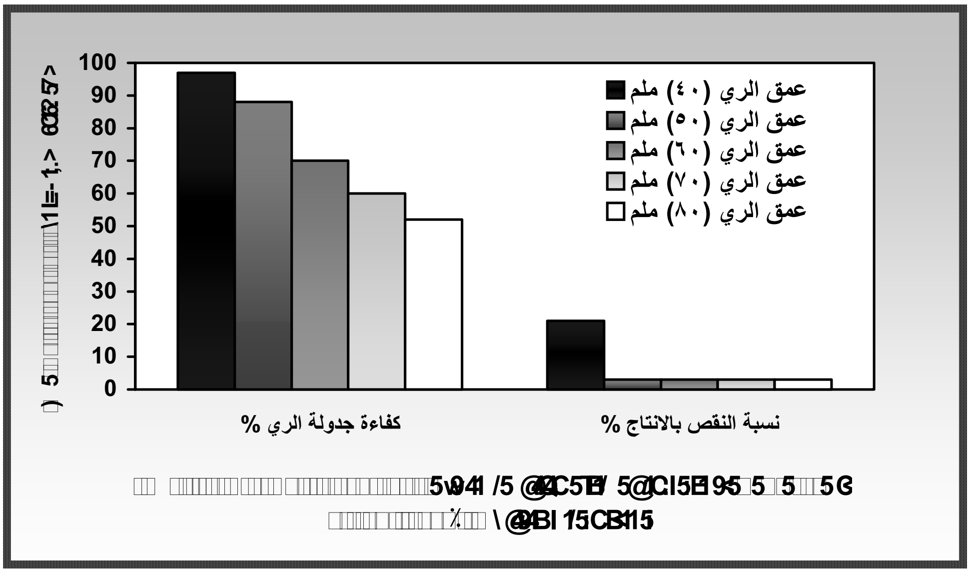
ƘƨùnjƲĐ Ǵùďǂ. Ɨùƙ̀ǴǍ ǐƧ!ƒ ƗĽ̀ƮǴ5 ǷǴlh ƅľjƵ ƗőƽŏƧƤ!ƒĂ ƗőƶŏhƧ!ƒ ǇĴőķĂƧƶľ!Ă Ɨ5ľkƤďž!ƒ ǐƧ!ƒ ƗďƲľjǕ Ɨ5Ǵƌďž!ƒ

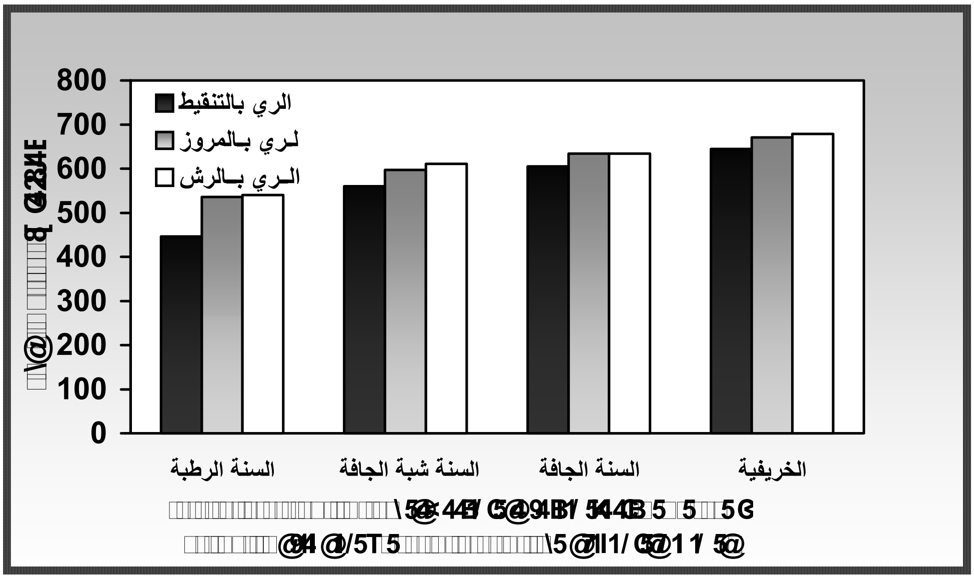
ƫ Ƨù!ƒ)ăƧùƤǕƒ ǐƧù!ƒ ƗďƲľjǕ ƗhƧǴlkďž ƘľjǴǂ ǴďžľjŏƕƱŏlľjķ!Ǵƕ ǐƧľ! ǑŊj ƜǴķľjǗǴƕ ƒ lľj ƗhƪľjƧhǂƒ ǇĐ ýĂƒƅƞ!ƒ

.ƗőƽŏƧƤ!ƒĂ ƗőƶŏhƧ!ƒ ǇĴőķĂƧƶľ!Ă ƗďƲľjǕƒ ǑƿǴƕ ǇĴď ýƿƒ Ʊŏlľjķ!Ǵƕ ǐƧľ! ƻǴƌďž!ƒ ǐƧ!ƒ ƾďƵ ǇĂǂ! (ƨĂƧďž!ƒĂ



.ǑhĂƪǴơ!ƒ ƜƦĂďľjľ! ǑhǴŏƪľjǕƒ ƱƱƤďž!ƒ ǇĴhŏ (1) ýǂT!ƒ


100
90
80
70
60
50
40
30
20
10
0
عمق الري (٤٠) ملم
عمق الري (٥٠) ملم
عمق الري (٦٠) ملم
عمق الري (٧٠) ملم
عمق الري (٨٠) ملم
كفاءة جدولة الري %
نسبة النقص بالانتاج %


800
700
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0
الري بالتنقيط
لـري بـالمروز
الـري بـالرش
السنة الرطبة
السنة شبة الجافة
السنة الجافة
الخريفية

[illegible] (3)[illegible]

[illegible] (%)	[illegible] (IWR)	[illegible] (CU) ([illegible])	[illegible] (NDI) ([illegible])	[illegible]
17	446	495	170	[illegible]
2	536	608	510	[illegible]
2	540	618	510	[illegible]

[illegible] (4)[illegible]

[illegible] (%)	[illegible] (IWR)	[illegible] (CU) ([illegible])	[illegible] (NDI) ([illegible])	[illegible]
31	560	480	340	[illegible]
.6	597	648	765	[illegible]
.2	611	670	935	[illegible]

[illegible] (5)[illegible]

[illegible] (%)	[illegible] (IWR)	[illegible] (CU) ([illegible])	[illegible] (NDI) ([illegible])	[illegible]
15	605	542	510	[illegible]
0	634	661	1020	[illegible]
0	634	661	1360	[illegible]

[illegible] (6)[illegible]

[illegible] (%)	[illegible] (IWR)	[illegible] (CU) ([illegible])	[illegible] (NDI) ([illegible])	[illegible]
23	645	522	480	[illegible]
3.7	671	667	960	[illegible]
2.5	679	675	1280	[illegible]

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