



"El saber de mis hijos
hará mi grandeza"



Sexto Congreso Nacional de Riego, Drenaje y Biosistemas

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USO DEL MODELO AQUACROP PARA GENERAR UN CALENDARIO DE RIEGO DEL CULTIVO DE MAÍZ, EN LA ZONA SUR DEL ESTADO DE OAXACA

RODRIGUEZ HERRERA DIANA YARISMA

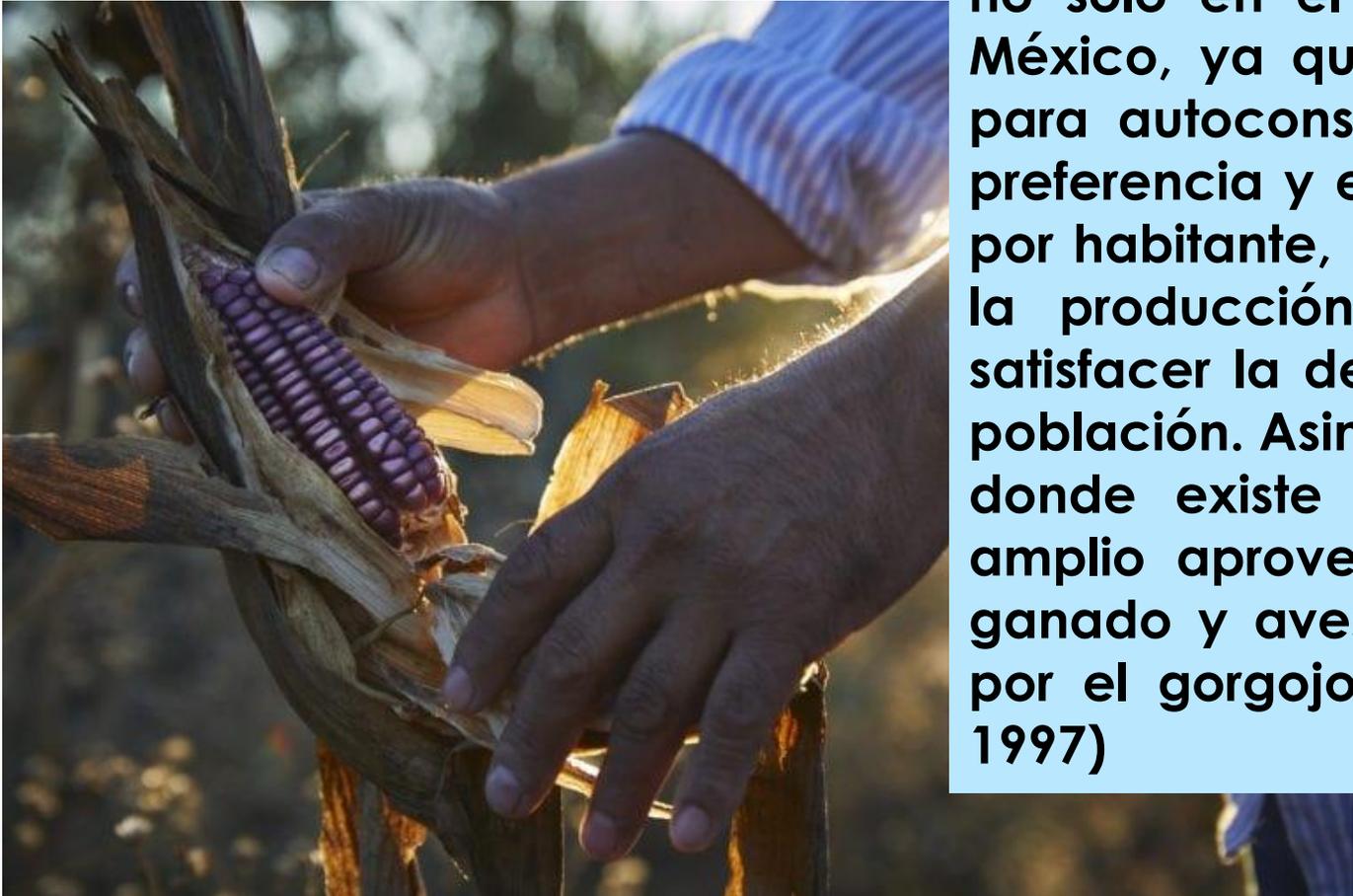


Enseñar la explotación de la tierra,
no la del hombre

Fecha de presentación: jueves 10 de junio de 2021



INTRODUCCIÓN



El maíz es el alimento básico de más importancia no sólo en el estado de Oaxaca, sino en todo México, ya que la producción es principalmente para autoconsumo y ocupa el primer sitio en la preferencia y en la cantidad de grano consumido por habitante, por lo que es prioritario incrementar la producción de esta gramínea, para poder satisfacer la demanda que año con año exige la población. Asimismo, en algunas regiones donde existe mayor producción, el maíz tiene amplio aprovechamiento en la alimentación del ganado y aves, ya sea de maíz limpio o picado por el gorgojo. (Instituto Nacional de Estadística, 1997)

OBJETIVO



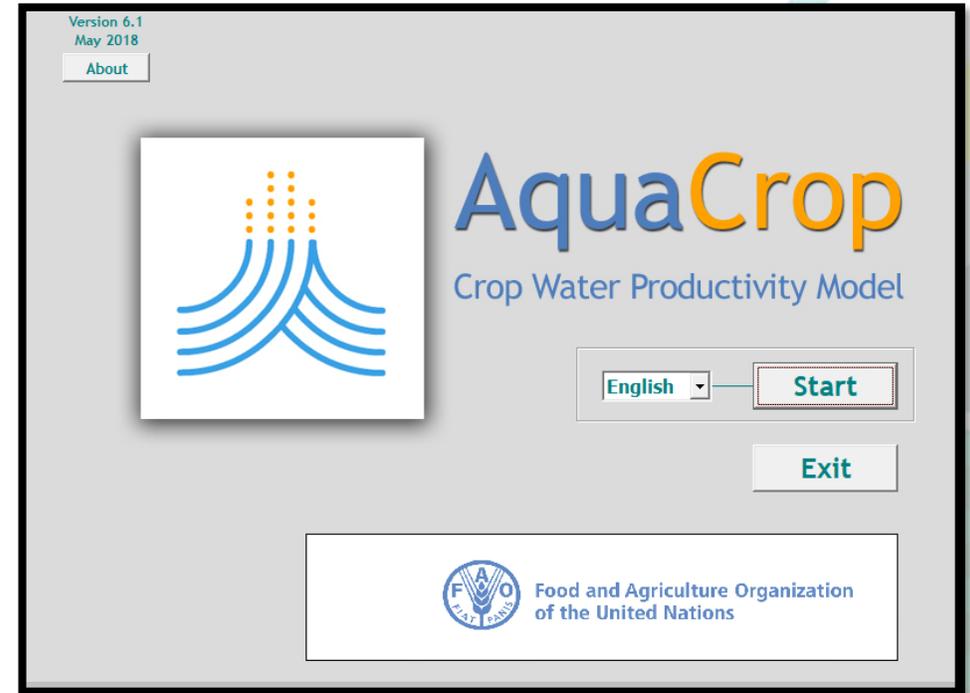
DAVID MANRIQUE

El objetivo de este trabajo es calibrar el modelo Aquacrop para generar un calendario de riego, en base a las condiciones de diferentes zonas de la sierra sur de Oaxaca, para el cultivo de maíz



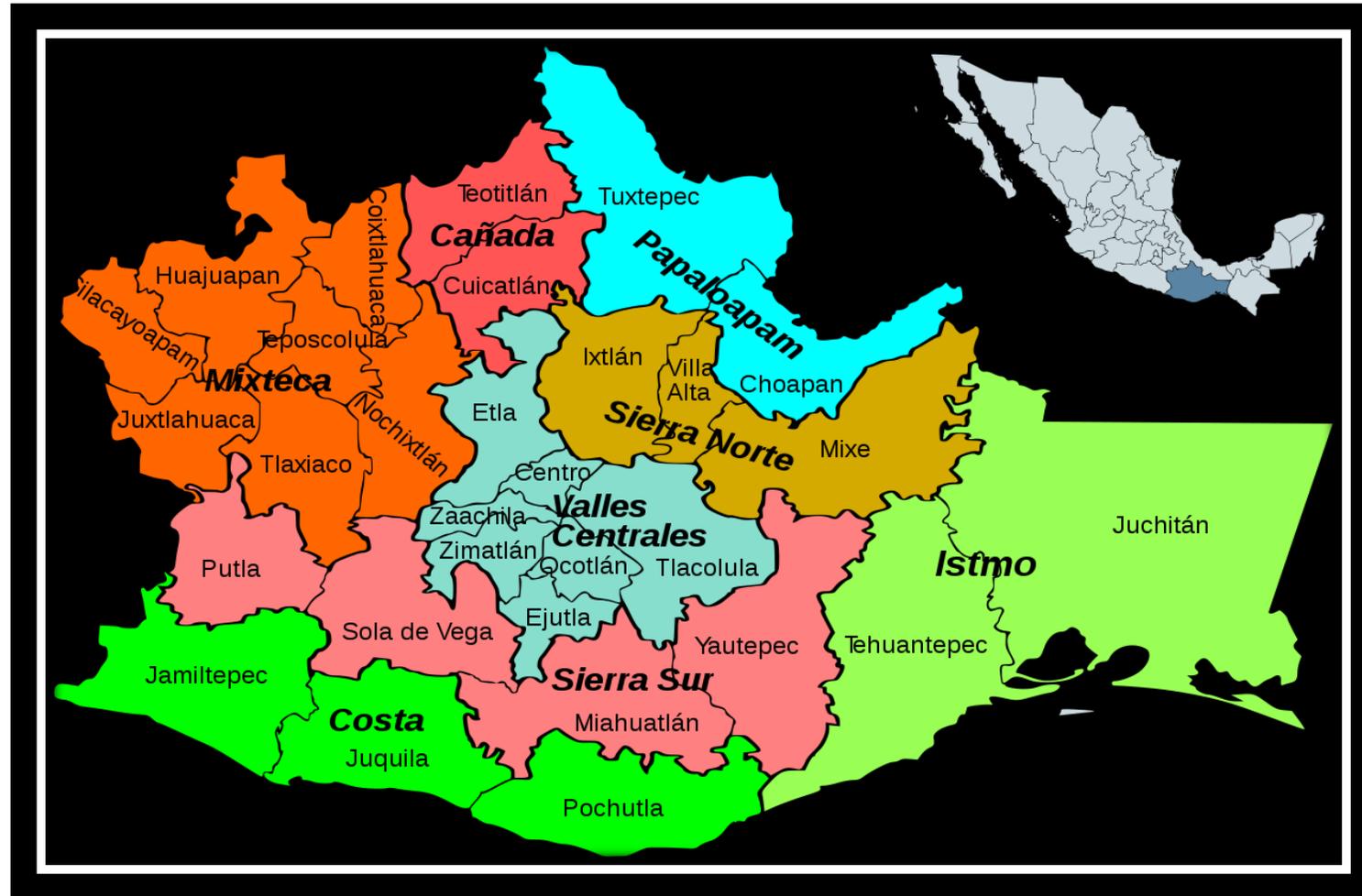
PROGRAMA AQUACROP

El modelo AquaCrop liberado por la FAO, puede utilizarse como herramienta computacional para analizar escenarios agrícolas en diferentes ciclos y localidades, considerando las condiciones climáticas de la región y parámetros del cultivo de interés. El modelo AquaCrop fue creado para simular el desarrollo y rendimiento de varios cultivos, especialmente bajo condiciones hídricas o con respuesta al suministro del riego. A pesar de lo anterior, el modelo puede generar simulaciones bajo condiciones de temporal (sin riego) para los diversos cultivos que están integrados en la base de datos de su sistema informático (software). (Hilario Flores-Gallardo, 2013)



<http://www.fao.org/aquacrop/es/>

METODOLOGÍA



WIKIPEDIA. (2010, 5 julio). *Regiones y distritos de Oaxaca: Sierra Sur al suroeste* [Ilustración]. Sierra Sur de Oaxaca.

https://en.wikipedia.org/wiki/Miahuatl%C3%A1n_District#/media/File:Oaxaca_regions_and_districts.svg



SIERRA SUR DE OAXACA

DISTRITO DE PUTLA

PUTLA VILLA DE GUERRERO

DISTRITO DE SOLA DE VEGA

VILLA SOLA DE VEGA

DISTRITO DE MIAHUATLÁN

MIAHUATLÁN DE PORFIRIO DÍAZ

DISTRITO DE YAUTEPEC

NEJAPA DE MADERO



ESTACIONES METEOROLOGICAS

PUTLA VILLA DE GUERRERO

00020094 PUTLA DE GUERRERO (CFE)

Latitud	17°07'00" N
Longitud	97°57'23"W
Altitud	1316 msnm.

VILLA SOLA DE VEGA

00020099 SAN MIGUEL SOLA DE VEGA (CFE)

Latitud	16°30'52" N
Longitud	96°58'39"W
Altitud	1409 msnm.

MIAHUATLÁN DE PORFIRIO DÍAZ

00020071 MIAHUATLAN (DGE)

Latitud	16°21'00" N
Longitud	96°37'00"W
Altitud	1537 msnm.

NEJAPA DE MADERO

00020009 BOQUILLA NUMERO UNO

Latitud	16°38'12" N
Longitud	95°57'35"W
Altitud	638 msnm.

ETo Calculator

ETo calculator



Version 3.2
September 2012

Evapotranspiration from a reference surface

About

Start program

Close program

 **FAO (Food and Agriculture Organization of the United Nations)**
Land and Water Division
Rome, Italy

FAO Land and Water Digital Media Series N° 36

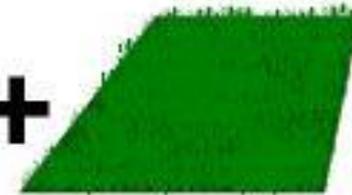
climate



Radiation
Temperature
Wind speed
Humidity

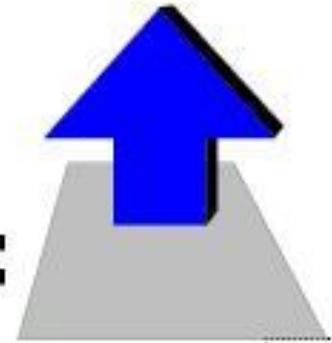
+

reference
surface



=

ETo



ETo calculator

1

Main menu

Data import menu

File type | Climatic station | Meteorological data | Climatic parameters | Status Report

Station description

Station: 000200094 Putla de Guerrero (CFE)

Country: Putla de Guerrero

Location: Degrees and Minutes
 Decimal degrees

Latitude: 17 degrees 7 minutes North

Longitude: 97 degrees 57 minutes West

Altitude: 1316 meter above sea level

Location

at the coast
 interior location

in arid or semi-arid area
 in semi-humid or humid area

light winds in area
 light to moderate winds in area
 moderate to strong winds in area

2

ETo calculator

Data and ETo menu

Station: 000200094 Putla de Guerrero (CFE) Country: Putla de Guerrero File: PUTLA.DTA

Input data description | Meteorological data and ETo | Plot data | Export results

Air temperature

Mean temperature [°C]

Minimum and Maximum temperature [°C]

Air humidity

Mean Relative Humidity [%]

Minimum and Maximum Relative Humidity [%]

Mean dew point temperature [°C]

Mean actual vapour pressure [kPa]

Psychrometric data

Mean dry and wet bulb temperature [°C]

Ventilated Coefficient psychrometer

Natural ventilated 0.000800

Indoors

IF missing air humidity

Tdew = Tmin + subtract 0.0 [°C] (sub)humid

Wind speed

Mean wind speed [m/sec]

height of measurement 2.0 [meter]

IF missing wind speed

U2 = 2.0 m/sec light to moderate wind

Sunshine and Radiation

Hours of bright sunshine (n) [hours]

Relative sunshine hours (n/N) [-]

Solar radiation (Rs) [MJ/m2.day]

Net radiation (Rn) [MJ/m2.day]

Coefficients Angstrom equation

IF missing radiation

Rs = 0.16 x SQRT(Tmax - Tmin) x Ra

Cancel Main menu

3

ETo calculator

Data and ETo menu

Station: 000200094 Putla de Guerrero (CFE) Country: Putla de Guerrero File: PUTLA.DTA

Input data description | Meteorological data and ETo | Plot data | Export results

Month	January	February	March	April	May	June	July
Year	1978	1978	1978	1978	1978	1978	1978
Tmax °C	30.0	30.7	33.1	34.2	33.0	29.6	29.2
Tmin °C	15.4	15.2	14.9	16.9	18.3	19.1	18.8
ETo mm/day	4.0	4.6	5.7	6.1	5.7	4.6	4.5

< 1977 1979 >

Symbols Switch Units Data Limits Save data

Cancel Main menu

AquaCrop

Main menu

Environment and Crop

Climate

Climate: (None) Specify climatic data when Running AquaCrop

Crop

Growing cycle: Day 1 after sowing: 22 March - Maturity: 24 July

Crop: DEFAULT.CRO a generic crop
Calendar mode

Management

Irrigation: (None) Rainfed cropping

Field: (None) No specific field management

Soil

Soil profile: DEFAULT.SOL deep loamy soil profile

Groundwater: (None) no shallow groundwater table

Simulation

Simulation period: 1. Simulation period: from 22 March - to 24 July

Initial conditions: 1 (None) Soil water profile at Field Capacity

Off-season: x Simulation period linked to cropping period

Project: (None) No specific project

Field data: 22 (None) No field observations

Run <<<<

Exit Program

FECHA	Evapotranspiración (mm/día)	Precipitación (mm)	Temp Min (°C)	Temp Max (°C)
1979 (ENERO)	4.5	21	13.806	31.645
1979 (FEBRERO)	5	17	15.91	32.821
1979 (MARZO)	6.2	0	14.967	34.951
1979 (ABRIL)	6.2	51.5	16.783	34.466
1979 (MAYO)	5.9	124	18	33.548
1979 (JUNIO)	4.8	268	19.533	30.733
1979 (JULIO)	4.8	416.5	19.112	30.209
1979 (AGOSTO)	4.6	466	18.871	29.896
1979 (SEPTIEMBRE)	4.1	605	19.366	28.916
1979 (OCTUBRE)	4.6	36.5	18.08	31.403
1979 (NOVIEMBRE)	4.6	3	16.3	32.583
1979 (DICIEMBRE)	4.4	0.5	15.645	32.548



AquaCrop: Putla Villa de Guerrero

CLIMA

Import climatic data

Select file | Time range | Climatic parameters | ETo | Import climatic data

Import data: File type
Free format text file (*.txt or *.CXT files)

Select file from list

file
00020094.PUTLA.txt

C:\... \AquaCrop-COMEII\PUTLA

C:\windows

C\
FAO
COMEII
AquaCrop-COMEII
PUTLA

double click on folder to change path and view contents

click to select file

276 lines (Time range)
4 columns (Climatic parameters)

Selected file 00020094.PUTLA.txt

Import climatic data

Select file | Time range | Climatic parameters | ETo | Import climatic data

Type and time range of climatic data

Type
 Daily
 10-daily
 Monthly

Time range
 not linked to a specific year

First Month January Last Month December
First Year 1978 Last Year 2000

>>> number of monthly records (=276) in specified time range

Import climatic data

Select file | Time range | Climatic parameters | ETo | Import climatic data

Climatic parameters

Column... 1 2 3 4
<< click in cell to select parameter >>

Symbol.....	ETo	Rain	Tmin	Tmax
Unit.....	mm/day	mm	°C	°C
Code.....	501	601	103	101

Missing data.....

Undefined Value -999.000

Missing.....	none	none	none	none
--------------	------	------	------	------

Data range.....

Column Max...	7.1	826.9	20.0	37.9
Column Min...	0.0	0.0	0.0	0.0

Create climate file

File Name
PUTLA CLI

Description
Información climatológica de Putla

Selected Rain, ETo, Temperature and CO2 file

File Name	Description
Rain 00020094.PUTLA.PLU	00020094.PUTLA : monthly rainfall data (January 1978 - December 2000)
ETo 00020094.PUTLA.ETo	00020094.PUTLA : monthly ETo data (January 1978 - December 2000)
Temp 00020094.PUTLA.Tnx	00020094.PUTLA : monthly temperature data (January 1978 - December 2000)
CO2 MaunaLoa.CO2	Default atmospheric CO2 concentration from 1902 to 2099

Data Base

Select file from Temperature Data Base

Create a new Temperature file

Cancel Create climate file



AquaCrop: Putla Villa de Guerrero

CULTIVO

File Name: MAIZPUTLA • CRO

Description: Cultivo de Maiz en Putla

Crop Type

- Fruit/Grain producing crops
- Leafy vegetable crops
- Root and Tuber crops
- Forage crops



Planting method

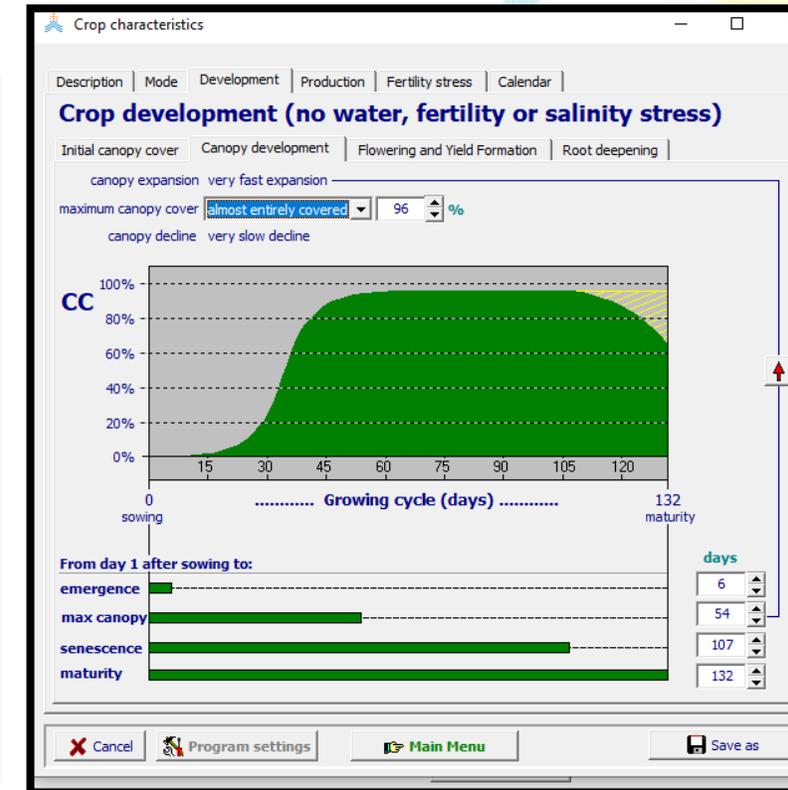
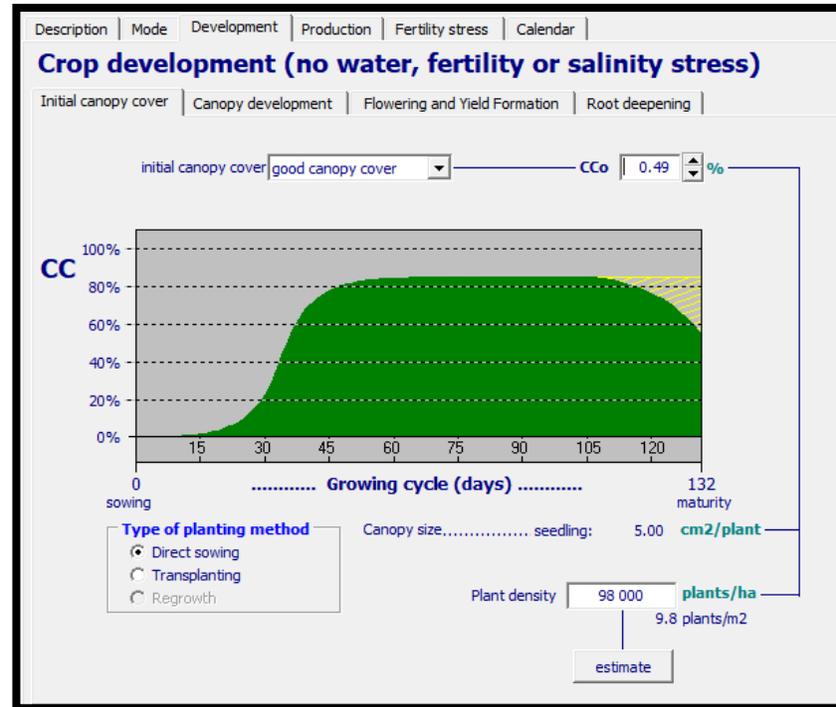
- Sowing
- Transplanting
- Regrowth

Cropping period

From 30 January 1978 .. day 1 after sowing
To 10 June 1978 crop maturity

Length of growing cycle

From day 1 after sowing to crop maturity..... 132 days

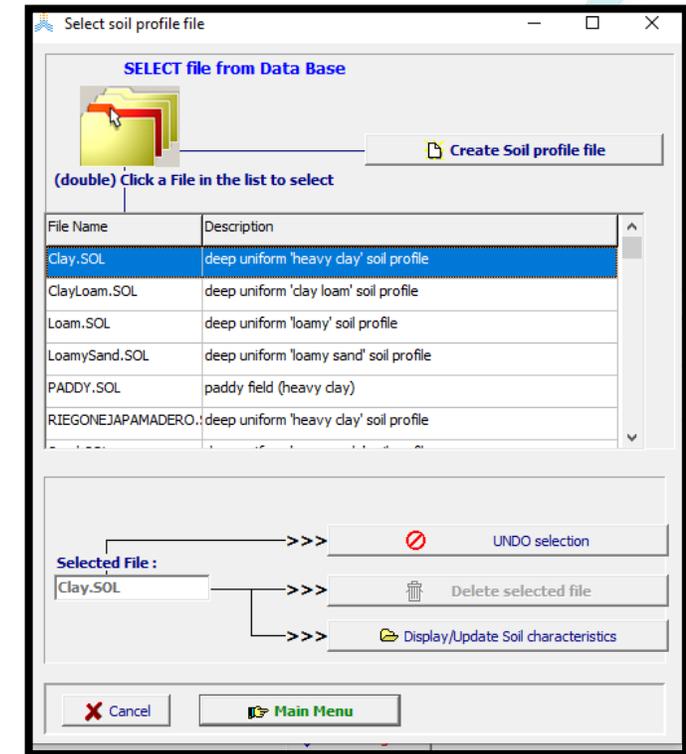
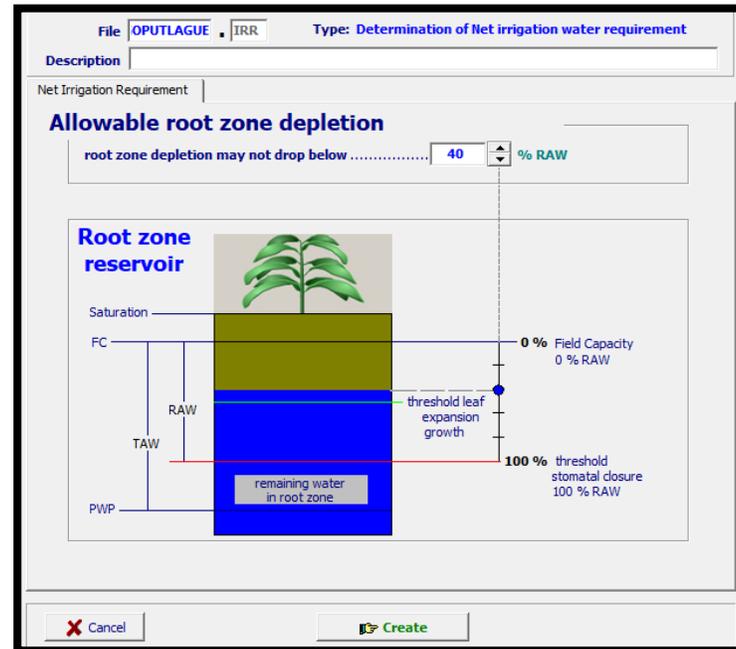
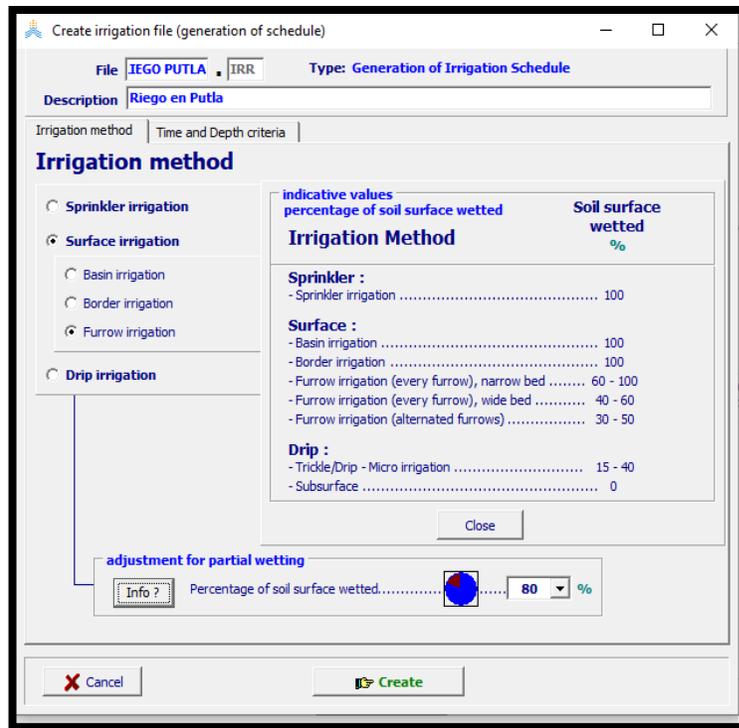




AquaCrop: Putla Villa de Guerrero

RIEGO

SUELO





AquaCrop: Putla Villa de Guerrero

PERIODO DE SIMULACIÓN

The 'Simulation period' dialog box shows the following configuration:

- Growing cycle:** 132 days, from 30 January 1978 to 10 June 1978.
- Simulation period:** 132 days, linked to the growing cycle.
- Start date:** 30 January 1978 (day 1 after sowing).
- End date:** 10 June 1978 (at maturity).
- Graphical display:** Crop, Simulation, and Climate axes are visible.
- Available climatic data:** From 1 January 1978 to 31 December 2000, File: PUTLA.CLI.

CONDICIONES INICIALES

The 'Create Initial conditions file' dialog box shows the following configuration:

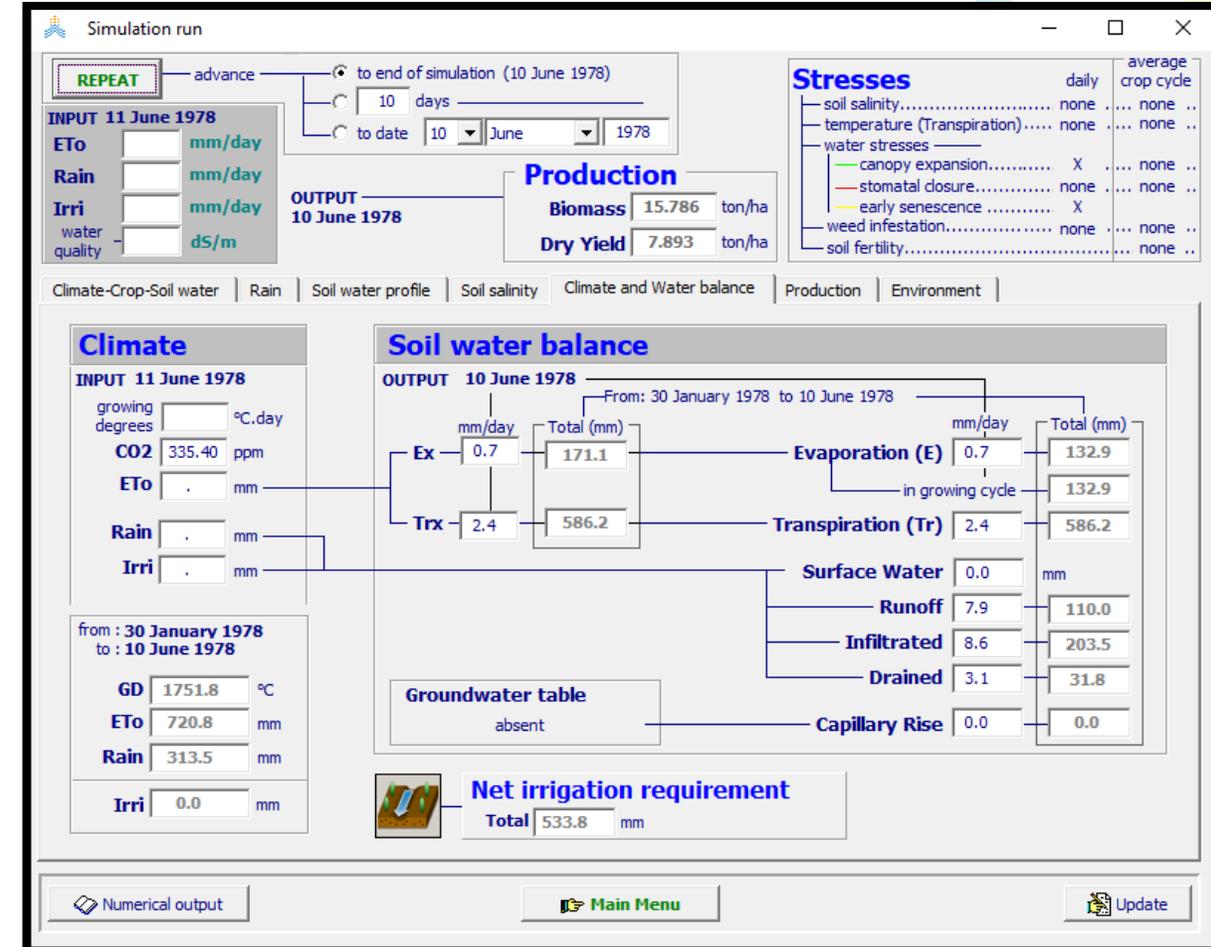
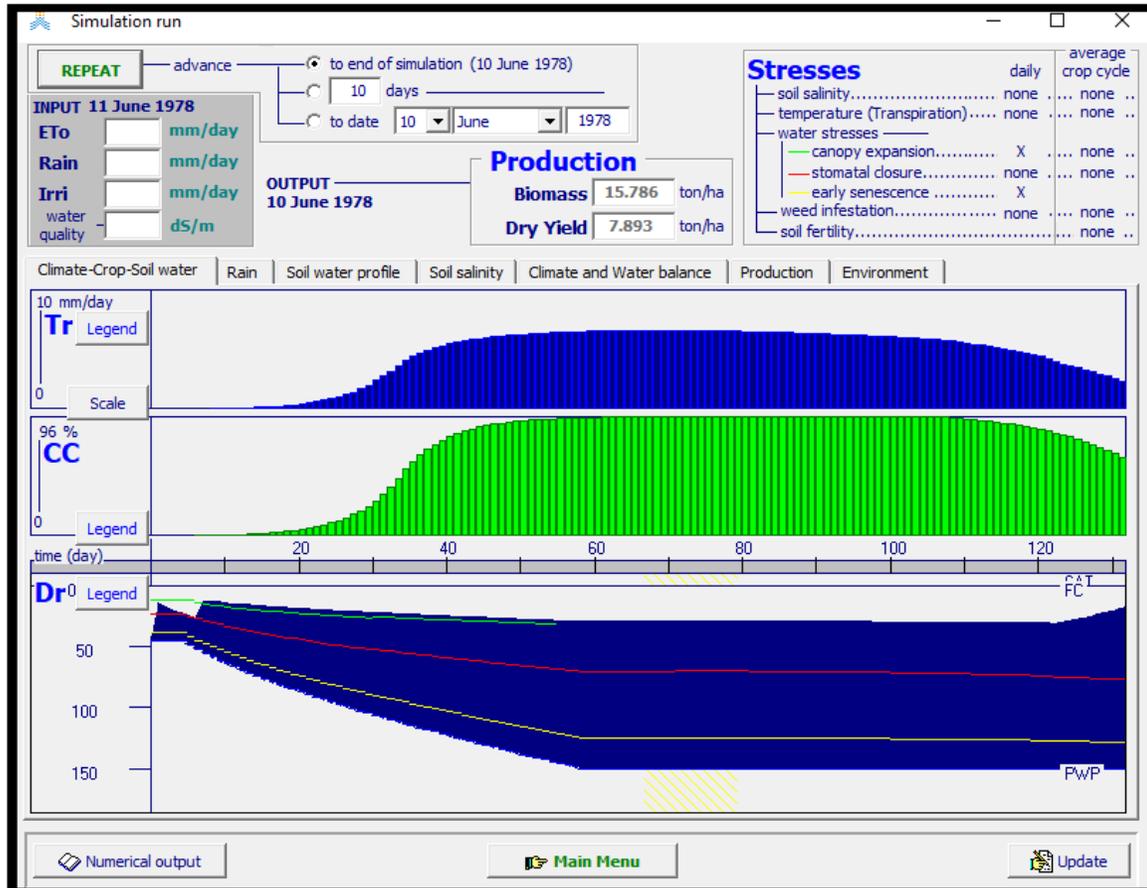
- File:** MAIZPUTLA, SWO
- Initial conditions for:** 30 January 1978
- Description:** MAIZ EN PUTLA
- Initial soil water and salinity content:** Selected.
- Specify soil water and salinity content:** for specific layers.
- Soil water profile:** A vertical bar chart showing soil water content (vol %) from 0 to 40% at depths of 0.20 m, 0.40 m, 0.60 m, 0.80 m, and 1.00 m. The 'Field Capacity' button is highlighted.
- layer(s) considered:** 1
- Table of soil profile data:**

thickness (m)	from - to (m)	Soil water content (vol %)	Soil salinity (dS/m)	
1	4.00	0.00 - 4.00	50.00	0.00



RESULTADOS

Putla Villa de Guerrero





RESULTADOS

Putla Villa de Guerrero

Numerical output

10-Day -----
Soil water balance

Time Aggregate: Day, 10-day, Month, Year

Range: From 30 January 1978 To 10 June 1978

Select Output File:
 Crop development and production
 Profile/Root zone soil water conter
 Soil water balance
 Climate input data
 Compartments soil water conter
 Net irrigation requirement

Legend

Decade	Month	Year	WCTot	Rain	Irrigation	Top Surface	Infiltrated	Run Off	Drained
			mm	mm	mm	mm	mm	mm	mm
3	1	1978	597.5	0.0	3.0	0.0	0.0	0.0	0.0
1	2	1978	598.1	0.0	40.9	0.0	0.0	0.0	0.0
2	2	1978	605.1	0.0	42.6	0.0	0.0	0.0	0.0
3	2	1978	606.6	2.4	36.4	0.0	2.4	0.0	0.0
1	3	1978	608.4	6.0	54.0	0.0	6.0	0.0	0.0
2	3	1978	610.1	10.0	54.9	0.0	10.0	0.0	0.0
3	3	1978	611.7	13.2	60.0	0.0	13.2	0.0	0.0

Numerical output

Monthly -----
Soil water balance

Time Aggregate: Day, 10-day, Month, Year

Range: From 30 January 1978 To 10 June 1978

Select Output File:
 Crop development and production
 Profile/Root zone soil water conter
 Soil water balance
 Climate input data
 Compartments soil water conter
 Net irrigation requirement

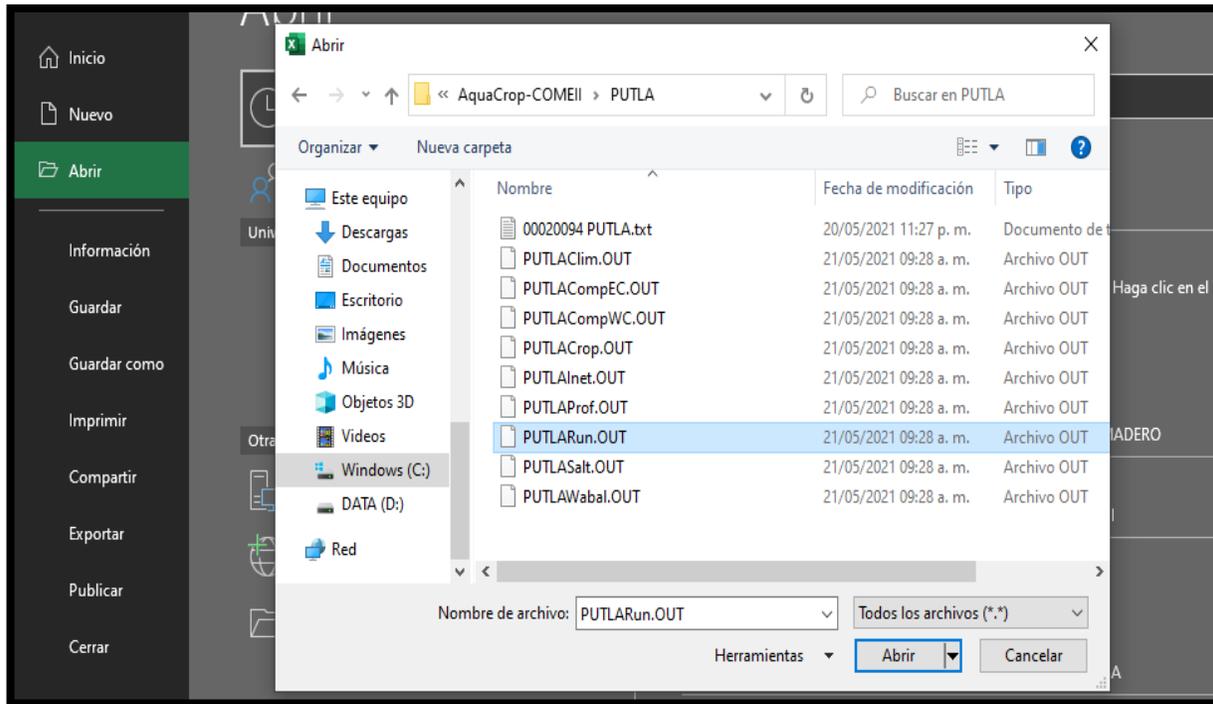
Legend

	Month	Year	WCTot	Rain	Irrigation	Top Surface	Infiltrated	Run Off	Drained
			mm	mm	mm	mm	mm	mm	mm
	1	1978	597.5	0.0	3.0	0.0	0.0	0.0	0.0
	2	1978	603.0	2.4	119.9	0.0	2.4	0.0	0.0
	3	1978	610.1	29.2	168.9	0.0	29.2	0.0	0.0
	4	1978	616.7	67.0	142.8	0.0	63.0	3.0	0.1
	5	1978	620.0	49.0	143.8	0.0	43.5	6.6	9.7
	6	1978	626.9	165.0	0.0	0.0	65.6	99.5	14.1



RESULTADOS

Putla Villa de Guerrero



RunNr	Day1	Month1	Year1	Rain mm	ETo mm	GD °C.day	CO2 ppm	Irri mm	Infiltr mm	Runoff mm	Drain mm	Upflow mm	E mm	E/Ex %
1	30	1	1978	313	721	1752	335.4	534	203	110	32	0	133	78



RESULTADOS

MIAHUATLÁN DE PORFIRIO DÍAZ

VILLA SOLA DE VEGA

REPEAT — advance — to end of simulation (10 June 1963)
 10 days
 to date 10 June 1963

INPUT 11 June 1963
 ETo mm/day
 Rain mm/day
 Irri mm/day
 water quality dS/m

OUTPUT 10 June 1963
Production
 Biomass 27.498 ton/ha
 Dry Yield 13.214 ton/ha

Stresses
 average crop cycle
 soil salinity..... none ..
 temperature (Transpiration)..... 3 % ..
 water stresses ———
 canopy expansion..... 6 % ..
 stomatal closure..... none ..
 early senescence none ..
 weed infestation..... none ..
 soil fertility..... none ..

Numerical output
 10-Day -----
Soil water balance
 Time Aggregate Day 10-day Month Year
 Range From 30 January 1963 To 10 June 1963
 Select Output File
 Crop development and production
 Profile/Root zone soil water conter
 Soil water balance
 Climate input data
 Compartments soil water conter
 Net irrigation requirement

Decade	Month	Year	WCTot	Rain	Irrigation	Top Surface	Infiltrated	Run Off	Drained
			mm	mm	mm	mm	mm	mm	mm
3	1	1963	260.6	0.0	34.8	0.0	0.0	0.0	0.0
1	2	1963	261.6	0.0	26.5	0.0	0.0	0.0	0.0
2	2	1963	264.8	0.0	35.0	0.0	0.0	0.0	0.0
3	2	1963	264.9	0.0	31.8	0.0	0.0	0.0	0.0
1	3	1963	265.1	0.0	53.6	0.0	0.0	0.0	0.0
2	3	1963	265.2	0.0	61.4	0.0	0.0	0.0	0.0
3	3	1963	273.1	2.2	82.5	0.0	2.2	0.0	0.0

REPEAT — advance — to end of simulation (26 June 1962)
 10 days
 to date 26 June 1962

INPUT 27 June 1962
 ETo mm/day
 Rain mm/day
 Irri mm/day
 water quality dS/m

OUTPUT 26 June 1962
Production
 Biomass 13.923 ton/ha
 Dry Yield 6.961 ton/ha

Stresses
 daily average crop cycle
 soil salinity..... none .. none ..
 temperature (Transpiration)..... none .. 1 % ..
 water stresses ———
 canopy expansion..... X .. none ..
 stomatal closure..... none .. none ..
 early senescence X .. none ..
 weed infestation..... none .. none ..
 soil fertility..... none .. none ..

Numerical output
 10-Day -----
Soil water balance
 Time Aggregate Day 10-day Month Year
 Range From 15 February 1962 To 26 June 1962
 Select Output File
 Crop development and production
 Profile/Root zone soil water conter
 Soil water balance
 Climate input data
 Compartments soil water conter
 Net irrigation requirement

Decade	Month	Year	WCTot	Rain	Irrigation	Top Surface	Infiltrated	Run Off	Drained
			mm	mm	mm	mm	mm	mm	mm
2	2	1962	141.5	0.0	28.8	0.0	0.0	0.0	0.0
3	2	1962	149.1	0.0	37.8	0.0	0.0	0.0	0.0
1	3	1962	149.2	0.0	41.6	0.0	0.0	0.0	0.0
2	3	1962	149.3	0.0	51.0	0.0	0.0	0.0	0.0
3	3	1962	149.3	0.0	69.5	0.0	0.0	0.0	0.0
1	4	1962	153.4	3.0	70.6	0.0	3.0	0.0	0.0
2	4	1962	158.9	9.0	55.3	0.0	9.0	0.0	0.0
3	4	1962	158.9	16.0	46.0	0.0	16.0	0.0	0.0



RESULTADOS

NEJAPA DE MADERO

Simulation run

REPEAT advance to end of simulation (10 June 1970)
 10 days
 to date 10 June 1970

INPUT 11 June 1970
ETo mm/day
Rain mm/day
Irri mm/day
water quality dS/m

OUTPUT 10 June 1970
Production
Biomass 28.646 ton/ha
Dry Yield 13.767 ton/ha

Stresses daily average crop cycle
soil salinity none ... none ..
temperature (Transpiration) none ... none ..
water stresses
- canopy expansion X ... 6 % ..
- stomatal closure none ... none ..
- early senescence X
weed infestation none ... none ..
soil fertility none ... none ..

Climate-Crop-Soil water | Rain | Soil water profile | Soil salinity | Climate and Water balance | Production | Environment

Numerical output

Monthly Soil water balance

Time Aggregate Day 10-day Month Year

Range From 30 January 1970 To 10 June 1970

Select Output File
 Crop development and production
 Profile/Root zone soil water conter
 Soil water balance
 Climate input data
 Compartments soil water conter
 Net irrigation requirement

Legend

Month	Year	WCTot	Rain	Irrigation	Top Surface	Infiltrated	Run Off	Drained
		mm	mm	mm	mm	mm	mm	mm
1	1970	1144.3	0.0	0.0	0.0	0.0	0.0	0.0
2	1970	1118.0	2.8	78.9	0.0	2.8	0.0	0.1
3	1970	1088.3	0.0	180.8	0.0	0.0	0.0	0.0
4	1970	1064.1	0.0	187.7	0.0	0.0	0.0	0.0
5	1970	1043.2	37.3	128.1	0.0	37.3	0.0	3.4
6	1970	1038.0	9.0	19.1	0.0	9.0	0.0	2.6



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"El saber de mis hijos
hará mi grandeza"



Sexto
Congreso Nacional de
Riego, Drenaje y Biosistemas
COMEII- 2021 / Hermosillo, Sonora



¡GRACIAS!

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Universidad Autónoma Chapingo
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