Assessment of Irrigation Scheduling and Water Consumption for Some Crops

By

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Abstract:

The need for Water Demand Assessment (WDA) is increased as the climate change issue has been complicating, and in situations where people work in agriculture and irrigation are not following the standards and best practices required for sustainable agriculture and irrigation, like in developing countries and the Arab region. This paper presents study to investigate crop water requirements (CWR) for "Marsa Matrouh, Egypt" calculatation of reference evapotranspiration (ET_o) ,figure out crop pattern and the irrigation schedule for the main crops planted there using field trials data, which had been executed at Marsa Matrouh Irrigation Research Station and data was collected by visits to Marsa Matrouh city. In these paper crop water requirements for three crops (banana, sweet pepper and potato) in Marsa Matrouh, the capital and the center of Matrouh Governorate, located in the north coast of Egypt were investigated. The method used to do so is "Cropwat" which is a calculation program developed by Food and Agriculture Organization of the United Nations (FAO), based on some input information. The input modules are Climat, Rain, Crop, Soil and Crop pattern for Marsa Matrouh and crops. Using CROPWAT 8.0 for WINDOWS and CLIMWAT 2.0 for CROPWAT are helpful, promising to increase the productivity and maintain the resources. The calculation modules are CWR, Schedules and Scheme for crops. The data that have been gotten of the net water demand and irrigations number for banana , sweet pepper and potato of field trials were compared with those results that have been gotten using CROPWAT 8.0 for WINDOWS and CLIMWAT 2.0 for CROPWAT. The results showed an increase in the estimated value as compared with real one for water consumption with a percentage of (3%) for banana and (26%) for potato. From the analysis of the obtained results, it was noticed in terms of the number of irrigations that there was a high matching between the estimated and real values for banana and potato, but for sweet pepper there was a difference in irrigations, this difference is due to the difference in crop coefficient values between the estimated program value and the calculated (real value. The problem with irrigation is that it consumes so much water if not properly managed so hopefully with the calculations of (CWR) to develop irrigation schedules under various management conditions.

Index Terms: Irrigation demand, Crop water requirement, Irrigation management, and Water Resources Management.

1. INTRODUCTION

Water is considered one of the most important national security issues in Egypt, past and present. Water is the biggest challenge for agriculture in Egypt, as water is one of the extremely scarce resources in the region. The Nile River is the main source of water in Egypt.

It is worth noting that the Nile River is the longest river in the world and serves at least 10 countries: Rwanda, Burundi, the Democratic Republic of the Congo, Tanzania, Kenya, Uganda, Ethiopia, South Sudan, Sudan, and Egypt, and there are many problems and conflicts throughout history from the difficulty of satisfying all the conflicting parties. Many treaties were agreed upon and signed, the last of which was in 1959, the most important of which was to allow Egypt to establish Aswan High Dam.

In light of the government's endeavor to save water, the government has taken measures aimed at rationalizing the consumption of water used to grow crops that need large quantities of water. The Ministry of Irrigation and Water Resources in Egypt is also working to launch campaigns to raise farmers' awareness of reducing water use.

Crop cultivation is an important part of the Egyptian economy, as the country has the second largest spending on agricultural imports as a share of export earnings in the region, at more than 35%. To this end, improvements and developments are planned in the various irrigation systems and water management and rationalization protocols.

The Water Demand Assessment (WDA) for crops is considered as the first important step to effectively and efficiently manage the production, and to maintain sustainable resources. WDA is also the most important element in water budgeting for any agricultural activity. WDA methods developed and empowered with profound technological solutions, tools and databases that make the estimation faster, easier, and more accurate.

The requirements for crops in the Marsa Matrouh region were calculated and determined using CROPWAT 8.0, with the knowledge of some meteorological standards for the region. CROPWAT 8.0 is empowered with data visualization engine to produce graphs and charts for better and faster data presentation and decision making.

In this paper, the author briefed her experience using CROPWAT 8.0 and CLIMWAT to assess the water needs and provide general guidance to produce three kinds of crops banana crop, sweet pepper crop, and potato crop, all in Matrouh Governorate located in the north coast in Egypt.

The main objectives are:

- How to irrigate.
- How much to irrigate.
- When to irrigate.

This is presented in this paper under the following headlines:

- Methodology.
- Results and discussion
- Conclusions and recommendations

2. METHODOLOGY

CROPWAT 8.0 for WINDOWS and CLIMWAT 2.0 for CROPWAT are two major computer programs (applications) which are used to make the estimation and offer a guiding framework form crops and irrigation management. These two powerful user-friendly and simple to use applications, developed under supervision of Food and Agriculture Organization of the United Nations (FAO), are connected to a global database of necessary data required to make the estimation & guide the agricultural & irrigation activities.

CLIMWAT2.0 for CROPWAT is a climatic database to be used together with the computer program CROPWAT and facilitates the calculation of crop water requirements, irrigation supply and irrigation scheduling for various crops for a range of climatological stations worldwide. It is worth noting that CLIMWAT 2.0 displays a set of agroclimatic data from more than 5,000 global stations distributed.

First, Definition to the subject area (Marsa Matrouh City) and researches are made to get the necessary required information to feed the applications. CROPWAT 8.0 and CLIMWAT 2.0 were installed & started. Simple configuration is required to determine the units of measurement.

In CLIMWAT 2.0, Egypt was chosen from the list of the available countries as shown in figure 1 below.

Then, Marsa Matrouh City was chosen from the list of locations in CLIMWAT 2.0 as seen in the below figure 2.

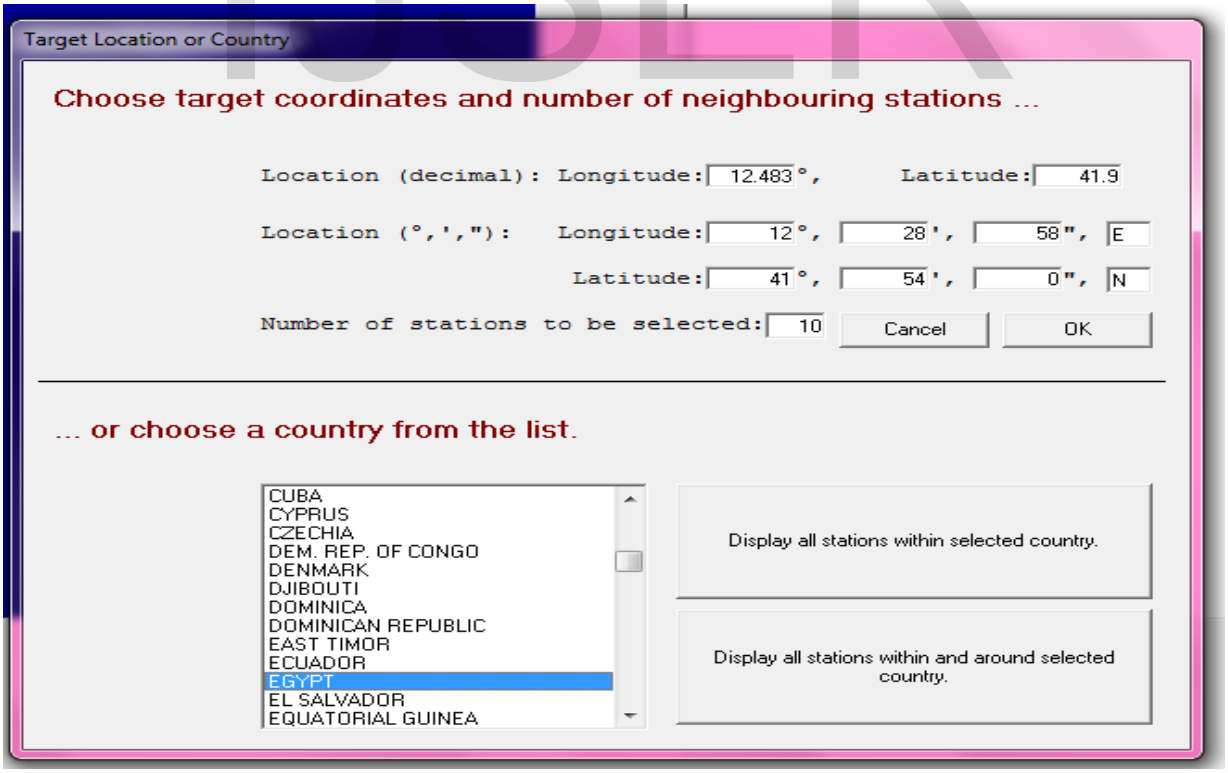


Figure 1 Selection of Egypt as the country location in CLIMWAT 2.0 for CROPWAT

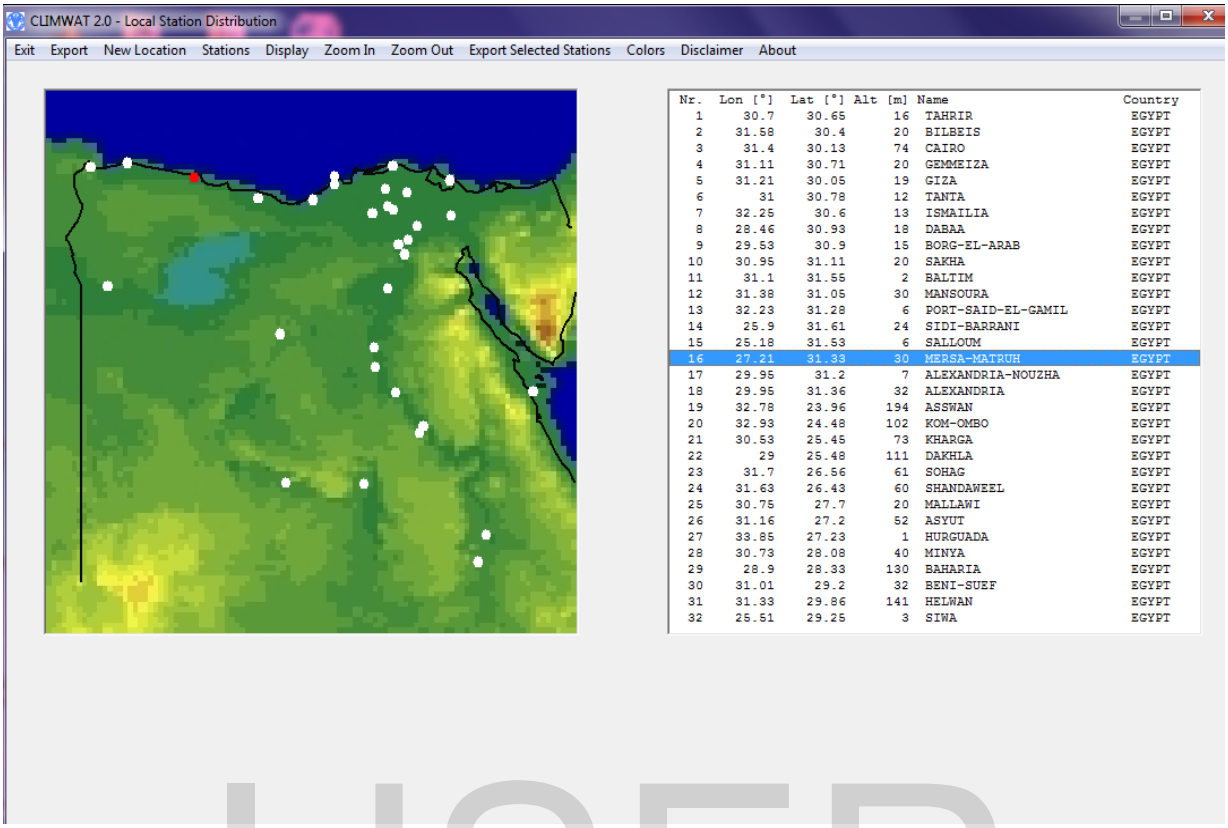


Figure 2 Selection of Marsa Matrouh as the defined area for the paper in CLIMWAT 2.0 for CROPWAT

By selecting the location (also known as station in the CROPWAT 8.0), a complete file with all required data was made to be used by the CROPWAT 8.0. As seen in the figure above, a red spot means the location of the Marsa Matrouh as it was selected from the list to the right. Marsa Matrouh is a harbor on North Coast of Egypt and the capital of Matrouh Governorate. Marsa Matrouh is about 240 km from Alexandria in the west, and 222 km from the Salloum area on the main highway from the Nile. Delta to the Libyan Border and 534 km to the north and west from Cairo. This lovely city is famous for tourism .It rises 30 m above the sea level, it is known for its lagoons and white-sand beaches. It is located on a large bay, it has the resort stretching along the shore. Main activities of the population (counted 108000 people in 2005, including around 40% of the total population of Matrouh Governorate) are trade, sheep and camels grazing as well as agriculture & cultivation of crops. The people of Marsa Matrouh are Bedouins (the most common ethnic in Matrouh Governorate), Egyptian, and Egyptian-Libyans ethnics

2.1 Initializing and Reviewing Climate /ETo Data

The Reference Evapotranspiration (ETo) illustrates the potential evaporation of a good irrigation herb crop. The water requirements of other crops are directly related to this climatic parameter. Although there are several methods for determining ETo, the Penman-Monteith methodhas been

recommended as the method of suitable combination to calculat ETo from climatic data on:

- Temperature
- Humidity
- Sunshine
- Wind speed are shown in Table 1

2.2 Initializing and Reviewing Rainfall Data

Average monthly rainfall: The computed mean of a series of precipitation records to be used in computing CWR is to represent average climatic conditions as shown below (Table 2). The design of the irrigation system capacity uses the dependable rainfall (80%).

Effective rainfall: It is the part of the rainfall used from the cultivated crop effectively after precipitation losses due to runoff which is taken into account when calculating the irrigation requirements of the crops.

Although the amount of rainfall average in Marsa Matrouh is estimated to be approximately 120 mm annually (values varies in different references from 100 mm per annum to around 150 mm per annum), and regarded to be among the highest in Egypt, but it is still regarded to be less than the international average by approximately 55% (the international averages start from 250 mm per annum). The phenomenon of varying rainfall is one of the main obstacles experienced by arid and semi-arid areas because of its bad effects on rain-fed agriculture. As the region lies in the semi-arid climate zone, agriculture depends on rainwater and groundwater, so winter is the most important planting season.

Taple 1. Receiving & Reviewing CLimate / ETo data of Marsa Matrouh in CROPWAT 8.0

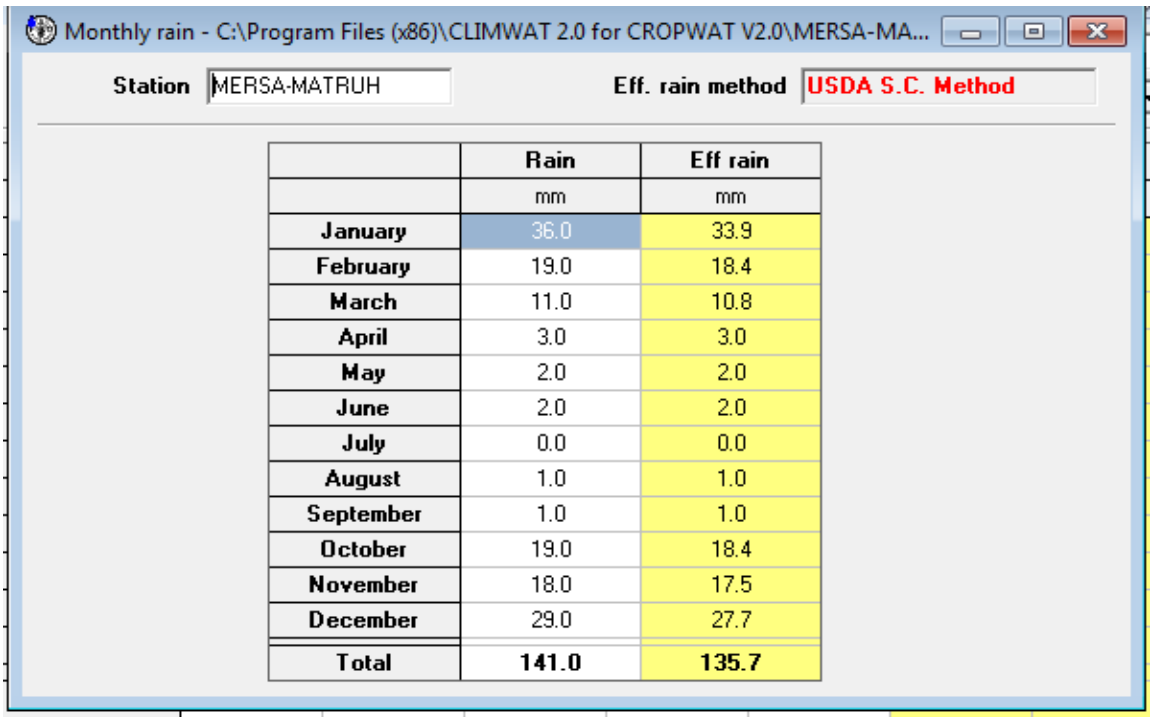
Monthly ETo Penman-Monteith - C:\Program Files (x86)\CLIMWAT 2.0 for CROPWAT V2.0\ME...

Country: Location 16 Station: MERSA-MATRUH

Altitude: 30 m. Latitude: 31.33 °N Longitude: 27.21 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	m/s	hours	MJ/m²/day	mm/day
January	8.7	17.7	84	5.2	4.6	9.7	1.83
February	8.9	18.5	82	5.3	6.0	13.1	2.27
March	10.4	19.6	85	5.2	7.4	17.5	2.64
April	12.5	22.9	84	5.3	8.7	21.6	3.52
May	15.1	25.3	84	4.5	9.3	23.8	4.11
June	18.6	28.1	86	4.6	9.7	24.6	4.51
July	20.7	28.6	91	4.4	10.0	24.8	4.34
August	21.2	29.5	89	4.0	9.5	23.1	4.37
September	19.9	28.5	90	4.0	8.1	19.1	3.56
October	17.2	26.5	92	3.9	6.2	14.0	2.52
November	13.5	22.8	98	4.1	4.5	10.0	1.39
December	10.4	19.3	93	5.0	5.1	9.7	1.37
Average	14.8	23.9	88	4.6	7.4	17.6	3.04

Taple 2. Rain amount in Marsa Matrouh (CROPWAT 8.0)



	Rain	Eff rain
	mm	mm
January	36.0	33.9
February	19.0	18.4
March	11.0	10.8
April	3.0	3.0
May	2.0	2.0
June	2.0	2.0
July	0.0	0.0
August	1.0	1.0
September	1.0	1.0
October	19.0	18.4
November	18.0	17.5
December	29.0	27.7
Total	**141.0**	**135.7**

2.3 Initializing and Reviewing Chosen Crops Data

Agriculture and produced corps rely on the region and on the method of irrigation used (totally rainfed agriculture, partially/ assisted irrigation, or totally permanent irrigation). The main crops include: olive, fig, grape, almond, water melon, wheat, melt, palm trees, and others. Some land reclamation initiatives and projects have been initiated in the region. Baseline data is gathered from the field through interviews with extension agents, farmers, and additional information from other agencies, as shown in the article.

Through “Open” command in the menu bar in CROPWAT 8.0, we can choose the subject crops. When Clicking the Crop button, CROPWAT 8.0 shows the related data of the crop as seen below (from figure 3 to figure 5), where the sweet pepper crop is displayed:

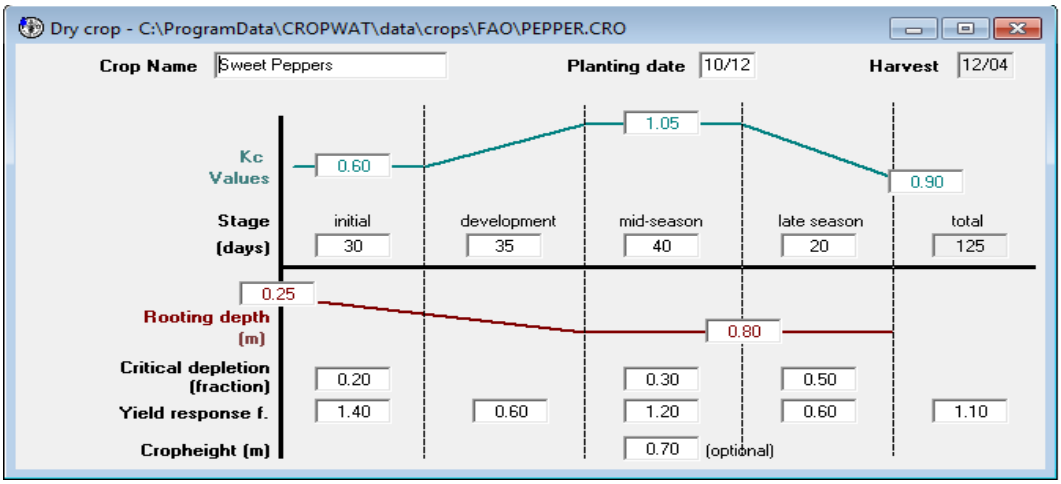


Figure 3 Sweet pepper crop data (CROPWAT 8.0)

In figure 4 below, the potato crop window is displayed:

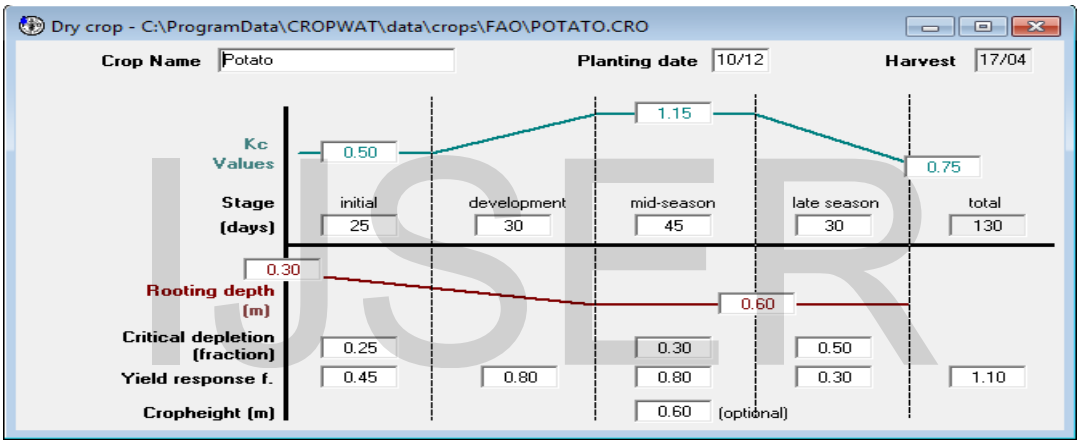


Figure 4 Potato crop data (CROPWAT 8.0)

And, below in figure 5, the banana crop window is displayed:

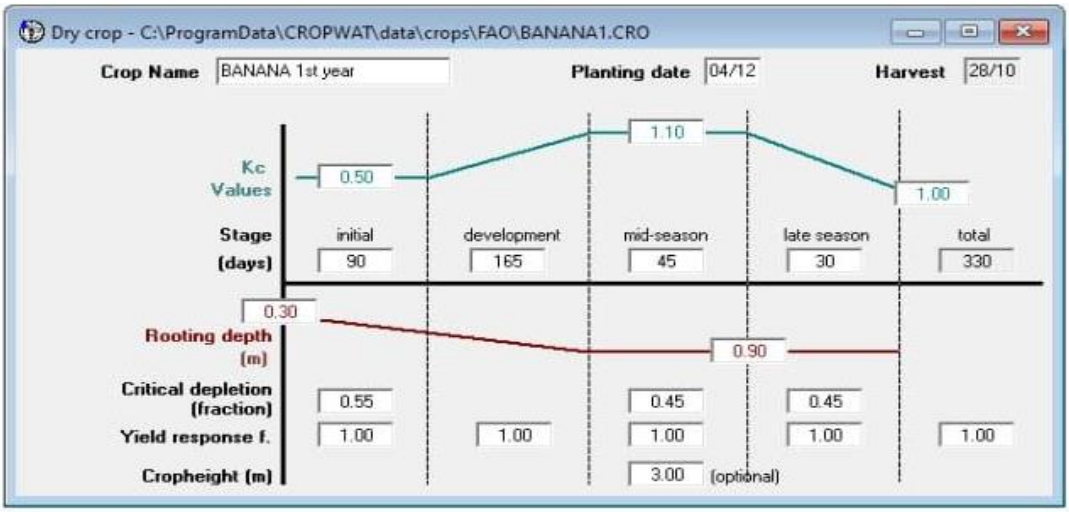


Figure 5 Banana crop data (CROPWAT 8.0)

2.4 Initializing and Reviewing Soil Data

The soil parameters important for irrigation scheduling and required for irrigation scheduling using the FAO CROPWAT program are seen below.

An estimate of the surface runoff for the effective rain calculation will be allowed by maximum rain infiltration rate. This is rain intensity function, soil type and slope class.

Sediments carried by flooding rainfalls form the soil of Marsa Matrouh because Marsa Matrouh is a coastal city. According to the researches have been done in preparing this paper, Marsa Ma-trouh soil is defined as “Red Sandy” soil. The type of the soil was chosen, and the soil table displayed the soil data, as seen in figure 6 below.

2.5 Crop and Cropping Pattern Data Processing

Data and information gathered on planting and harvesting dates for each crop are placed and arranged into a crop pattern, as shown below.

The Crop module requires crop data over the different development stages, follow:

- Initial stage.
- Development stage
- Mid-season stage.
- Late season stage.

The chosen crops patterns then were selected and initialized from the Crop Pattern button, as seen below figure7.

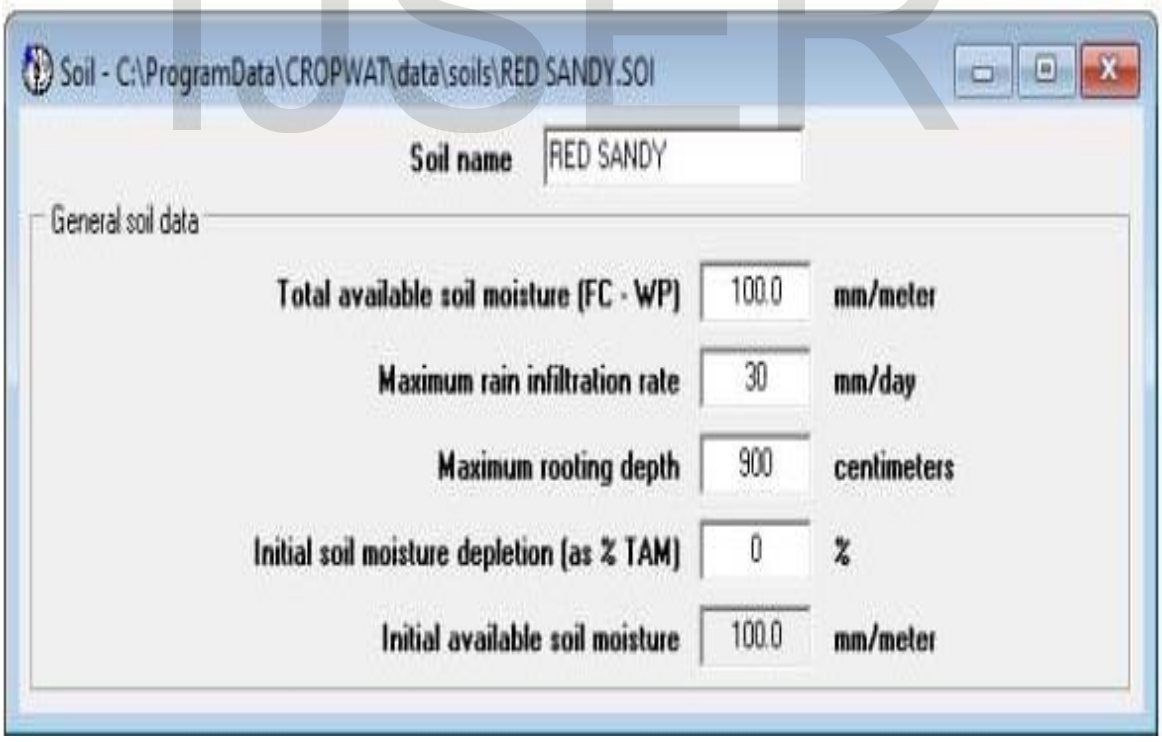


Figure 6 Soil characteristics in Marsa Matrouh (CROPWAT 8.0)

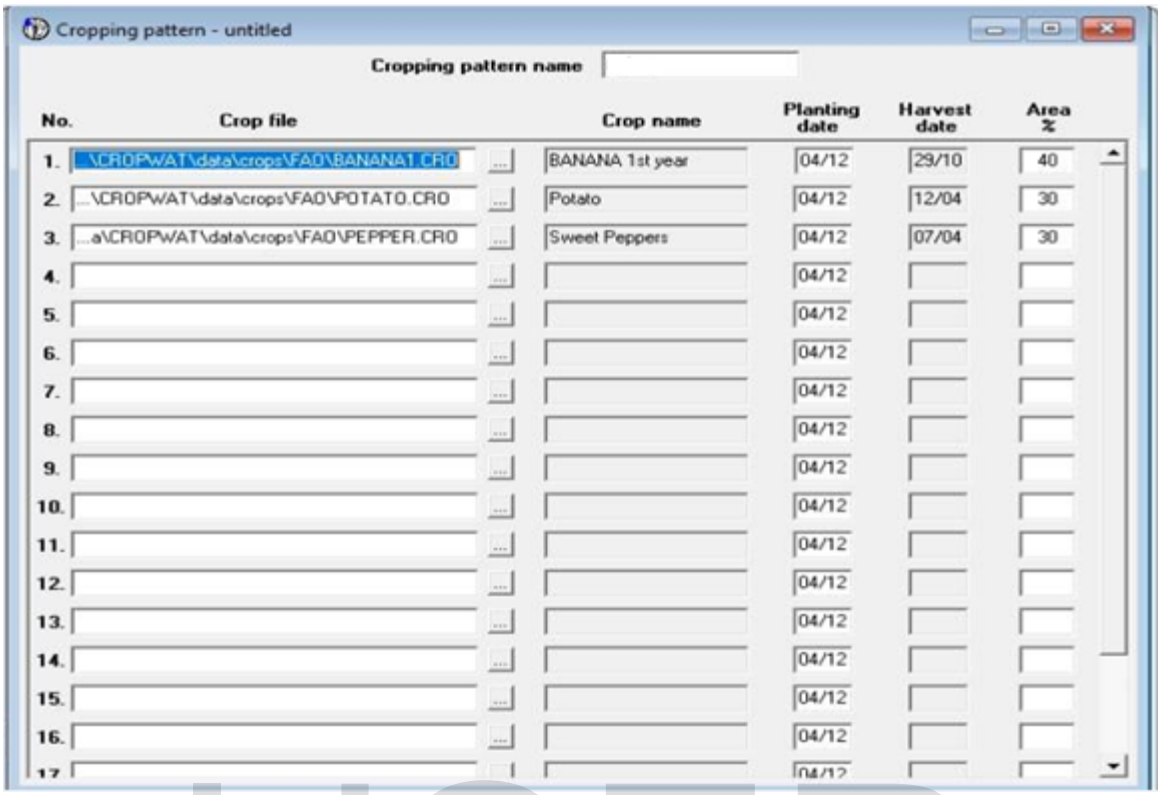


Figure 7 Defining the crops chosen for this paper (CROPWAT 8.0)

3. Results and Discution

3.1 Data Visualization

CROPWAT 8.0 has powerful data visualization engine. Below (figure 8) there are details on the climate and weather in the subject area.Blowing winds from Mediterranean Sea moderate the temperature as the weather of Marsa Matrouh is hot (arid to semi-arid climate), the same as Egypt North Coast, leading to a summer moderately hot and humid while in winters sleet and hail are also common. Marsa Matrouh Summer is sunny ,hot and dry, with highest temperatures recorded in July, August, and September; while in the colder months (December to February), the weather is nice as there is some rain and cloud cover. Thus, Marsa Matrouh (plus to Port Said) has the coolest summer days of any other cities or resorts in Egypt, although not significantly cooler than other northern coastal places, and also it is one of the wettest places in Egypt, where average temperature is 19°C (av. low around 9°C, av. high is 28°C), wind is NW at 11 km/h, and humidity is 72%, average evaporation is 3.4-7.1 mm/day. CORPWAT 8.0 can offer more information about the climate/weather of the subject area. This information would be of great importance to manage and follow up agricultural activities and irrigation management activities. Examples are seen in figures 8 and 9 below:

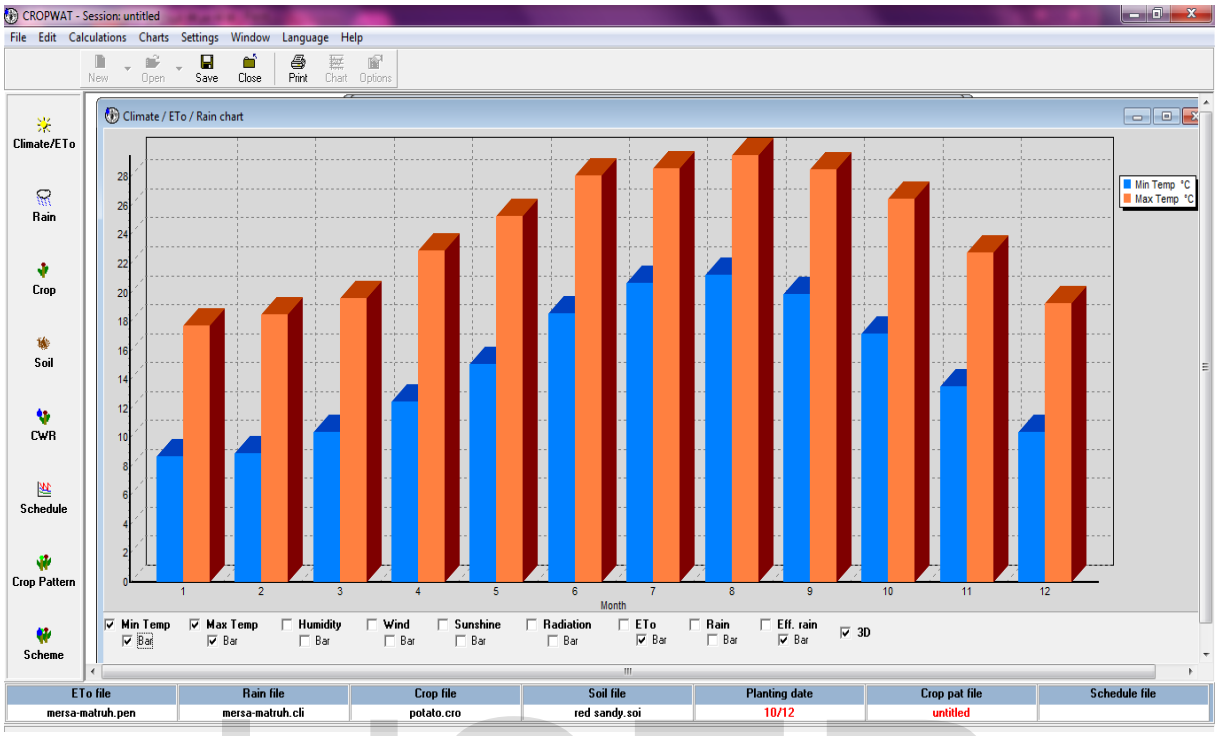


Figure 8Temperature variations in Marsa Matrouh as shown in CROPWAT 8.0

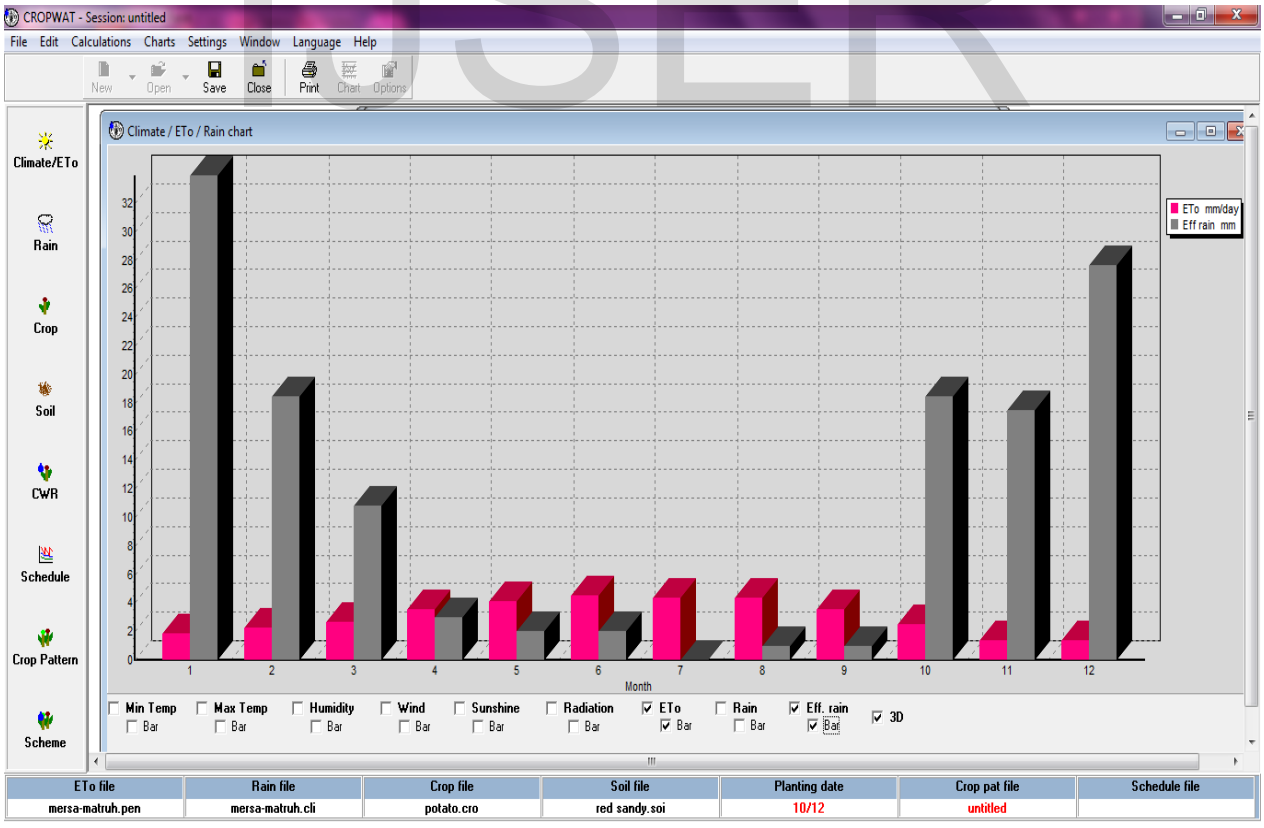


Figure 9 Rain relations with ETo as in Marsa Matrouh as shown in CROPWAT 8.0

As seen in the chart below (figure 10, there is relative high humidity during the year due to the location of the city. It is higher in November when which it may reach 98%, while it is lower in February (around 60%). Low wind speed is observed in general at the average of 5 m/s.

The chart below (figure 11) displays different relations of climate features with the rain and ETo.

Figure 12 below, shows the soil water retention in mm compared with the period of time after plant (in days). As seen in the figure, we can notice the increase of the soil water retention average after plant to get saturation in average of 60 days, after which it stays almost within the same level.

Figure 13 is the visualized chart shows the sun hours average, the radiation average, the total rain & the effective rain, all distributed over the 12 months of the year. A peak in radiation is seen in the summer season, although the slight elevation of sun hours witnesses during the seasons with pouch in late fall & winter.

Figure 14 below, shows the average of wind speed in meters per second monthly. ETo & effective rainfall and sun hours are shown for reference. The figure shows th steady wind speed over the year.

Figure 15 visualizes the humidity average in Marsa Matrouh, which is high as expected as Marsa Matrouh is a coastal city. The humidity average is slightly increased starting from the mid-summer till the end of the year.

The irrigation requirements for the selected crops are visualized over the months in figure 16.

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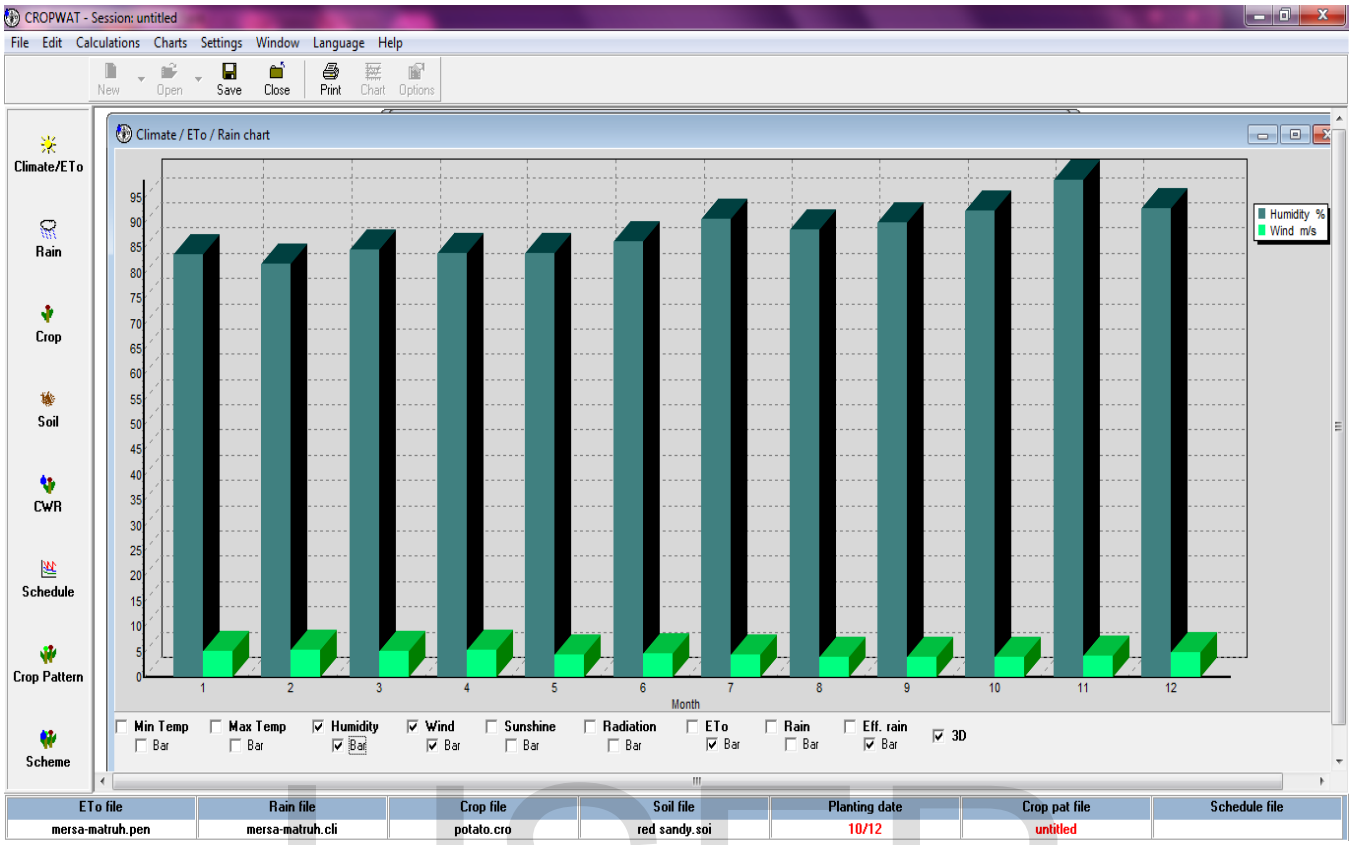


Figure 10 Relation between wind speed and humidity among the months of the year in Marsa Matrouh as shown in CROPWAT 8.0

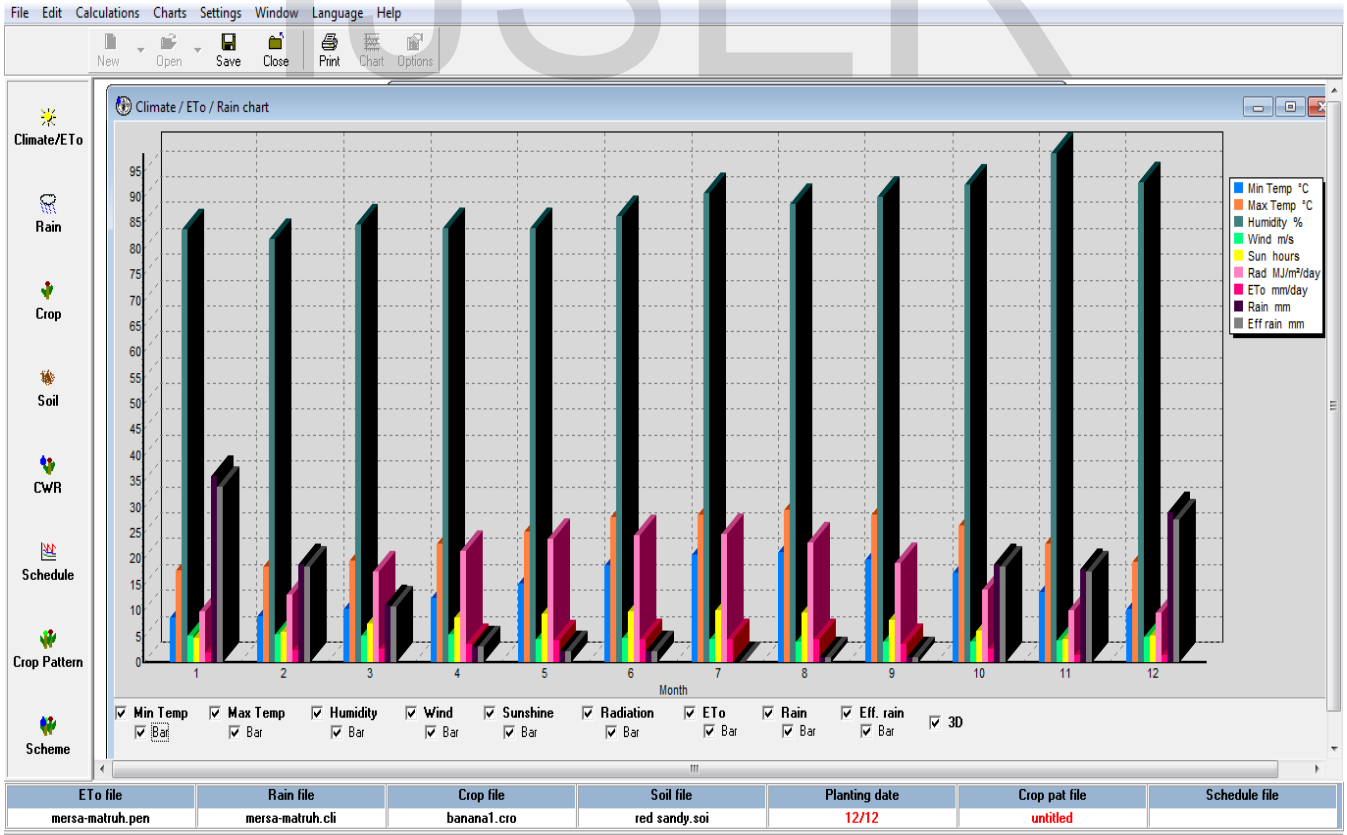


Figure 11Different climate features in Marsa Matrouh shown in CROPWAT 8.0

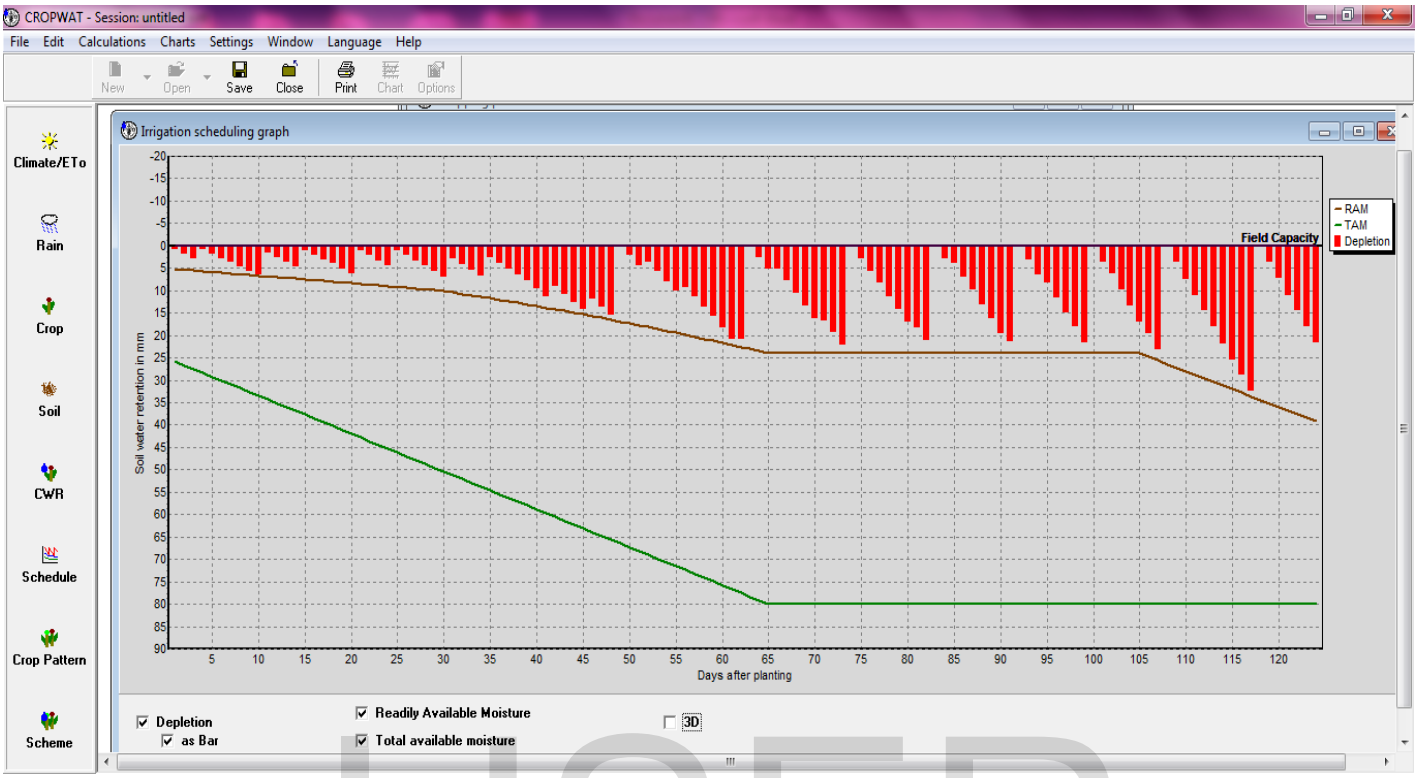


Figure 12 Soil Water Retention (in mm) vs. time (in days), in Marsa Matrouh as visualized by CROPWAT 8.0

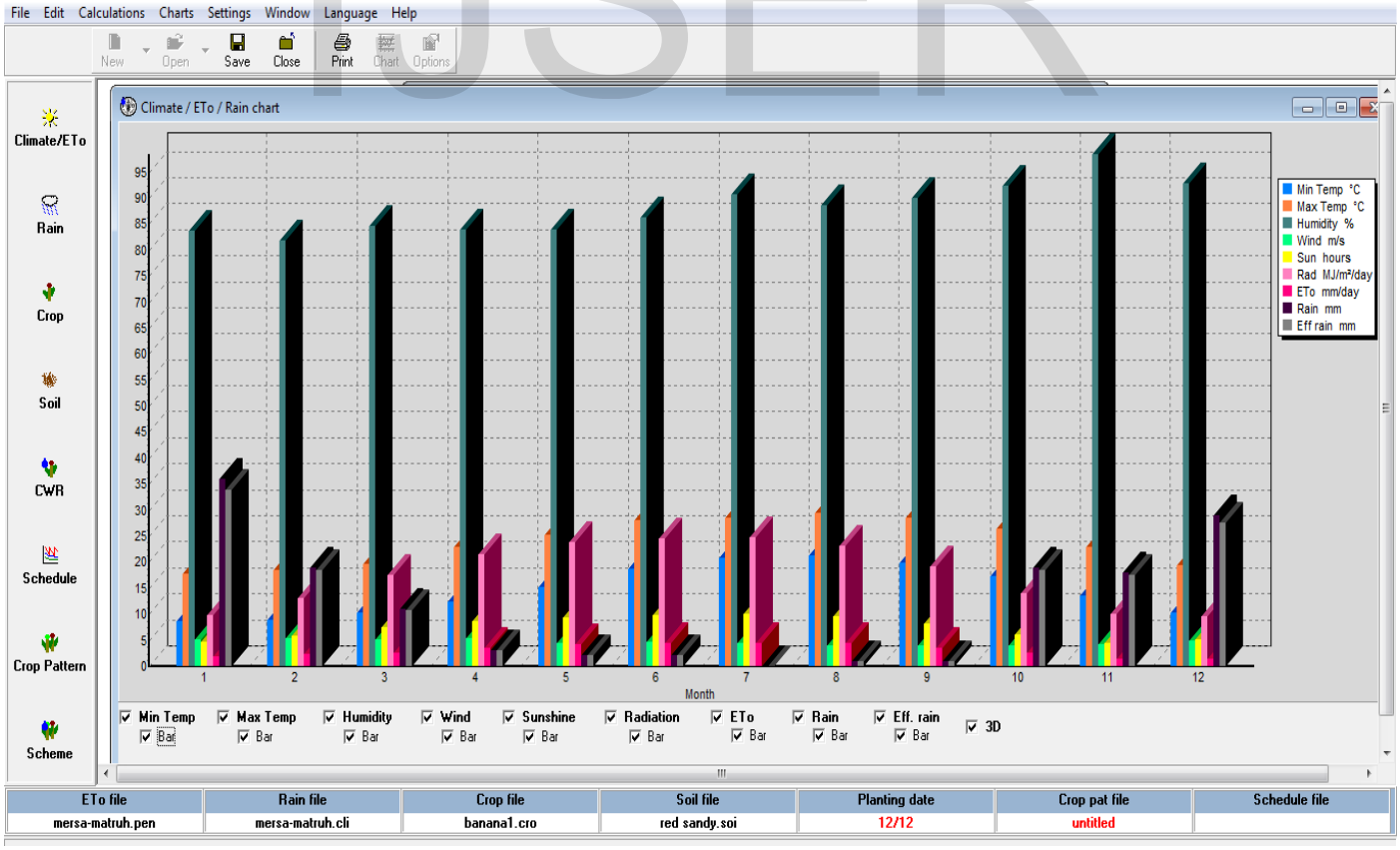


Figure 13 Different climate features in Marsa Matrouh shown in CROPWAT 8.0

Figure 14 Sun hours & average radiation over the seasons in Marsa Matrouh

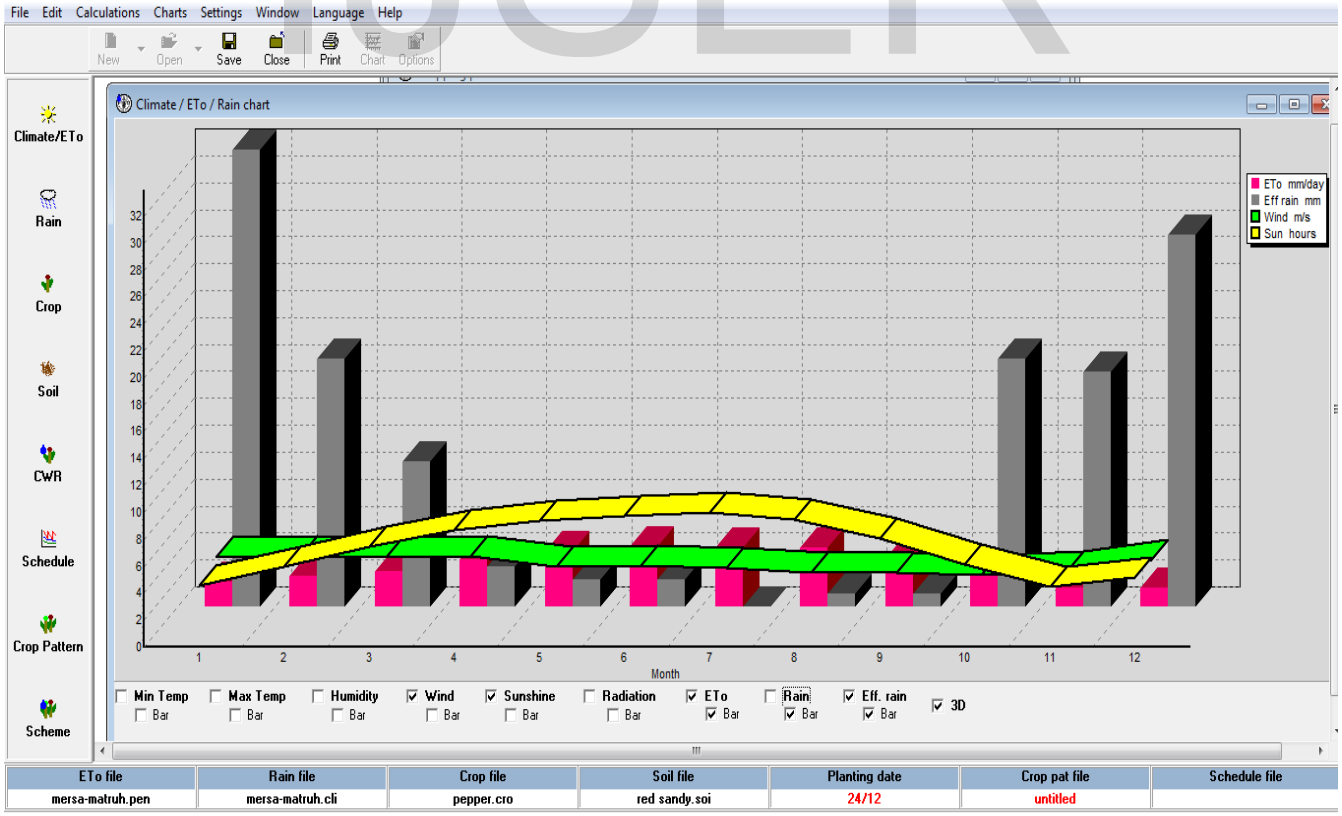


Figure 15 Wind speed in m/s average over the year in Marsa Matrouh as visualized by CROPWAT 8.0

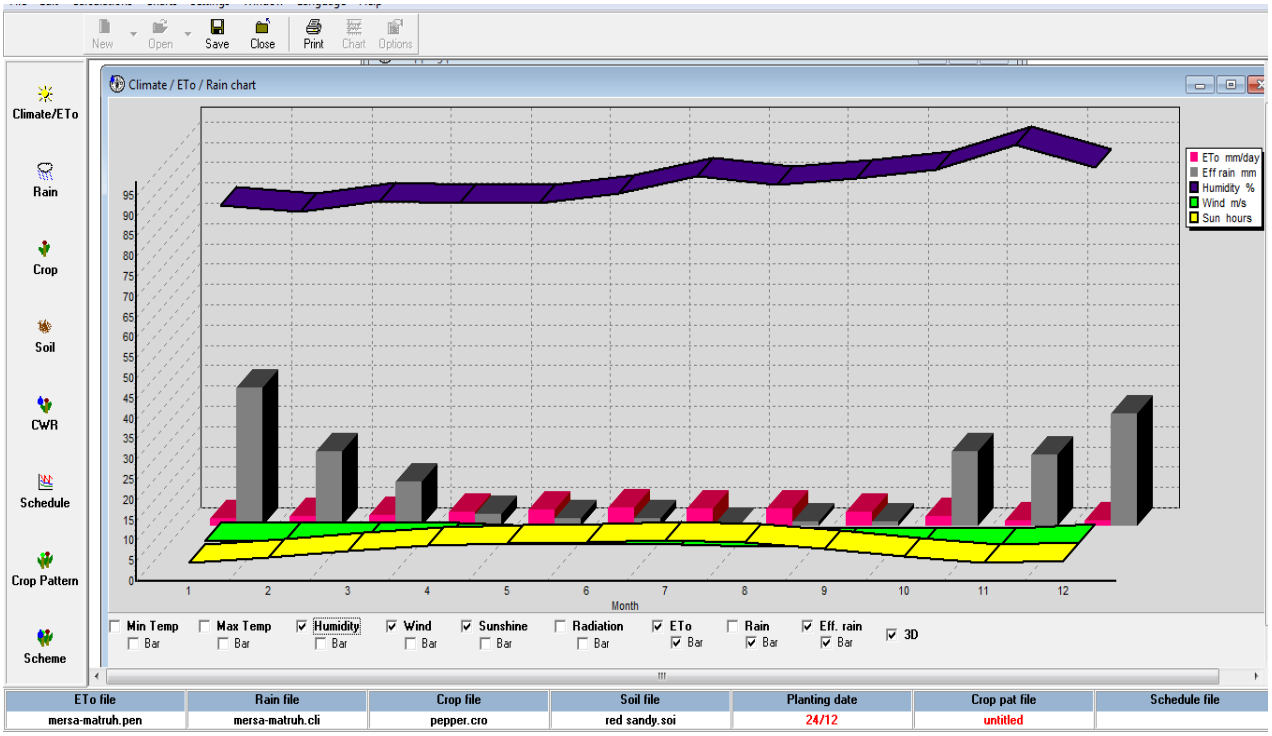


Figure 16Humidity average as visualized in CROPWAT 8.0 for Marsa Matrouh. Other indicators are also displayed for reference.

Figure 17The irrigation requirements for the selected crops in Marsa Matrouh as visualized in CROPWAT 8.0

The program is ready now for providing the main results/outputs as described next , after initializing and revision to all data, and applying any required modifications or fine-tuning,

3.2 Crop Water Requirements

The water requirements for each crops selected, which is one of the most main outputs of CROPWAT 8.0, is seen in detailed tables for each crop as shown below (figure 17 & figure 18):

3.3 Scheduling

Scheduling shows the proposed crop irrigation schedule that CROPWAT 8.0 presents based on the data fed to the program, and the expertise built in the system. The figure 19 below shows the schedule proposed by CORPWAT 8.0:

3.4 Scheme.

Scheme Supply shows the details and values should be regarded for irrigation the crops, as seen in figure 20 and figure 20 below:

Rapid analysis of the results can clearly explain that the results are very much matching the values and recommendations for the crop water requirement provided by the human expertise.

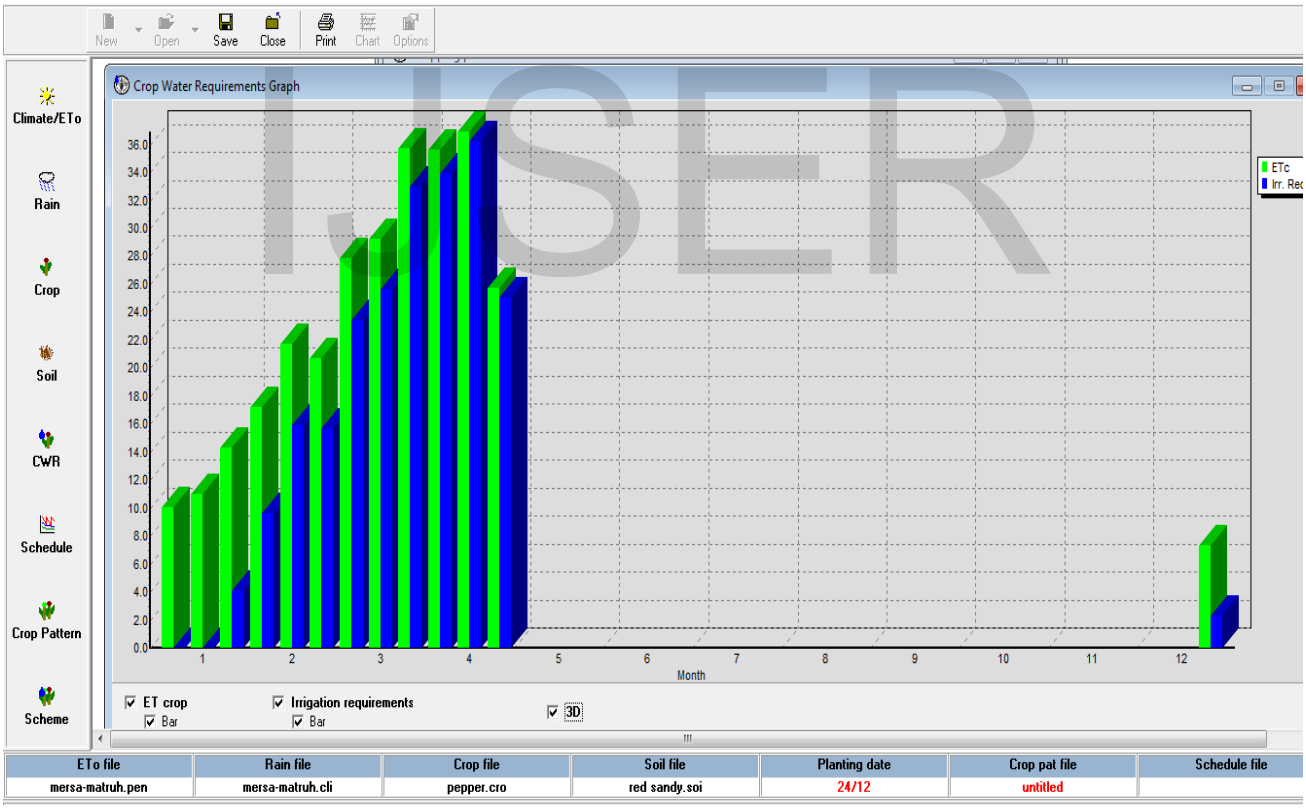
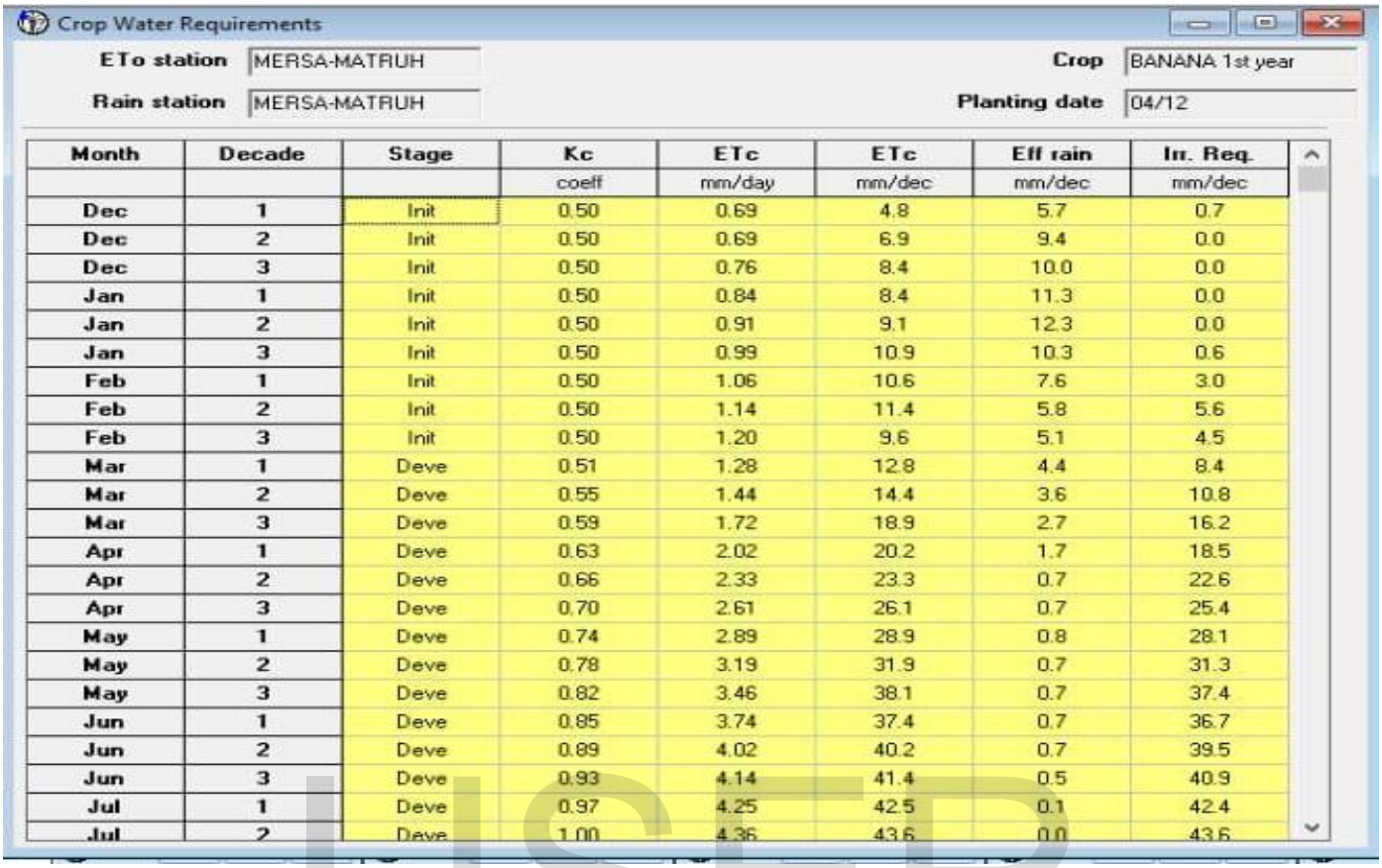


Figure 17The irrigation requirements for the selected crops in Marsa Matrouh as visualized in CROPWAT 8.0



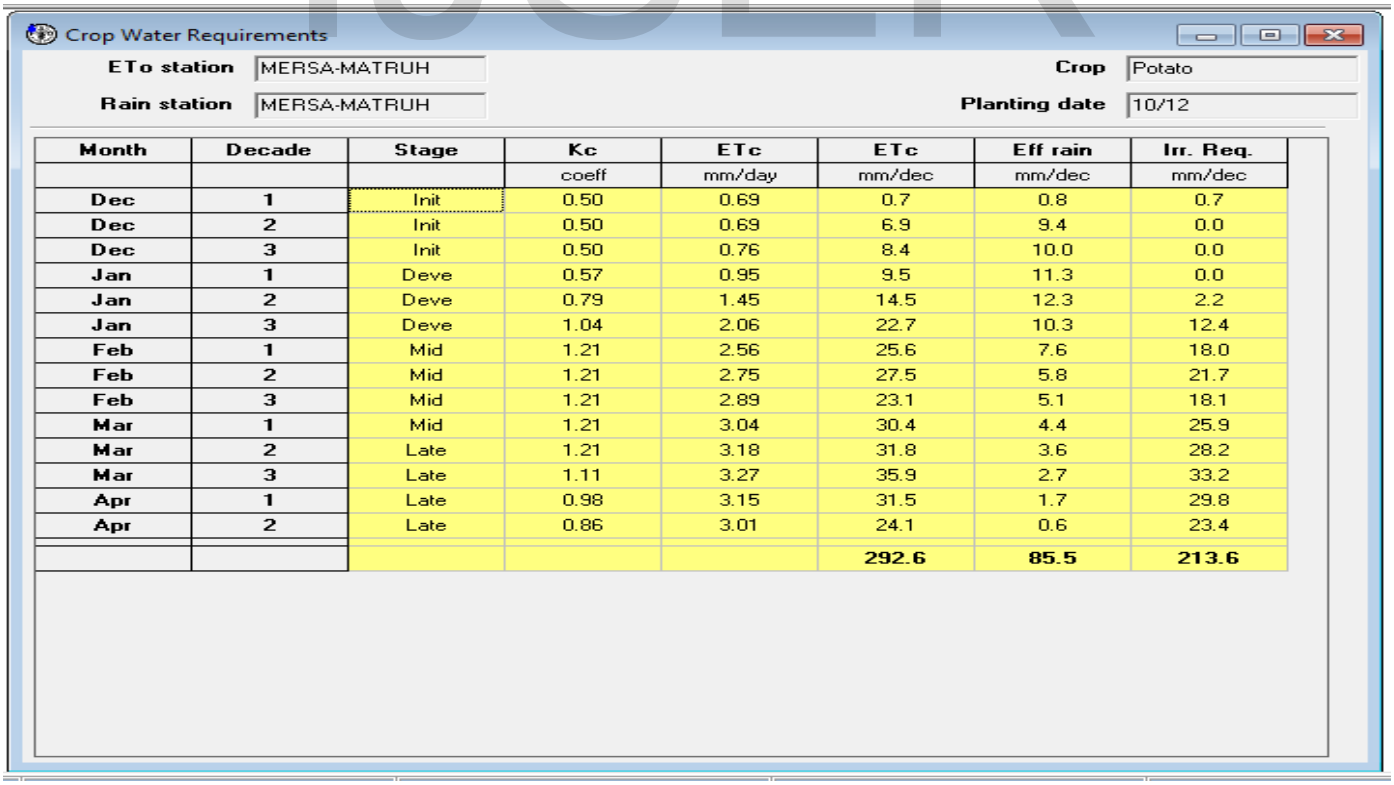
Crop Water Requirements

ETo station: MERSA-MATRUH | Crop: BANANA 1st year

Rain station: MERSA-MATRUH | Planting date: 04/12

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Dec	1	Init	0.50	0.69	4.8	5.7	0.7
Dec	2	Init	0.50	0.69	6.9	9.4	0.0
Dec	3	Init	0.50	0.76	8.4	10.0	0.0
Jan	1	Init	0.50	0.84	8.4	11.3	0.0
Jan	2	Init	0.50	0.91	9.1	12.3	0.0
Jan	3	Init	0.50	0.99	10.9	10.3	0.6
Feb	1	Init	0.50	1.06	10.6	7.6	3.0
Feb	2	Init	0.50	1.14	11.4	5.8	5.6
Feb	3	Init	0.50	1.20	9.6	5.1	4.5
Mar	1	Deve	0.51	1.28	12.8	4.4	8.4
Mar	2	Deve	0.55	1.44	14.4	3.6	10.8
Mar	3	Deve	0.59	1.72	18.9	2.7	16.2
Apr	1	Deve	0.63	2.02	20.2	1.7	18.5
Apr	2	Deve	0.66	2.33	23.3	0.7	22.6
Apr	3	Deve	0.70	2.61	26.1	0.7	25.4
May	1	Deve	0.74	2.89	28.9	0.8	28.1
May	2	Deve	0.78	3.19	31.9	0.7	31.3
May	3	Deve	0.82	3.46	38.1	0.7	37.4
Jun	1	Deve	0.85	3.74	37.4	0.7	36.7
Jun	2	Deve	0.89	4.02	40.2	0.7	39.5
Jun	3	Deve	0.93	4.14	41.4	0.5	40.9
Jul	1	Deve	0.97	4.25	42.5	0.1	42.4
Jul	2	Deve	1.00	4.36	43.6	0.0	43.6

Figure 18 Water requirements for banana crop as indicated by CROPWAT 8.0



Crop Water Requirements

ETo station: MERSA-MATRUH | Crop: Potato

Rain station: MERSA-MATRUH | Planting date: 10/12

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Dec	1	Init	0.50	0.69	0.7	0.8	0.7
Dec	2	Init	0.50	0.69	6.9	9.4	0.0
Dec	3	Init	0.50	0.76	8.4	10.0	0.0
Jan	1	Deve	0.57	0.95	9.5	11.3	0.0
Jan	2	Deve	0.79	1.45	14.5	12.3	2.2
Jan	3	Deve	1.04	2.06	22.7	10.3	12.4
Feb	1	Mid	1.21	2.56	25.6	7.6	18.0
Feb	2	Mid	1.21	2.75	27.5	5.8	21.7
Feb	3	Mid	1.21	2.89	23.1	5.1	18.1
Mar	1	Mid	1.21	3.04	30.4	4.4	25.9
Mar	2	Late	1.21	3.18	31.8	3.6	28.2
Mar	3	Late	1.11	3.27	35.9	2.7	33.2
Apr	1	Late	0.98	3.15	31.5	1.7	29.8
Apr	2	Late	0.86	3.01	24.1	0.6	23.4
					292.6	**85.5**	**213.6**

Figure 19 Water requirements for potato crop as indicated by CROPWAT 8.0

Crop irrigation schedule

ETo station: MERSA-MATRUH | Crop: Potato | Planting date: 10/12 | Yield red.: 0.0 %
Rain station: MERSA-MATRUH | Soil: RED SANDY | Harvest date: 17/04

Table format: Irrigation schedule / Daily soil moisture balance

Timing: Irrigate at critical depletion
Application: Refill soil to field capacity
Field eff. 70 %

Date	Day	Stage	Rain	Ks	Eta	Depl	Net Irr	Deficit	Loss	Gr. Irr	Flow
			mm	fract.	%	%	mm	mm	mm	mm	l/s/ha
31 Jan	53	Dev	0.0	1.00	100	30	17.6	0.0	0.0	25.2	0.06
11 Feb	64	Mid	0.0	1.00	100	34	20.4	0.0	0.0	29.2	0.31
20 Feb	73	Mid	0.0	1.00	100	32	19.0	0.0	0.0	27.2	0.35
29 Feb	82	Mid	0.0	1.00	100	35	21.0	0.0	0.0	30.0	0.39
8 Mar	90	Mid	0.0	1.00	100	33	19.8	0.0	0.0	28.2	0.41
15 Mar	97	Mid	0.0	1.00	100	34	20.3	0.0	0.0	29.0	0.48
22 Mar	104	End	0.0	1.00	100	34	20.7	0.0	0.0	29.6	0.49

Actual water use by crop	289.6	mm	Moist deficit at harvest	23.5	mm
Potential water use by crop	289.6	mm	Actual irrigation requirement	213.7	mm
Efficiency irrigation schedule	100.0	%	Efficiency rain	85.5	%
Deficiency irrigation schedule	0.0	%			

Yield reductions

Stagelabel	A	B	C	D	Season	
Reductions in ETc	0.0	0.0	0.0	0.0	0.0	%
Yield response factor	0.45	0.80	0.80	0.30	1.10	
Yield reduction	0.0	0.0	0.0	0.0		%

Figure 20 Scheduling details for potato crop as indicated by CROPWAT 8.0

CROPWAT - Session: untitled

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Climate/ETo | Rain | Crop | Soil | CWR | Schedule | Crop Pattern | Scheme

Scheme Supply

ETo station: MERSA-MATRUH
Rain station: MERSA-MATRUH
Cropping pattern: fatima

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. BANANA 1st year	0.6	13.1	35.4	66.5	96.8	117.1	136.0	145.6	117.5	60.1	0.0	0.7
2. Potato	20.3	57.8	83.8	32.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
3. Sweet Peppers	12.7	51.2	80.2	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Net scheme irr.req.												
in mm/day	0.3	1.4	2.0	1.4	1.2	1.6	1.8	1.9	1.6	0.8	0.0	0.0
in mm/month	10.1	37.9	63.4	42.6	38.7	46.9	54.4	58.3	47.0	24.0	0.0	1.0
in l/s/h	0.04	0.16	0.24	0.16	0.14	0.18	0.20	0.22	0.18	0.09	0.00	0.00
Irrigated area	100.0	100.0	100.0	100.0	40.0	40.0	40.0	40.0	40.0	40.0	0.0	100.0
(% of total area)												
Irr.req. for actual area	0.04	0.16	0.24	0.16	0.36	0.45	0.51	0.54	0.45	0.22	0.00	0.00
(l/s/h)												

ETo file	Rain file	Crop file	Soil file	Planting date	Crop pat file	Schedule file
mersa-matruh.pen	mersa-matruh.cli	banana1.cro	red sandy.soi	04/12	untitled	

Figure 21Proposed scheme for the three selected crops as indicated by CROPWAT 8.0

Conclusion and Recommendations

1. A review analysis comparing the values & guiding resulted from CROPWAT 8.0 with those obtained and prepared without software assistance would confirm that the results generated by CROPWAT 8.0 are matching the recommendations and guidance provided by the human expertise. This conclusion is logic as CROPWAT 8.0 and CLIMWAT 2.0 are just applications based on and designed by human expertise and knowledge.
2. Another point is confirmed is the friendly environment and the simple structure of these programs. This simplicity is required as the programs are not designed only for the specialized or expert skilled literate people; but also to the public including the farmers in the developing countries who are among the poorest population, and are not expected to have high level of education in the most of the time.
3. CROPWAT 8.0 for WINDOWS and CLIMWAT 2.0 for CROPWAT are two useful programs to manage agricultura and irrigation management, made by Food and Agriculture Organization of United Nations (FAO).
4. It has been noticed that these programs have been accurate in reaching to the values, recommendations, and guidance regarding producing the selected crops. The simplicity, easy to use, and user friendly environment all have been clearly noticed too.
5. Using CROPWAT 8.0 and CLIMWAT 2.0 is highly recommended to estimate the water requirements and provide general guidance and instructions on scientific basis on how to manage agricultural and irrigation activities to increase the productivity, while maintaining the resources for the individuals and for the communities. This recommendation is valid as these two programs are widely used and respected in the world, sponsored by a respected specialized international non-for profit organization (FAO), easy to learn, simple to use in a friendly environment, accurate, fast, can enhance productivity and save resources, and are free of charge.
6. Regional & local authorities are encouraged to spread & motivate using these programs among the targeted populations, with focus on the farmers. Special training courses should be conducted, and efforts should be made to make required hardware and software available for the poorest people to get the benefits of such systems. Partnerships with NGOs and Social Corporate Responsibilities from international and local origins should be established for that purposes.
7. It is recommended also to make these applications available in Arabic, as they are already available in English, French, Russian, and Spanish.
8. These two programs help extension agents and farmers to assess the risks in their farms.

9. Cropwat is very useful for extension agents and farmers, so agricultural advisory services must be trained to use the program.
10. Knowing when to plant crops is very important in agriculture, because this enables officials to improve the use of water resulting from rainfall/ precipitation.
11. Priority should be given to crops that are easily adapted to local climatic conditions, because this is more resistant to water poverty, damage and disease.

References

1. Andrea Shundi. 2006. Country Pasture/Forage Resource Profiles. FAO.
2. Adriana, M.; and V. Cuculeanu (2000). Use of a decision support system for drought impact assessment and Agricultural mitigation options in Romania. Proceedings of the Central and Eastern European Workshop on Drought Mitigation, 12-15 April, Budapest-Felsogod, Hungary. P259-266.
3. Allen, R.G.; L.S. Pereira; D. Raes; and M. Smith (1998). Crop evapotranspiration, guidelines for computing crop water requirements.FAO Irrigation And Drainage Paper No. 56. Roma, Italy. Bryant, K.J.; V.W. Benson; J.R. Kiniry; J.R.
4. Bryant, K.J.; V.W. Benson; J.R. Kiniry; J.R. Williams; and R.D. Lacewell (1992). Simulating corn yield response to irrigation timings: Validation of the EPIC model. J. Prod. Agric., 5: 237-242.
5. Cuenca, R.H. (2004). Irrigation system design - an engineering approach. Arabic Version, A. Alazba (editor), Press of King Saud University, Riyadh, Saudi Arabia. 622 p.
6. Diku, Abdulla – "Use of CROPWAT 8.0 Program for Assessment of Water Demand of Some Agricultural Crops in Albania" – International Journal of Sciences – September 2015.
7. Diku A. 2014. Report on Vulnerability Assesment for the Agriculture and forestry sector under Third National Communication to UNFCCC.
8. Diku A. 2013: "Identification and implementation of adaptation response measures to Drini – Mati River Deltas", supported by the UNDP Climate Change Program in Albania..
9. Dirja, M.; V. Budiu; I. Pacurar; and M. Jurian (2003). Research regarding the water consumption of tomatoes, greenpepper and cucumbers cultivated in solariums. Journal of Central European Agriculture. l 4(3):266-272.
10. FAO 2012. Irrigation and Drainage paper - Crop yield response to water.
11. G. Sethuraman, Srinivasa Naidu. 2008. International Encyclopaedia of Agricultural Science and Technology. 5 Irrigation management. P.175.
12. Gatta, G.; M.M. Giuliani; M. Monteleone; E. Nardella; and A. De Caro (2006). Deficit irrigation

scheduling in Processing Tomato. Riv. Agron., 14(4): 277-289.

13. Hyndman, R.; J. Koehler Anne; and B. Koehler (2006). Another look at measures of forecast accuracy. International Journal of Forecasting. 22 (4): 679–688.
14. IWRM (2004). IWMI estimating water requirements guidelines in Arab region. IWMI International Water Management Institute. Working Paper 184.
15. Le Houerou 1993; Decker et al., 1986; Pollak and Corbett 1993; Ellis et al., 1992; Long et al., 1983 Agriculture in a Changing Climate: Impacts and Adaptation.
16. Martin Smith, Pasquale Steduto.Yield response to water: The original FAO water production function.
17. Ministry of Agriculture, Food and Consumer's Protection. 2010. Statistical yearbook.
18. Marsa Matrouh – Wikipedia, the International Encyclopedia – www.wikipedia.org
19. Nazeer, M. (2011). Simulation of maize crop under irrigated and rainfed conditions with CropWat model. ARPN Journal of Agric. and Biol. Sci., 4:68-73.
20. Third National Communication of Albania to the United Nations Framework Convention on Climate Change.
21. Williams; and R.D. Lacewell (1992). Simulating corn yield response to irrigation timings: Validation of the EPIC model. J. Prod. Agric., 5: 237242.
22. Willmott, C. J. (1982). Some comments on the evaluation of model performance. Bull A. Meteorol. Soc., 63: 1309-1313.