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CROPWAT 8.0 Software is used to Estimate Crop Water Requirements and Reference Evapotranspiration (Tomato Farming in the Mostaganem Region)

A. Boualem[1], S. Benhassine[1]

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ABSTRACT

Understanding water requirements is crucial for managing irrigation water in the province of Mostaganem in order to better meet demand and integrate supply. We decided to utilize the Windows version of CROPWAT 8.0. We estimated evaporation and then irrigation water requirements for tomato crops after entering fundamental climatic data from 2010 to 2022. We obtained irrigation schedules and tables that appropriately depict the crop's water requirements and reference evapotranspiration for tomatoes based on soil, climate and plant characteristics after entering the data into CROPWAT 8.0. Next, we contrasted the monthly outcomes with the identical plant's annual results. This work is part of sustainable development and especially the rational use of irrigation water following the Cropwat model. The use of cropwat is essential to maintain the correct irrigation schedule, especially in terms of irrigation timing and period. The results obtained showed that the crop requirement is always lower than the irrigation requirement, so the results obtained either monthly or annually are adequate.

Key words: CROPWAT 8.0, ETc, ETo, Mostaganem, Tomato.

Abbrivations: ETc: Crop water requirement, Eti: Irrigation water requirement, ETo: Reference evapotranspiration, Rains eff: Effective rainfall.

Geographic boundaries

Our study region covers an area of 2,269 km^2, extending from 0°8′ West to 0°46′ East and from 36°29′ to 35°37′ North. It is located in the northwestern part of Algeria Anonymous (2023). The Mediterranean Sea forms its northern and northwest borders, which offers a coastline of approximately 120 km. It is bordered to the east by the wilaya of Chleff, to the south by the wilayas of Mascara and Rélizane and to the west by the wilaya of Oran (Fig 1). In 1987, the wilaya of Mostaganem had a population of 504,000, which increased to 737,000 in 2008, with an average density of 325 inhabitants per km^2 (Caïd *et al*., 2019).

Morphological characterisic of the tomato

The tomato is considered an annual plant in cultivation, although it is a perennial in its native region (Chaux and Foury, 1994).

Vegetative system

Root system

The root system is robust, with extensive branching and a fibrous shape. It is very active in the first 30 to 40 centimeters. Roots can be found up to 1 meter deep in the soil (Fig 2).

The stem

The stem has an angular shape and is thick between the pubescent (hairy) nodes. At the beginning of growth, it has a herbaceous consistency and becomes lignified with age (Chougar, 2012) (Fig 3).

After four or five leaves, this monomodal growth becomes sympodial, meaning that the axillary buds give rise to successive branches. The terminal buds, on the other hand, flower or abort (Chougar, 2012).

The branches that develop from the axillary buds generate leaves at each intersection and conclude with an inflorescence (Chaux and Foury, 1994).

The stem has two types of hairs, either simple or glandular. The latter contain an essential oil that gives the plant its distinctive fragrance (Kolev, 1976).

The leaves (Fig 4)

The leaves are composed of 5 to 7 main leaflets, 10 to 25 cm long and a number of small, oval intercalary leaflets, slightly toothed on the edges and grayish on the underside. They are often folded into spoon shapes or even have rolled edges. The leaves alternate on the stem (Raemaekers, 2001).

Cropwat 8.0 model

CROPWAT is a software program that helps manage irrigation, created by FAO in 1992, using the modified

[1]Faculty of Natural and Life Sciences, University of Mostaganem, Algeria.

Corresponding Author: S. Benhassine, Faculty of Natural and Life Sciences, University of Mostaganem, Algeria.
Email: boualemabdelkader@gmail.com

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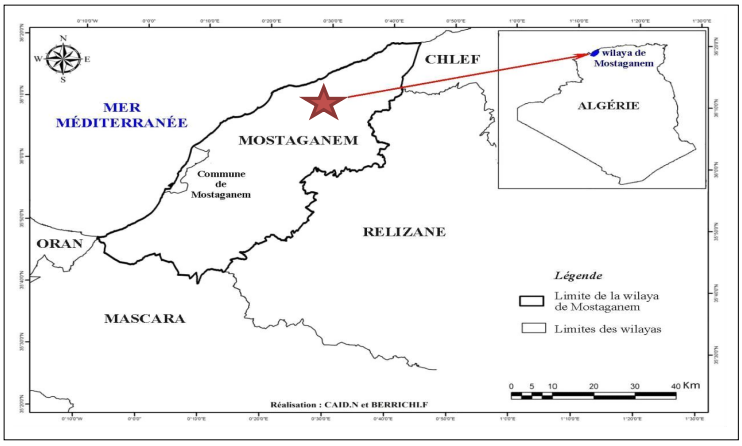

Fig 1: Location of the study area (Caïd, Chachoua and Berrichi, 2019).

Fig 2: Root system (Chaux and Foury, 1994).

Fig 3: Tomato stem (Chougar, 2012).

Fig 4: Tomato leaf (Chougar, 2012).

Penman-Monteith formula. FAO Irrigation and Drainage Bulletins 24 and 33 can be used to calculate crop water requirements and irrigation water volumes. It also allows for the creation of an irrigation schedule adapted to different cropping methods and for assessing the impact of water shortages on crops and the effectiveness of various irrigation methods.

CROPWAT 8.0 is a Windows application that can determine plant water requirements and irrigation needs using new and existing climate and agricultural information (Doorenbos and Pruitt (1975). In addition, the application offers the ability to create irrigation schedules adapted to various management situations and calculate the water supply required for different types of crops.

The CROPWAT software is structured into eight distinct modules, five of which are dedicated to data entry and three to calculassions (FAO, 2016). These modules can be accessed via the main menu, but are more easily accessible via the module bar, which is always visible on the left side of the main window. This layout allows the user to easily combine climate, agricultural and soil information to estimate crop water requirements, create irrigation schedules, (Boualem *et al.,* 2015) and manage the area's water supply.

CROPWAT data entry modules are as follows:

For climate/ETo: This involves entering measured ETo data or climate information to facilitate the calculation of Penman-Monteith ETo.

- **Rainfall:** This involves collecting rainfall data and calculating effective rainfall.
- **Crop:** This allows for crop data and planting dates to be taken into account.
- **Soil:** This involves recording soil information (only required for the irrigation schedule).
- **Crop rotation:** for recording the data required for crop supply calculations.

CROPWAT calculation modules are:

- **Water requirements**: for calculating crop water requirements.
- **Calendar:** for calculating irrigation schedules.
- **Perimeter:** for calculating perimeter supply based on a specific crop rotation.

In this section, (Abdelkader Boualem, 2023), we present and interpret the results. First, we calculate evaporotranspiration ETo, crop water requirements ETc, effective precipitation Peff and irrigation water requirements ETi on a monthly basis. We then compare these results with evapotranspiration ETo, crop water requirements ETc, effective precipitation Peff and irrigation water requirements ETi on an annual basis for tomatoes grown in the Mostaganem province using software developed by FAO (CROPWAT 8.0) during the period 2010-2022.

Calculation of ETo for the period (2010-2022)

Monthly ETo evapotranspiration averages are displayed in Fig 5, 6 and (Table 1) (Mehta, 2015). determined over a 13-year period (2010-2022), is 3.6 mm/month, while the average annual ETo value is 3.71 mm/year. For the period 2010-2022, the monthly peak of ETo is reached in July with a value of 6.19 mm/day, while the monthly trough is reached in January with a value of 1.16 mm/day. Furthermore, the annual ETo reached a peak of 5.12 mm/day in 2012, while its lowest value, 3.42 mm/day, was recorded in 2013.

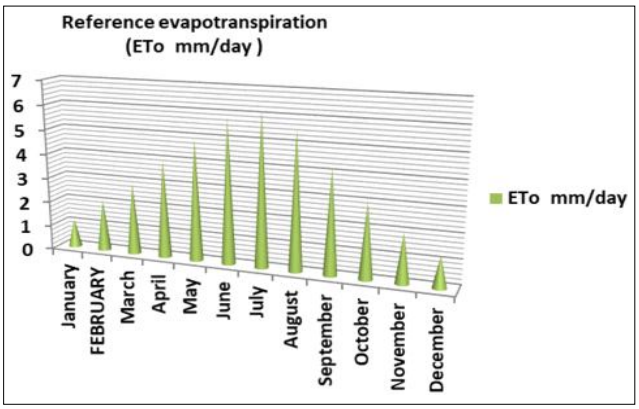

Fig 5: Monthly ETo in the wilaya of mostaganem over 13 years (2010-2022).

Calculation of effective precipitation for the period (2010-2022)

Based on the observations in Fig 7, 8 and (Table 1) the monthly average effective precipitation (Peff) calculated over a 13-year period (from 2010 to 2022) is 326.8 mm, while the annual average effective precipitation is 317.24 mm.

For the period from 2010 to 2022, the effective precipitation (Peff) record a monthly peak of 55.3 mm in January, while its lowest level is 1 mm in July. For the period 2010 to 2022, the effective precipitation Peff recorded an annual peak of 414 mm in 2014 and a minimum annual fall of 214.4 mm in 2020.

Calculation of water requirements for ETc crops of the period (2010-2022)

Fig 9, 10 and (Table 2) show that the water requirements for the ETc crop, (Allen *et al.*, 1998) calculated over a 13-year period (2010-2022), show a monthly average of 754.9 mm/dec/year, while the annual average water requirements for the ETc crop are 798.21 mm/dec/year.

The water requirements of the ETC (Mehta and Vyas, 2016). Crop peak at a monthly maximum of 81.6 mm/dec in July during the Mid-season phase, while the monthly minimum value is 8.9 mm/dec in October during the Late-season phase for the period from 2010 to 2022.

The water requirements of the ETc crop recorded an annual maximum of 1144.9 mm/dec/year in 2012 and an annual minimum of 706.8 mm/dec/year in 2018 during the period from 2010 to 2022.

Table 1: Presentation of the results of effective precipitation and evapotranspiration of the references during the period (2010-2022).

Months	ETo mm/day	Rains eff (mm)	Years	ETo mm/day	Rains eff (mm)	ETc mm/dec
January	1.16	55.3	2010	3.7	383.7	768.7
February	2.1	32.6	2011	3.44	381.7	739.4
March	2.9	39.9	2012	5.12	352.9	1144.9
April	3.98	33.3	2013	3.42	386	747.6
May	4.93	15.1	2014	3.47	414	756.3
June	5.84	4.3	2015	3.57	315	769.7
July	6.19	1	2016	3.58	244	749
August	5.58	3.6	2017	3.68	279.9	790.3
September	4.22	15.3	2018	3.44	375.2	706.8
October	3.04	28.8	2019	3.56	246.4	790.6
November	2	54.1	2020	3,7	214.4	782.9
December	1.26	43.5	2021	3.74	287.1	811.4
			2022	3.83	243.9	819.2

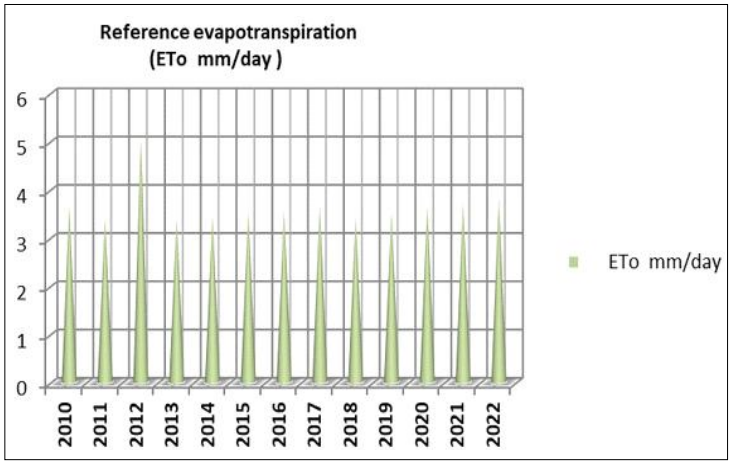

Fig 6: Annual ETo in the wilaya of mostaganem over 13 years (2010-2022).

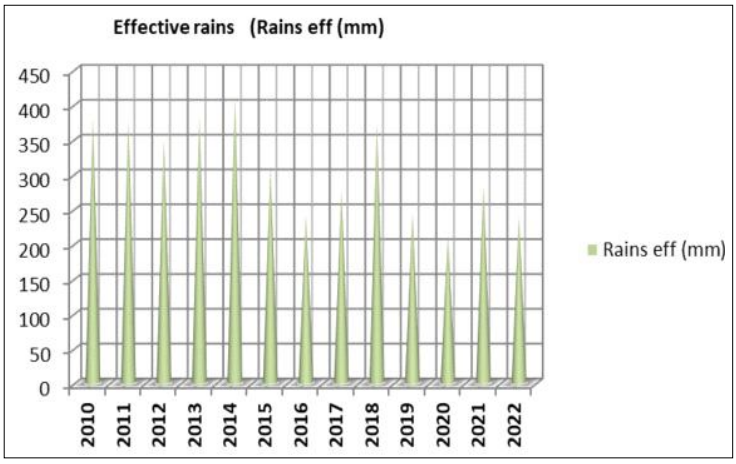

Fig 7: Annual effective precipitation in the wilaya of mostaganem over 13 years (2010-2022).

Table 2: Presentation of the results of water requirements for cultivation and irrigation during the period (2010-2022).

Months	Phase	ETc mm/dec	Months	Phase	Need irrigation (mm/dec)
May	Init	26.6	May	Init	21.9
May	Init	34.6	May	Init	30.9
June	Init	33.2	June	Init	30.8
June	Growth	40.1	June	Crois	38.9
June	Growth	50.2	June	Crois	49.3
June	Growth	61.3	June	Crois	60.8
June	Growth	72.6	June	Crois	72.6
June	Mid-season	81.6	June	Mi-sais	81.2
August	Mid-season	70.9	August	Mi-sais	70.3
August	Mid-season	68.4	August	Mi-sais	67.6
August	Mid-season	69.2	August	Mi-sais	67
Sep	Late-season	55.7	Sep	Arr-sais	52
Sep	Late-season	45.3	Sep	Arr-sais	40.2
Sep	Late-season	36.3	Sep	Arr-sais	29.7
Oct	Late-season	8.9	Oct	Arr-sais	5.1

Calculation of ETi irrigation requirements for the period (2010-2022)

Fig 11, 12 and (Table 2) show the irrigation requirements. Average monthly ETi, calculated over 13 years (2010-2022), amounts to 718.3 mm/year/dec, while average annual ETi irrigation requirements are 763.38 mm/dec/year.

ETi irrigation requirements reach a monthly peak of 81.2 mm/dec in July during the Mid-season phase, while the lowest point is 5.1 mm/dec in October during the Late-season phase for the period (2010 to 2022). ETc irrigation requirements reached a maximum annual value of 1125.2 mm/dec/year in 2012 and a minimum

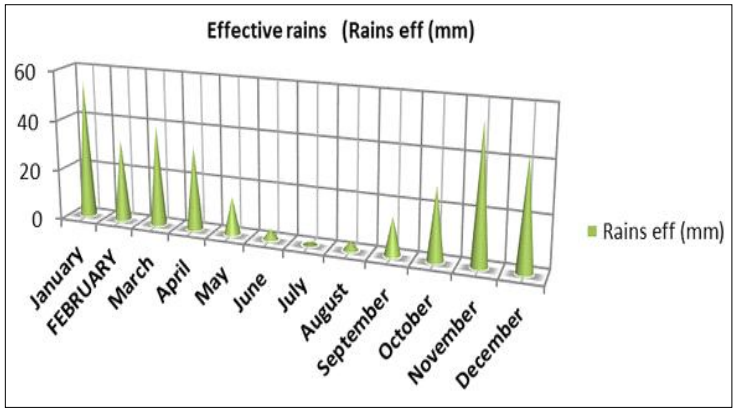

Fig 8: Monthly effective precipita tion in the wilaya of mostaganem over 13 years (2010-2022).

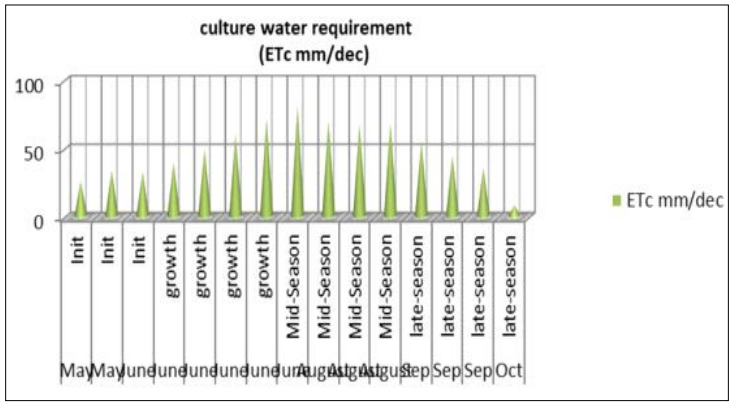

Fig 9: Monthly water requirements for ETc cultivation in the wilaya of mostaganem over 13 years (2010-2022).

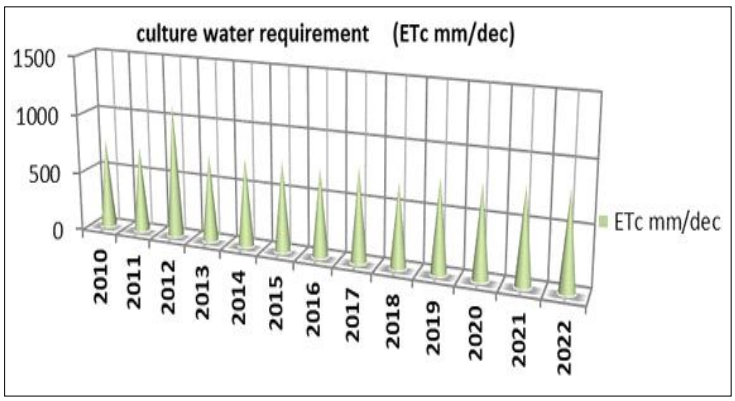

Fig 10: Water requirements for annual crops in the wilaya of mostaganem over 13 years (2010-2022).

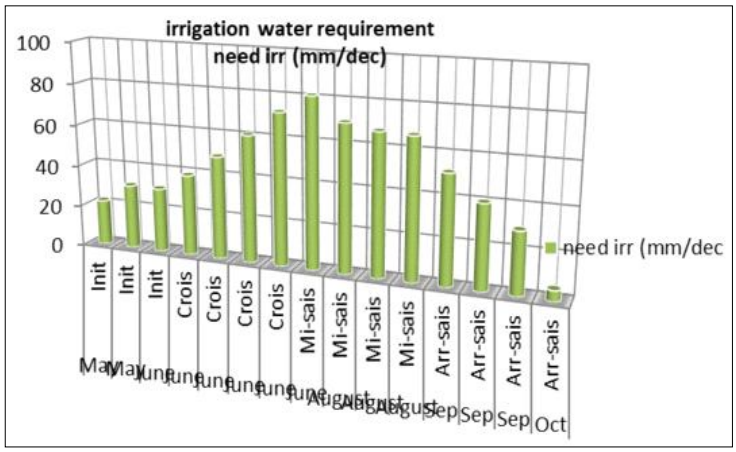

Fig 11: Monthly ETi irrigation needs in the wilaya of mostaganem over 13 years (2010-2022).

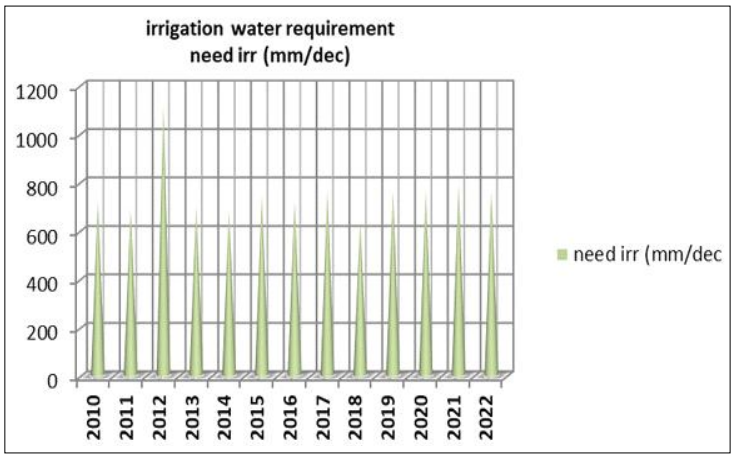

Fig 12: Annual ETi irrigation needs in the wilaya of mostaganem over 13 years (2010-2022).

annual value of 644.1 mm/dec/year in 2018 during the period (2010 to 2022).

CONCLUSION

The central objective of our study is to analyze the reference water and evapotranspiration requirements of tomatoes in the Mostaganem province using CROPWAT 8.0 software. Climate data (temperature, precipitation, relative humidity, wind speed) and sunshine data were collected by the Algerian National Meteorological Office over a 13-year period (2010-2022).

Based on the results obtained, we can deduce that:

- The average monthly ETo determined over a 13-year period (2010-2022) is 43.2 mm/month, while the average annual ETo is 48.25 mm/dec/month.
- Average monthly effective precipitation determined over a 13-year period.
- The total precipitation between 2010 and 2022 is 326.8 mm, while the average annual effective precipitation is 317.24 mm.
- The average monthly water requirement for the ETc crop, established over a 13-year period (2010-2022), is 754.9 mm/dec/year, while the average annual water requirement for the ETc crop is 798.21 mm/dec/year.
- The average monthly irrigation requirements (ETi), estimated over a 13-year period (2010-2022), amount to 718.3 mm/dec/year. However, the average annual irrigation requirements amount to 763.38 mm/dec/year.
- It is important to emphasize at the conclusion of this study that the aim is to assess the monthly reference water requirements and evapotranspiration of tomatoes in the Mostaganem province. This is also compared to the water requirements and evapotranspiration.

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Disclaimers

The content, opinion and views expressed in the research article published in the Journal of Agrometeorology are the views of the author and do not necessarily reflect the views of the organizations they belong to.

Conflict of interest

The author declares that there is no conflict of interest.

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