Journal of Agrometeorology

ISSN : 0972-1665 (print), 2583-2980 (online)
Vol. No. 25 (4) : 613-615 (December - 2023)
https://doi.org/10.54386/jam.v25i4.2376
https://journal.agrimetassociation.org/index.php/jam

Short Communication

Estimation of crop water requirement of tomato in Algeria using CROPWAT model

ABDELKADER BOUALEM

Faculty of Natural and Life Sciences, University of Mostaganem, National Route N 11 Kharouba (Algeria)
Corresponding Author email: Boualemoumnia@yahoo.fr

Algeria is a North African country with a Mediterranean coastline and a Saharan desert interior. Most of Algeria is arid desert (the Sahara) and semi-arid lands, with low and unreliable rainfall, and few crops can be grown here (Boualem *et al.,* 2015). Agriculture in Algeria contributes about 12% of Algeria's gross domestic product while employing 20% of the rural population in all aspects of raising crops on 8.5 millions hectares of arable land. Tomato is one of the important crop of the country with production of 1.8 million tons (Anonymous 2023). It is the most widely utilized crop in Algeria and particularly in Algiers and Oran. Because of the substantial tomato production in the region, a significant processing sector has sprung up to produce concentrate, sauces, juices, and preserves. Agricultural success in such areas heavily relies on effective irrigation planning and management, given the limited natural water supply. To achieve this, we delve into the intricate relationship between various factors, including agricultural parameters, climate conditions, soil characteristics, and the specific needs of tomato crops. The study presented here focuses on a critical aspect of agricultural development, particularly in arid regions characterized by low rainfall and high evaporation rates. The primary objective of this research is to address the pressing need for a comprehensive understanding of the water requirements of tomato cultivation, a staple crop in these regions.

The investigation aims to bridge the gap between theoretical models and practical application. We highlight the significance of accurately estimating reference evapotranspiration (ET) as a fundamental parameter in irrigation decision-making. In this context, we critically examine various ET estimation methods, including established approaches like the Penman-Monteith method and innovative tools such as CROPWAT software. We also explore the use of crop factors to translate reference ET into actual transpiration rates, a crucial step in irrigation and water management.

Five years (2016-2020) climatic data of two stations Oran (Latitude 35.70°N, Longitude 0.65°W) and Algiers (Latitude 36.77°N, Longitude 3.10°E) were used to workout the crop water requirement of tomato. The city Oran is located at the bottom of a bay open to the north on the Gulf of Oran. The region of Algiers is located in the north of Algeria. It is bounded to the east by the Mediterranean basin.

The CROPWAT 8.0 model requires time-series data for minimum temperature, maximum temperature, latitude, longitude, altitude, sunshine hours, and wind speed. The module includes the calculation of both radiation and reference evapotranspiration (ETo) using the Penman- Monteith FAO approaches. The crop water requirement (ETc) was obtained by multiplying the reference evapotranspiration by the average crop factor (Doorenbos and Pruitt, 1975). Penman-Monteith method as given in FAO-56 (Allen *et al.,* 1998) uses following equation for computation of reference evapotranspiration (ETo):

$$ETo = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

Where; ETo is reference evapotranspiration (mm/day), Rn is net radiation on the surface of the culture (MJ/m²/day), G is heat flux exchanged with the ground (MJ/m²/day), T is daily temperature at 2m altitude (°C), u_2 is wind speed at 2m altitude (m/s), es is saturation vapor pressure (kPa), e_a is actual vapour pressure (kPa), e_a-e_s is deficit of saturation vapor pressure (kPa), Δ is slope of the vapor pressure curve (kPa/°C), and γ is psychrometric constant (kPa/°C).

The monthly reference evapotranspiration (ETo) calculated using above formula along with the weather parameters viz. maximum, minimum temperatures, rainfall and effective rainfall of two stations are presented in Table 1. At Oran, the minimum temperature ranged between 1.3 ^{0}C in January to 18.8 ^{0}C in August during the year while maximum temperature ranged between 21.3 ^{0}C in January to 38.9 ^{0}C in August. The climatic

Article info - DOI: *https://doi.org/10.54386/jam.v25i4.2376*
Received: 24 September 2023; Accepted: 4 November 2023; Published online : 30 November, 2023

Table 1: Monthly weather parameters and ETo at Onam and Algiers

Months	Oran					Algiers				
	Tmin (° C)	Tmax (° C)	ETo (mm/day)	Rainfall (mm)	Effective rain (mm)	Tmin (°C)	Tmax (°C)	ETo (mm/day)	Rainfall (mm)	Effective rain (mm)
January	1.3	21.3	1.1	47.8	44.1	8.0	22.7	1.67	90.0	77.1
February	2.9	24.6	1.89	26.8	25.7	8.8	23.0	2.26	60.4	54.6
March	4.7	27.2	2.81	34.8	32.8	9.2	29.1	3.75	78.8	68.9
April	7.3	28.6	3.60	49.1	45.3	11.9	26.6	3.89	53.0	48.5
May	10.1	35.4	4.94	23.7	22.8	14.5	28.7	4.53	13.9	13.6
June	14.4	35.2	5.23	10.4	10.2	18.2	31.8	5.15	11.7	11.5
July	17.4	38.2	5.53	0.7	0.7	21.1	35.9	5.81	0.7	0.7
August	18.8	38.9	5.29	0.7	0.7	22.5	36.3	5.72	4.0	4.0
September	14.5	34.3	3.92	9.3	9.2	18.3	33.5	4.36	38.6	36.2
October	9.2	33.9	3.03	37.7	35.4	14.5	31.9	3.31	28.7	27.3
November	4.9	28.0	2.04	52.3	47.9	11.7	28.4	2.32	89.9	76.9
December	3.6	22.7	1.2	43.3	40.3	10.7	22.7	1.71	85.9	74.1

Table 2: Phase wise crop water requirement (ETc) and irrigation requirement at 10-days of tomato at Onam and Algiers

Months	Phases	Oran		Algiers	
		ETc (mm/dec)	Need irrigation (mm/dec)	ETc (mm/dec)	Need irrigation (mm/dec)
August	Initial	17.6	17.3	19.2	17.2
September		26.2	24.7	28.9	19.2
September		23.5	21.2	26.2	12.2
September	Growth	22.9	17.4	25.3	12.9
October		25.7	16.4	27.9	19.6
October		27.9	15.5	29.9	23.5
October		32.0	18.4	34.4	21.6
November	Mid-season	28.2	13.0	30.7	8.9
November		24.4	7.5	27.0	0
November		21.0	5.3	24.6	0
November		17.6	3.7	22.2	0
December	Late season	14.2	1.3	19.8	0
December		14.1	0.5	19.9	0
January		11.0	0	15.9	0
January		6.7	0	9.9	0

pattern at Algiers is also similar but with less fluctuation during the year in comparison to that of Oran. At Algiers, the minimum temperature ranged between 8.0 ^{0}C in January to 22.5 ^{0}C in August during the year while maximum temperature ranged between 22.7 ^{0}C in January to 36.3 ^{0}C in August (Table 1). The data on variation in references evapotranspiration clearly show that the temperatures have a significant impact on the reference evapotranspiration (ETo), since the monthly variation in ETo was similar to that of temperature variation. The daily ET_o was more than 5 mm/day during June, July and August months at both the stations while it was less than 2 mm/day in December and January months. The total monthly ETo was highest in July (171.4 mm at Oran and 180.1 mm at Algiers) and lowest in January (34 mm at Oran and 51.8 mm at Algiers). Thus, the ETo was found to vary with location and seasons (Mehta and Pandey, 2015)

The crop water requirement (ETc) computed for tomato crop during its crop growing season starting from August to January for two locations are presented in Table 2. The ETc of tomato at both the stations (Oran and Algiers) were lowest during late stage of maturity and highest during grand growth period and mid stage of the crop. Mehta and Pandey (2016) also reported the temporal variation in crop water requirements of different crops in Gujarat, India. The water requirement at Algiers was higher than that at Oran. Due to substantial rain during mid and late season of the crop, the irrigation requirement was minimum at Oran while at Algiers there was no water requirement during mid and late season state.

Thus, the study highlights the relation between climatic variation, reference evapotranspiration (ETo), crop water requirement (ETc) and irrigation demand of tomato crop at two distinct locations (Oran and Algiers) of Algeria. The information generated will be helpful for better irrigation planning in these regions.

ACKNOWLEDGMENTS

The author thanks the meteorological office of Algeria for providing the meteorological data needed to carry out the work.

Funding: The research was conducted without financial support.

Conflict of Interest Statement: The author declares that there is no conflict of interest.

Data Availability: The author confirms that the data supporting this study are available in this manuscript.

Author contribution: create original drafts of research ideas, carry out experiments, and write, review, and revise them.

Disclaimer: 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.

Publisher's Note: The periodical remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

REFERENCES

Allen, R. G., Pereira, L. S., Raes, D. and Smith, M. (1998). Crop evapotranspiration: Guidelines for computing crop water requirements. Irrigation and Drainage Paper 56, FAO of the United Nations, Rome. 300 pp

Anonymous (2023). https://en.wikipedia.org/wiki/Agriculture_in_Algeria

Boualem. Abdelkader, Khaldi Abdelkader, Larid Mohamed (2015). The impact of climate change on the choice of irrigation technology in the region of Mostaganem (Algeria). *WALIA journal* 31(S1): 15-21. Available online at. www.Waliaj.com ISSN 1026-3861.

Doorenbos, J. and Pruitt, W. O. (1975). Guidelines for predicting crop water requirements, Irrigation and Drainage Paper24, FAO of the United Nations, Rome. 179 pp

Mehta, Rashmi and Vyas Pandey. (2015). Reference evapotranspiration (ETo) and crop water requirement (ETc) of wheat and maize in Gujarat. *J. Agrometeorol.*, *17*(1) : 107–113. https://doi.org/10.54386/jam.v17i1.984

Mehta, Rashmi and Vyas Pandey. (2016). Crop water requirement (ETc) of different crops of middle Gujarat. *J. Agrometeorol.*, *18*(1) :83–87. https://doi.org/10.54386/jam.v18i1.906