Irrigation scheduling strategies for pepper based on evaporation and reference evapotranspiration

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A B S T R A C T

The experiment with drip irrigated pepper was conducted at the Rimski Šančevi experimental field of the Institute of Field and Vegetable Crops in Novi Sad in 2019. The irrigation was scheduled on the basis of the water balance method. Two methods were used to compute the daily evapotranspiration of pepper (ET_d): reference evapotranspiration (ET_o) and evaporation from an open water surface (E_o). Crop coefficients (k_c) and corrective coefficients (k) were used to convert ET_o and E_o values into ET_d. K_c and k were 0.3–0.4, 0.6–0.7, 0.9–1.1, 0.8–0.9 and 0.4, 0.7, 1.0 and 0.8 for initial stage, crop development, mid season, and late season, respectively. ET_o was calculated by the Hargreaves equation. E_o values were measured by a Class-A pan located at a meteorological station near the experimental plot. Irrigation started when readily available water (RAW) in the 0.3 m soil layer was completely absorbed by plants. Differences in crop yield (Y) and irrigation water use efficiency (IWUE) obtained using E_o (42.58 t ha^{-1}, 15.20 kg m^{-3}) and ET_o (40.78 t ha^{-1}, 14.56 kg m^{-3}) were not statistically different. Evapotranspiration rate was 364.2 mm and 337.3 mm in E_o and ET_o variant, respectively. The fact that the differences in Y and IWUE between different calculations of ET_d were not statistically significant indicates that both methods can be recommended for irrigation scheduling programs for pepper in the climatic conditions of the Vojvodina region. However, priority should be given to ET_o due to the easy accessibility and reliability of data.

Keywords: pepper, irrigation, yield, water productivity, evapotranspiration.

И З В О Д

Наводњавање паприке системом кап по кап обављено је у Институту за ратарство и повртарство на огледном пољу Римски Шанчеви (Нови Сад) 2019. године. Време заливања је одређивано водним билансом. Две методе су коришћене за обрачун дневног утрошка воде на евапотранспирацију паприке (ET_d): референтна евапотранспирација (ET_o) и евапорација са слободне водене површине (E_o). Коефицијенти културе (k_c) и коефицијенти корекције (k) коришћени су за претварање ET_o и E_o вредности у ET_d. Вредности k_c и k биле су 0,3–0,4; 0,6–0,7; 0,9–1,1; 0,8–0,9 односно 0,4; 0,7; 1,0 и 0,8 за почетак вегетације, интензивни пораст, централни део вегетације и крај вегетације. ET_o је рачуната поступком Харгривса (Hargreaves). E_o вредности су мерене евапориметром класе А, постављеним на метеоролошкој станици у непосредној близини огледне парцеле. Наводњавање је обављано када је лакоприступачна вода у слоју земљишта до 30 cm била утрошена од стране биљака. Разлике у приносу (Y) и продуктивности утрошене воде наводњавањем (IWUE) коришћењем E_o (42,58 t ha^{-1}, 15,20 kg m^{-3}) и ET_o (40,78 t ha^{-1}, 14,56 kg m^{-3}) нису биле статистички значајне. Вредности евапотранспирације у периоду вегетације паприке биле су 364,2 mm односно 337,3 mm на варијантама обрачуна E_o и ET_o. Чињеница да нису утврђене статистички значајне разлике у вредностима Y и IWUE указује да се обе методе могу користити у обрачуну ET_d у реализацији рационалног заливног режима паприке у климатским условима Војводине. Међутим, предност због доступности података ипак треба дати поступку ET_o.

Кључне речи: паприка, наводњавање, принос, продуктивност утрошене воде, евапотранспирација.

1. Introduction

Pepper (*Capsicum annum* L.) belongs to the family Solanaceae. It is cultivated in warm climate regions worldwide, such as Asia, northern America, southern and central Europe, and tropical and subtropical Africa (Thampi, 2004), and is native to Mexico, Central America, and northern South America (Echer et al., 2002). It is the world's second most important vegetable after tomato. The world production of fresh pepper is about 34.5 million tons (MT) and 3.9 MT of dry pepper (FAOSTAT, 2016); 1.93 million ha of crop-growing surface area (Ertek and Bolat, 2016) yielded an average of 12 t ha^{-1} (FAOSTAT, 2016). China (17.5 MT), Mexico (2.7 MT), Indonesia (2.0 MT), and Spain (1.1MT) we re the largest producers of fresh pepper, while India (1.4MT) was the highest producer of dry peppers. Pepper is one of the leading

horticultural crops in Serbia. Over the last three years (2017/2019), a total of 15 460 hectares of land were under pepper, with an average yield of 12 t ha^{-1} and an annual production of 187 000 t (Statistical Office of the Republic of Serbia, 2019). In Vojvodina, the northern province of the Republic of Serbia, pepper is grown on 2 900 hectares, with an average yield of 15.9 t ha^{-1} and an annual production of 43 000 t. Lower average pepper yields in Serbia, compared to those achieved in the leading pepper growing countries (South Korea 67.2 t ha^{-1}, USA 53.9 t ha^{-1}, Japan 53.9 t ha^{-1}, and Germany 45.6 t ha^{-1}, FAOSTAT, 2016), are primarily due to improper management practices, insufficient amount and unfavorable distribution of precipitation in the growing season, and poor optimization of the irrigation regime.

Pepper is considered one of the most susceptible crops with regard to water stress in horticulture (Antony and Singandhupe, 2004; Showemimo and Olarewaju, 2007; Ferrara et al., 2011). Many studies confirmed that reductions in the water supply at any growth stage of pepper have a negative effect on yield. For high yields of good quality pepper, an adequate water supply is required during the whole crop cycle (Dorji et al., 2005; Sezen et al., 2006).

Thus, irrigation scheduling is one of the main elements of irrigation practice (Vučić, 1976; Bošnjak, 1983; Pejić, 1993), and the most effective tool for increasing the yield of cultivated plants and water use efficiency as well saving water by avoiding its excessive application. The aim of irrigation is to optimize the soil water content, so that plant water deficit is controlled and the root is not water-logged. Inappropriate irrigation could result in water stress (Pejić et al., 2011a,b).

One of the most important aspects of irrigation practice to be considered is the determination of the irrigation schedule for different cultivated plants in relation to the soil, climatic conditions and biological properties of plants. There are several methods used for determining the time of irrigation, the most common being the water budget method, which is a quick and convenient means of estimating when to apply irrigation. The budget method estimates water depletion from the root zone due to evapotranspiration, with irrigation and effective rainfall as inputs. The amount of water lost through surface runoff and deep percolation (moving below the root zone) must be taken into consideration. To schedule irrigation using the water budget method, precise estimation of daily crop evapotranspiration is required (Pejić, 2000; Ertek et al., 2007; Bryla et al., 2010; Pejić et al., 2019). Experimentally, evapotranspiration can be measured directly in the field on experimental plots or by lysimeters. This, however, is both difficult and expensive. Therefore, crop evapotranspiration (ET$_c$) estimation based on reference evapotranspiration (ET$_o$) and crop coefficients (k$_c$) will increasingly gain ground in irrigation scheduling over the coming years. Numerous papers have shown that the Penman-Monteith method, the FAO-56 PM equation (Allen et al., 1998), is reliable in all climatic conditions and is therefore proposed by the FAO organization as standard for reference evapotranspiration (ET$_o$) calculation. Due to its simplicity and high correlation with the results obtained by the Penman-Monteith method, the Meteorological Institute of Serbia gives daily values of ET$_o$ calculated by the Hargreaves method. The relationship between ET$_o$ and the crop actually grown is given by the crop factor (k$_c$). ETc can be more simply calculated from pan evaporation (E$_o$) and crop factor (k). Studies have revealed that the pan evaporation method gives better results than the other methods for ET$_c$ estimation. This is due to the identical effects of air temperature, solar radiation and other climatic factors on both E$_o$ and ET$_c$ (Smajstrla et al., 2000). To clarify the relationship between E$_o$ and ET$_c$, regression analysis should be applied to determine the crop factor (k) (Vučić, 1976; Bošnjak, 1983; Ertek and Bolat, 2016). Class-A pan is the most common type of evaporation pan, provided it is used uniformly. Today, this evaporimeter is used at meteorological stations around the world, primarily due to the simplicity of measurement techniques, low cost and easy maintenance (Sahin et al., 2015).

In the situation of growing human population, increasing food demand and limited fresh water resources, water use efficiency in irrigated agriculture is of particular importance. Irrigation water use efficiency (IWUE) provides a more realistic assessment of irrigation effectiveness. It is a useful indicator for quantifying the impact of irrigation scheduling decisions and irrigation water applied on crop yield. IWUE values will be below the optimum if the irrigation schedule is not synchronized with the water needs of crops, soil properties and weather conditions (Pejić et al., 2018). The parameter, IWUE, generally tends to increase with a decline in irrigation if that water deficit does not occur at any single growth period (Howell, 2001). All the factors that increase yield and decrease water consumption through ET favorably affect the water use efficiency (Wang et al., 1996).

For the proper design of irrigation systems or the development of an irrigation schedule for any crop, data on crop requirements for water (ET$_c$) are needed (Sahin et al., 2015; Pejić et al., 2016). Water requirements for pepper during the growing season are much higher than those for other crops, which is the result of the poorly developed root system (Ertek and Bolat, 2016) and large transpiring leaf surface (Delfine et al., 2000). For high pepper yields, an adequate water supply and relatively moist soils are required during the total growing period (Bošnjak et al., 2005; Tanaskovik et al., 2016). The water requirement of pepper in the climatic conditions of Vojvodina is 571–667 mm (Bošnjak et al., 2005).

The objective of the study was to compare ET$_o$ and E$_o$ commonly used for irrigation programs and ET$_c$ prediction in order to determine which method is best suited to pepper growers in the climatic conditions of the Vojvodina region. The assessment will be made based on the yield and other growth parameters.

2. Materials and methods

The experiment with irrigated pepper was conducted in 2019 at the Rimski Šančevi experimental field of the Institute of Field and Vegetable Crops in Novi Sad, Serbia (N 45° 20` Lat., E 19° 51` Long., 84 m above sea level) on a calcareous chernozem soil on a loess terrace (Water physical properties – FC – soil water at field capacity, 26.01 % of dry soil weight; LCM – soil water at lentocapillary moisture (625 kPa), 15.61 % of dry soil weight; WP – soil water at wilting point (1500 kPa), 12.65 % of dry soil weight, SBD – soil bulk density, 1.13 g cm^{-3}, D – rooting depth where bulk roots

are expected to develop, 0.3 m, RAW – readily available water not limiting for evapotranspiration, 40.56 mm, Chemical characteristics – Reaction (pH in water) 8.05; $CaCO_3$ 1.95%; Organic matter 2.63; N% 0.173; Available P_2O_5 23.2 mg 100 g^{-1} soil; Available K_2O 27.5 mg 100 g^{-1} soil; Particle size – Total sand, silt and clay, 33%, 48% and 18%, respectively; Texture grade – loam). In the period 1964–2018, the annual mean air temperature, precipitation and relative humidity were 11.6°C, 637 mm, and 75%, respectively. According to the Hargreaves climate classification system, the study area is classified as semiarid in the summer period, from June to August (Bošnjak, 2001). Pepper variety 'Amfora' was used for the trials. The row and intra-row spacing was 0.7 and 0.25 m, respectively. The size of the experiment plot was 67 m^2, but the size of the experimental unit was 8.4 m^2 (1.4 × 6 m) and was replicated four times.

The trial was established as a block design and adapted to the technical specifications of the drip irrigation system. The plants were irrigated with a lateral placed in every row with drippers spaced every 0.33 m. Drippers had an average flow of 2.0 L $hour^{-1}$ under a pressure of 70 kPa. The irrigation was scheduled on the basis of the water balance method (the soil water budget). The budget method estimates water depletion from the root zone due to evapotranspiration, with an allowance being made for any water inputs (irrigation and effective rainfall). Irrigation started when readily available water in the 0.3 m soil layer was completely absorbed by plants. (Ertek and Bolat, 2016 reported that about 70% of pepper roots are spreading at 10–30 cm soil depth, which indicates that deeper soil layers are not necessary for the cultivation of pepper.)

Two methods were used to compute the daily evapotranspiration of pepper (ET_d): reference evapotranspiration (ET_o) and evaporation from an open water surface (E_o). Crop coefficients (k_c) and crop factor (k) were used to convert ET_o and E_o values into ET_d. K_c and k were 0.3–0.4, 0.6–0.7, 0.9–1.1, 0.8–0.9 and 0.4, 0.7, 1.0 and 0.8 for initial stage, crop development, mid season, and late season, respectively. K_c and k were considered for different growth stages of pepper based on FAO-56 (Allen et al., 1998). ET_o was calculated by the Hargreaves equation (Hargreaves and Samani, 1985):

$$ET_o = 0.0023 \, (T_m + 17.8) \, \sqrt{T_{max} - T_{min}} \, R_a$$

where: ET_o – reference evapotranspiration (mm day^{-1}), T_m –average daily air temperature (°C), T_{max} –maximum daily temperature (°C), T_{min} –minimum daily temperature (°C), R_a –extraterrestrial radiation (MJ m^{-2} day^{-1}).

Daily ET_o values were obained from the website of the Republic Hydrometeorological Service of Serbia (2020). E_o values were measured by a Class-A pan located at a meteorological station near the experimental plot.

Irrigation water use efficiency (IWUE) was calculated as fresh pepper yield (Y) divided by the total seasonal irrigation water applied (I) (Tanner and Sinclair, 1983, Bos, 1985, Stanhill, 1986, Molden et al., 2010).

The irrigation rate was 20 mm at the beginning of the season and 30 mm in mid-season. The volume of irrigation water and the pressure in the system were controlled respectively by a flow meter and a pressure gauge installed in the hose nozzle used for irrigation.

Pepper seedlings were transplanted to treatment plots on June 18 and harvested by hand on September 20 at harvest maturity. Due to bad weather conditions, transplanting was done a month later. All recommended agronomic practices regarding the cultivation and plant protection of pepper were applied at the experimental plot.

The data reported for yield and yield components were subjected to analyses of variance (ANOVA). LSD test was used to group the means of irrigation when the F-test was significant. Different letters indicate significant differences between values.

3. Results and discussion

In the period July–August, rainfall was 83.5 mm, which was lower by 41.5 than the long-term average for the region (125 mm), while the amount of water added by irrigation was 260 mm in both variants (Table 1, Figures 1 and 2). However, the average air temperature (Table 1) in the same period (22.6°C) was higher by 1.0°C compared to the long-term average (21.6°C), which certainly affected the water consumed through evapotranspiration. Total E_o and ET_o during the growing period of pepper were 539.3 mm and 453.8 mm, respectively (Table 3).

The yield of pepper was 40.78 t ha^{-1} in the ET_o variant, and 42.58 t ha^{-1} in the E_o variant (Table 2). The yields in tested variants were not statistically different. The result of the study is in line with the findings by Bošnjak et al. (2005), who reported that the yield of pepper cultivar 'Amfora' irrigated by sprinklers varied from 35.5 to 43.54 t ha^{-1}, at the same experimental field. Trivikrama et al. (2018) reported similar results for pepper yield, in arid conditions of India, with different irrigation levels 0.5, 0.75, and 1.0 ET_c; maximum yield of 43.59 t ha^{-1} was obtained from treatment 1.0 ET_c, with the seasonal irrigation water amount of 562.5 mm. Also, Sezen et al. (2006) found the highest yield of drip irrigated pepper in the variant with full irrigation of 44.2–47.8 t ha^{-1} under the Mediterranean climatic conditions of Turkey. Differences regarding yield components (number of fruits per plant, fruit weight) and morphological characteristics of pepper (fruit length, fruit diameter, pericarp thickness) between the two methods of ET_d calculation were not significant, except for the content of dry matter; 7.4 % E_o, 6.7 % ET_o (Table 2).

Table 1.

Sum of monthly precipitation (mm) and mean monthly air temperatures (°C) for the growing season of pepper (Meteorological Station, Rimski Šančevi) in 2019

Month	Precipitation	Temperature	Long term average precipitation (1964–2018)	Long term average air temperature (1964–2018)
June	20[†]	23.3[†]	89[†]	20.1[†]
July	18	22.0	67	21.8
August	65	23.1	58	21.4
September	16[†]	19.2[†]	48[†]	17.0[†]
Total/average	120 (83.5)[‡]	21.9 (22.6)[‡]	262 (125)[‡]	20.1 (21.6)[‡]

[†]Monthly precipitation sums and mean monthly air temperatures are for the period June 18–30 and September 1–18. [‡]For comparison with long term average values, the data for the period July–August are relevant.
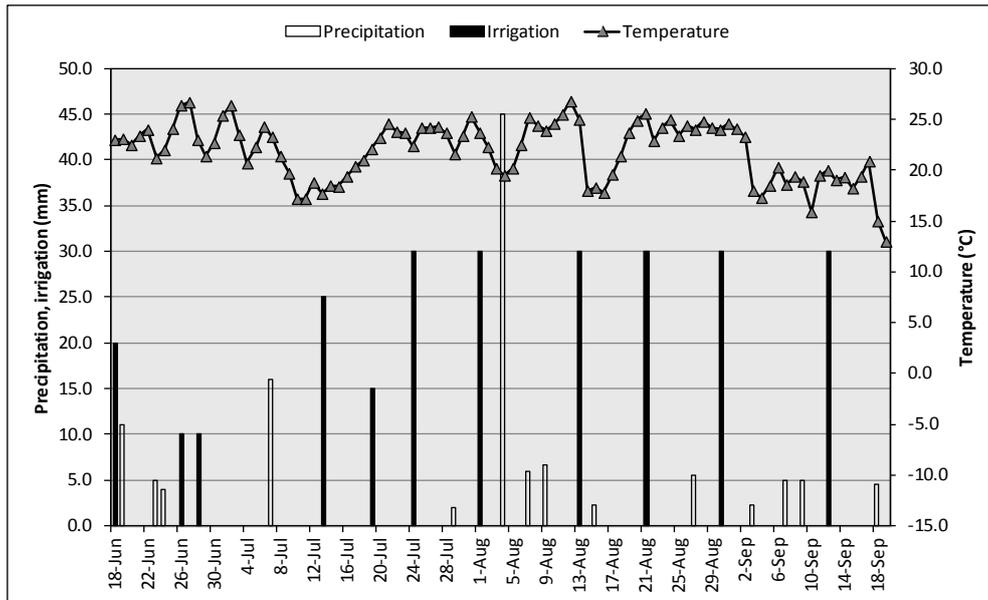
Figure 1. Irrigation schedules, irrigation water applied, and meteorological data (daily precipitation and mean daily air temperatures) in ET_o variant
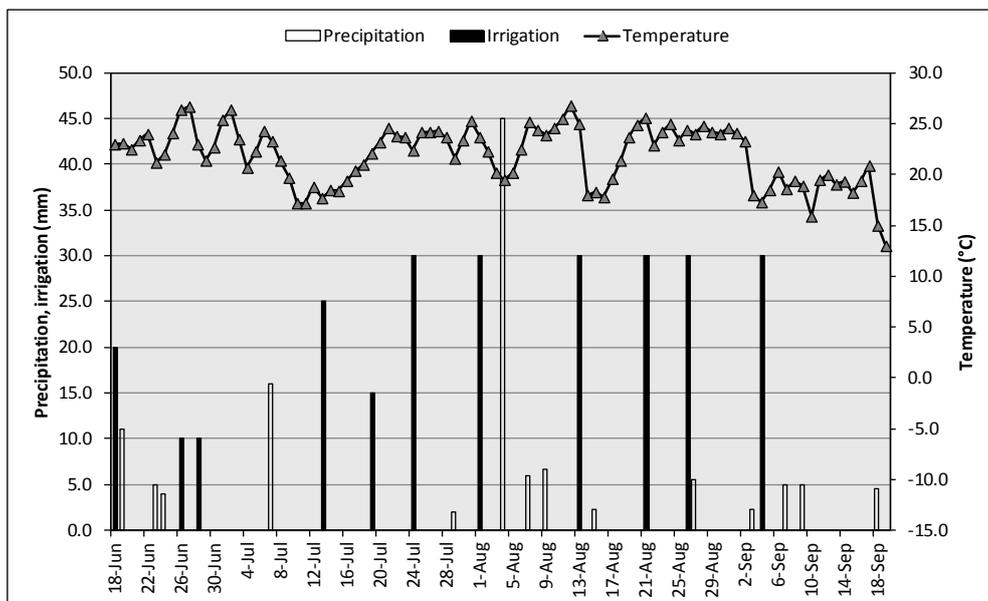
Figure 2. Irrigation schedules, irrigation water applied, and meteorological data (daily precipitation and mean daily air temperatures) in E_o variant

Efficient use of irrigation water (IWUE) is essential for increasing agricultural productivity. Pejic et al. (2011a) pointed out that special attention should be paid when comparing results because IWUE calculations may be different (Viets, 1962, Tanner and Sinclair, 1983, Bos, 1985, Stanhill, 1986, Molden et al., 2010). In rainfed areas under complementary irrigation, IWUE calculation differs (the calculation also takes into

account yields without irrigation, Bos, 1985) in relation to arid regions where crop production cannot be realized under natural water supply conditions (IWUE values are calculated as the ratio of yield to water added by irrigation, Viets, 1962). IWUE values were 15.2 kg m^{-3} in E_o and 14.6 kg m^{-3} in ET_o variant. Padrón et al. (2015) reported the IWUE value of 12.3 kg m^{-3} for pepper in subtropical humid climatic conditions in Brasil for the yield of 37.1 t ha^{-1} and the amount of irrigation water applied of 301 mm. IWUE of 4.2 kg m^{-3} for the yield of 21.57 t ha^{-1} and irrigation rate of 518 mm was found in Turkey (Kara and Yildirim, 2015). It

is very interesting to compare our results with the results of drip irrigated pepper cultivated in the arid region of Northwest China regarding yield, crop evapotranspiration and water use efficiency. In the growing season from May to September the highest IWUE value of 19.27 kg m^{-3} coincided with the yield of 34.5 t ha^{-1}. The soil matric potential of -30 kPa at 25 cm depth was recommended for irrigation management. Water applied by irrigation and water consumed through evapotranspiration were 179 mm and 313.1 mm, respectively (Liu et al., 2012).

Table 2.
Yield and yield components of pepper depending on the method used for computing the daily amount of water consumed through evapotranspiration

Var.	Rep.	No. of fruits per plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Pericarp thickness (mm)	Content of dry matter (%)	Yield (t ha^{-1})	IWUE (kg m^{-3})
E_o	1	9	87.6	13	5.6	4	8.0	44.31	15.82
	2	9	92.3	13	5.8	5	6.9	44.59	15.92
	3	8	97.8	12	5.9	4	7.3	44.64	15.94
	4	7	90.1	13	5.7	4	7.2	36.80	13.14
average		8 a	92.0 a	12.8 a	5.8 a	4.2 a	7.4 a	42.58 a	15.20 a
ET_o	1	8	96.3	13	5.8	4	6.6	42.21	15.08
	2	7	92.8	12	5.8	4	6.5	37.56	13.41
	3	9	84.6	13	6.5	4	7.0	41.49	14.82
	4	9	81.6	12	5.5	4	6.5	41.88	14.96
average		8a	88.8 a	12.5 a	5.9 a	4.0 a	6.7b	40.78 a	14.56 a

E_o – evaporation from an open water surface, ET_o – reference evapotranspiration
Values followed by the same letter are not significantly different at the 0.05 probability level

Evapotranspiration rates were 364.2 mm and 337.3 mm in E_o and ET_o variants, respectively (Tables 3, 4, and 5). The obtained values are lower than those previously reported by Bošnjak et al. (2005) for the climatic conditions of Vojvodina (571–667 mm), primarily due to the shorter growing period. Similar ET_c values (380 mm) for humid Indian climate were found by Arya et al. (2017). Sezen et al. (2011) reported the yields of 21.390 t ha^{-1} and 35.92 t ha^{-1} and seasonal evapotranspiration of 327 mm and 517 mm of pepper in water-stressed and well irrigated treatments, respectively, under the Mediterranean climatic conditions of Turkey. Comparing the values of water consumed through evapotranspiration for cultivated plants is an ungrateful task. Evapotranspiration depends on the amount of water in the soil (Vučić, 1976), environmental conditions (Bošnjak, 1983), the length of the growing period (Pejić et al., 2007). Evapotranspiration is greatest at optimal soil moisture; it decreases with decreasing water content in the soil. The obtained monthly (July and August) and daily

values of pepper ET (Tables 3, 4, 5 and Figure 3) in the range 108–194 mm and 3.5–6.3, respectively, are in agreement with Bošnjak et al. (2005). They reported pepper ET in July and August in the range from 161 to 181 mm and average daily values of 5.5 mm. ET_d values ranged from less than 2 mm day^{-1} early in the season, when plants were small, to 8–9 mm day^{-1} during the peak ET period in late July to early August (Figure 3), when plants reached full effective cover and peppers were ready for harvest; these values were completely in agreement with the results obtained by weighing lysimeters in the central Californian region, as reported by Bryla et al. (2010). Pepper consumed the highest amount of water during fruit setting and fruit growth, from mid-season to late season (130.4 mm and 159.9 mm for ET_o and E_o variants, respectively) (Table 3). Therefore, this growth stage of pepper is most sensitive to water stress. But, many studies confirmed that obtaining high yields of pepper requires an adequate water supply during the whole crop cycle (Sezen et al., 2006, Demirel et al., 2012).
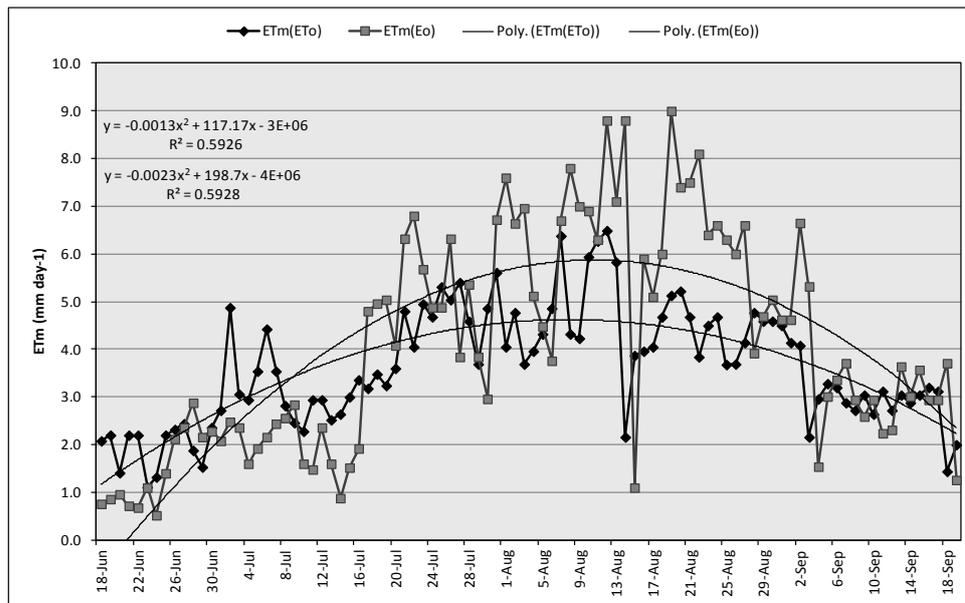
Figure 3. Daily pepper evapotranspiration (ET_d)

Table 3.
Reference evapotranspiration (ET_o), evaporation (E_o), and pepper evapotranspiration (ET_m, ET_d)

Growth stages	ET_o (mm)	ET_c (mm)	ET_d (mm)	E_o (mm)	ET_c (mm)	ET_d (mm)
Initial stage June 18 – July 1	74.4	28.0	2.0	66.2	20.9	1.5
Crop development July 2 – July 22	110.1	69.7	2.2	114.3	61.7	2.0
Mid-season July 23 – August 13	114.0	109.2	5.0	149.4	121.7	5.5
Late season August 14 – September 20	157.9	130.4	4.7	209.4	159.9	5.7
Sum/average for growing season	456.4	337.3	3.5	539.3	364.2	3.7

Table 4.
Water balance for pepper in ET_o variant

Balance elements	Month				
	June	July	August	September	Growing season
ET_o	68	165	152	72	457
k_c	0.3–0.4	0.6–0.7	0.9–1.1	0.8–0.9	-
t	23.3	22.0	23.1	18.9	21.8
ET_m	25	116	142	54	337
P	20	18	66	17	121
Δ	-5	-25	0	0	-
r	30	25	0	0	-
ET_a	25	43	66	17	151
d	0	73	76	37	186
s	0	0	0	0	0
Irr	40*	70	120	30	260
ET_d	1.9	3.7	4.6	3.0	3.3

ET_o – reference evapotranspiration (mm), k_c – crop coefficients, t – mean monthly air temperature (°C), ET_c – plant evapotranspiration under irrigation conditions (mm), P – the monthly amount of precipitation (mm), Δ – the difference between ET_c and P (mm), r - pre-season readily available soil water reserve (mm), ET_a – plant evapotranspiration under non-irrigated conditions (mm), d – the deficit of readily available water in the soil (mm), s – surplus water, i.e. water percolated into the soil layers below the active rhizosphere of plants (mm), Irr – water applied by irrigation (mm)

Table 5.
Water balance for pepper in E_o variant

Balance elements	Month				
	June	July	August	September	Growing season
E_o	61	175	211	92	539
k	0.4	0.7	1.0	0.8	-
t	23.3	22.0	23.1	18.9	21.8
ET_c	19	108	194	43	364
P	20	18	66	17	121
Δ	+1	-30	0	0	-
r	30	30	0	0	-
ET_a	19	48	66	17	150
d	0	60	128	26	214
s	1	0	0	0	0
Irr	40*	70	120	30	260
ET_d	1.5	3.5	6.3	2.4	3.4

E_o – evaporation from a free water surface (mm), k – correction coefficients, t – mean monthly air temperature (^{o}C), ET_c – plant evapotranspiration under irrigated conditions (mm), P – the monthly amount of precipitation (mm), Δ – the difference between ET_c, P (mm), r – pre-season readily available soil water reserve (mm), ET_a – plant evapotranspiration under non-irrigated conditions (mm), d – a deficit of readily available water in the soil (mm), s – surplus water, i.e. water percolated into the soil layers below the active rhizosphere of plants (mm), Irr – water applied by irrigation (mm)

4. Conclusions

The comparison between ET_o and E_o methods, which are commonly used for irrigation programs and crop evapotranspiration prediction, showed that differences in crop yield and irrigation water use efficiency were not statistically different. That indicates that both methods could be recommended for irrigation scheduling programs for pepper under the climatic conditions of the Vojvodina region. However, priority should be given to the ET_o k_c due to easy accessibility and reliability of data.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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