REFERENCE EVAPOTRANSPIRATION ESTIMATE FOR THE MUNICIPALITY OF LENÇÓIS/BA

Matheus Ferreira Almeida[1], Leandro Dias da Silva[2], Raul Antonio Araújo do Bonfim[3], Mateus Pires Barbosa[4], Mikaela Oliveira Souza[5], Paulo Araquém Ramos Cairo[6]

ABSTRACT: In order to compare two methods for estimating reference evapotranspiration (ETo) with the Penman-Monteith method, dry and humid seasons of 2018 in the municipality of Lençóis in the State of Bahia, located in the Chapada Diamantina region (South Center), The coefficient of determination (R^2) values were applied, the standard error of the estimate (SEE) and the standard error of the adjusted estimate (SEEa) for the methods of Hargreaves and Samani and Priestley-Taylor, in addition to forced linear regression, with data referring to climatic variables obtained from an automatic INMET station, at the study site. The Priestley-Taylor method obtained the best results, for both stations, dry and humid for this locality, in relation to the other method studied. The method, therefore, may be recommended for the estimation of ETo, and consequently, in the application of irrigation and water resources in this region.

KEYWORDS: irrigation, Penman-Montheith, climatic variables

ESTIMATIVA DA EVAPOTRANSPIRAÇÃO DE REFERÊNCIA PARA O MUNICÍPIO DE LENÇÓIS/BA

RESUMO: Com o objetivo de comparar dois métodos para estimativa da evapotranspiração de referência (ETo) com o método Penman-Monteith, estações secas e úmidas do ano de 2018 no município de Lençóis no Estado da Bahia, localizada na Região da Chapada Diamantina (Centro-Sul), aplicou-se os valores coeficiente de determinação (R^2), o erro padrão da

[1] Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Estrada do Bem Querer km 04, Caixa Postal, 95, CEP 45031-900, Vitória da Conquista, BA, (77) 99972-0591, e-mail: theualmeida.tf@gmail.com
[2] Pós-Doutorando, Programa de Pós-Graduação em Agronomia, UESB, Vitória da Conquista, BA.
[3] Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.
[4] Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.
[5] Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.
[6] Prof. Doutor, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.

estimativa (SEE) e o erro padrão da estimativa ajustada (SEEa) para os métodos de Hargreaves e Samani e Priestley-Taylor, além da regressão linear forçada, com os dados referentes as variáveis climáticas obtidos de uma estação automática do INMET, no local de estudo. O método Priestley-Taylor foi o que obteve os melhores resultados, para ambas as estações, seca e úmida para esta localidade, em relação ao outro método estudado. O método, portanto, pode ser recomendado para a estimativa da ETo, e consequentemente, na aplicação da irrigação e recursos hídricos dessa região.
PALAVRAS-CHAVE: irrigação, Penman-Montheith, variáveis climáticas

INTRODUCTION

With the increasing world population, the amount of water required by this also rises, requiring that rationalization processes be used, mainly affecting irrigated agriculture, therefore, the consumption of water in the different stages of plant development allows the administration of a more rational and efficient irrigation, according to the demand of the crop (Fernandes & Turco, 2003).

In irrigated agriculture, knowledge of evapotranspiration is of great importance in estimating crop water requirements as well as for the rational management of water resources, therefore, it is fundamental to determine the real need for the amount of water to be used (Silva et al., 2015).

Estimating evaporative and transpiration water losses is of great importance for activities such as irrigation projects and reservoir management (Borges & Mendiondo, 2007). Determining evapotranspiration under field conditions is not a simple practice, since its measurement depends on improper operational irrigation management methods, which are expensive, and most of the time, do not give you the result at that time (Paiva & Souza, 2016).

There are therefore simplified methods, such as reference evapotranspiration (ETo) which is an indirect technique that conducts an estimate of water requirements by the plant, using meteorological data for its quantification, being fundamental for a better planning and efficiency of the water use (Alencar et al., 2015).

The Penman-Monteith formula (PM-FAO 56) can be used as a standard method, according to United Nations Food and Agriculture Organization (FAO) consultants, for the estimation of ETo, because it is based on physical processes, and incorporates physiological

and aerodynamic parameters, and their results indicate greater safety compared to other available methods (Allen et al., 1998).

The objective of this work, therefore, is to compare two methods for estimating ETo with the Penman-Monteith method, dry and humid seasons of 2018 in the municipality of Lençóis in the state of Bahia.

MATERIAL AND METHODS

The work was carried out in the state of Bahia, in the municipality of Lençóis, located in the South Center region, also known as Chapada Diamantina, coordinates 12º 34' S and 41º 23' W and average altitude of 457 m. According to the Köppen classification, the climate is of type Aw, with average annual temperature of 24 ºC and average annual precipitation of 1206 mm.

The economy of the city was geared towards the extraction of diamonds, but is currently tourism, the great propellant of the economy, since the city is in the Chapada Diamantina National Park. However, agriculture also contributes to the economy of the municipality through irrigated fruticulture, such as passion fruit, mango and pineapple.

The data referring to climatic variables were obtained through an automatic station of INMET, located in the municipality of Lençóis/BA. The ETo estimation calculations were performed using the Penman-Montheith methods (Allen et al., 1998) (1), Hargreaves e Samani (1985) e Priestley-Taylor (1972).

$$ETo = \frac{0.408\,\Delta(\mathrm{Rn} - \mathrm{G}) + \gamma \frac{900}{\mathrm{T} + 275} u_2 (e_s - e_d)}{\Delta + \gamma(1 + 0.34 u_2)} \quad (1)$$

wherein:

ETo - reference evapotranspiration ($mm.d^{-1}$); Rn- net radiation at the surface ($MJ.m^{-2}.d^{-1}$); G - soil heat flux ($MJ.m^{-2}.d^{-1}$); T - air temperature (°C); u_2 - wind speed at 2.0 m height ($m\ s^{-1}$); (e_s-e_d) - vapor pressure deficit (kPa); Δ - the slope of the curve saturation vapor pressure ($kPa.\ C^{-1}$); γ - psychrometric constant ($kPa.\ C^{-1}$).

To compare the ETo values between Penman-Montheith and the other methods, were used the criteria proposed by Jensen et al. (1990), that are the standard error of the estimate

(SEE) (2) and the standard error of the adjusted estimate (SEEa) (3) and coefficients of determination (R^2) to the evaluation methods.

$$SEE = \left(\frac{\sum(Y_i - Y_m)^2}{n-1}\right)^{0.5} \quad (2)$$

$$SEEa = \left(\frac{\sum(Y_{ic} - Y_m)^2}{n-1}\right)^{0.5} \quad (3)$$

wherein:

Y_i - evapotranspiration estimated by the method ($mm.d^{-1}$); Y_m - evapotranspiration estimated by the standard method ($mm.d^{-1}$); Y_{ic} – estimate using evapotranspiration, adjusted by coefficients of linear regression ($mm.d^{-1}$); and n- total number of observations.

RESULTS AND DISCUSSION

It is observed in table 1 that the Priestley-Taylor method is the one that obtained the best coefficient of determination (R^2). However, the Hargreaves & Samani method is what obtained results close, higher for the standard error of estimation (SEE) and standard error of the adjusted estimate (SEEa), for the dry period in the city under study.

The same occurs in the parameters cited for the humid period, according to table 1, being SEE and SEEa, for the Hargreaves & Samani method, with more satisfactory results in this period, when compared to the dry period. Garcia et al. (2017) obtained coefficient of determination (R^2) to the Hargreaves & Samani method superior to that found in this work, however, considered inferior to other methods also tested.

Pereira et al. (2009) found results also inferior to this work for the Priestley-Taylor method, held in Serra da Mantiqueira-MG, for both periods, dry and humid, the latter being significantly higher when compared to the dry period. This is explained by the fact that the method is sensitive to climatic variations, in relation to the dependence of solar radiation, that of summer, rainy season, for winter, dry period, decreases the intensity, demonstrating irregular photoperiods.

Table 1. Coefficient of determination (R^2), standard error of estimation (SEE) and standard error of adjusted estimation (SEEa), during dry and humid period in Lençóis/BA.

Penman-Montheith	Lençóis - Period Dry		
	R²	SEE	SEEa
Hargreaves & Samani	0.6477	0.56	0.51
Priestley-Taylor	0.9992	0.33	0.33
Penman-Montheith	Lençóis - Period Humid		
	R²	SEE	SEEa
Hargreaves & Samani	0.7633	0.71	0.68
Priestley-Taylor	0.9993	0.33	0.33

Unlike what occurs in the region where the city of Lençóis is located, which is closest to the equator, thus demonstrating regular photoperiods, in both seasons, and with this a coefficient of determination close to 1, for the two periods studied.

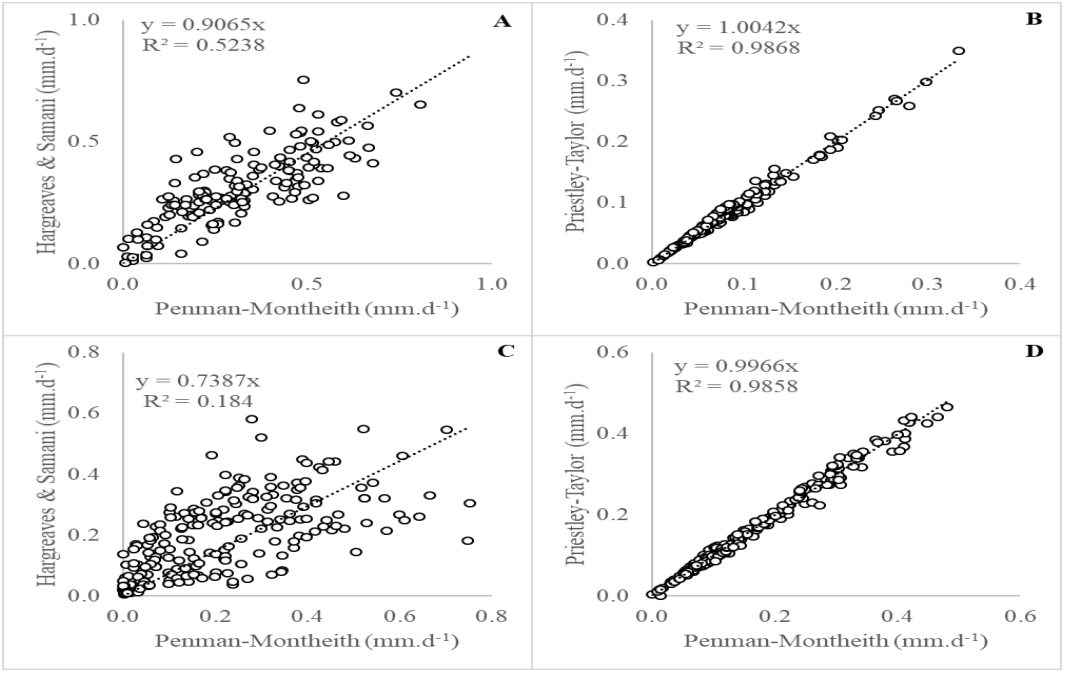

Figure 1. Linear regression between daily values of reference evapotranspiration (ETo) for dry period (A and B) and humid period (C and D), forced by origin, estimated by the Penman-Montheith method in relation to Hargreaves & Samani and Priestley-Taylor for the municipality of Lençóis/BA.

CONCLUSIONS

The Priestley-Taylor method obtained better results and with this greater reliability for both periods, dry and humid, and may therefore, be used to define the best irrigation methods and the like in the city of Lençóis/BA.

ACKNOWLEDGEMENTS

To CNPq, FAPESB, CAPES and UESB.

BIBLIOGRAPHIC REFERENCES

ALENCAR, L.P.; SEDIYAMA, G.C.; MANTOVANI, E.C. Estimativa da evapotranspiração de referência (ETo padrão FAO), para Minas Gerais, na ausência de alguns dados climáticos. **Engenharia Agrícola**., v.35, n.1, p.39-50, 2015.

ALLEN, R.G.; PEREIRA, L.S.; RAES, D.; SMITH, M. **Crop evapotranspiration: Guidelines for computing crop water requirements.** Irrigation and Drainage Paper, 56, FAO, Rome (1998).

BORGES, A.C.; MEDIONDO, E.M. Comparação entre equações empíricas para estimativa da evapotranspiração de referência na Bacia do Rio Jacupiranga. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.11, n.3, p.293-300, 2007.

FERNANDES, E.J.; TURCO, J.E.P. Evapotranspiração de referência para manejo da irrigação em cultura de soja. **Irriga**, v. 8, n. 2, p. 132-141, 2003.

GARCIA, A.D.B.; MENDONÇA, J.C.; ALMEIDA, C.M. Métodos de estimativa da evapotranspiração de referência (ETo) no município de Santa Teresa, ES. **Irriga**, v. 22, n. 4, p. 701-714, 2017.

HARGREAVES, G.L.; SAMANI, Z.A. Reference crop evapotranspiration from temperature. **Basin. Journal of the Irrigation and Drainage Division**-ASCE, New York, v. 111, n. 1, p. 113-124. 1985.

JENSEN, M.E.; BURMAN, R.D.; ALLEN, R.G. **Evapotranspiration and irrigation water requeriments**. New York: ASCE, 1990. 332 p.

PAIVA, C.M.; DOUZA, A.L.S. Avaliação de Métodos de Estimativa da Evapotranspiração de Referência para Fins de Manejo da Irrigação. **Anuário do Instituto de Geociências – UFRJ**, v. 39, n.1, p. 42-51, 2016.

PEREIRA, D.R.; YANAGI, S.N.M.; MELLO; C.R.; SILVA, A.M.; SILVA, L.A. Desempenho de métodos de estimativa da evapotranspiração de referência para a região da Serra da Mantiqueira, MG. **Ciência Rural**, v.39, n.9, p. 2488-2493, 2009.

PRIESTLEY, C.H.B.; TAYLOR, R.J. On the assessment of surface heat flux and evaporation using large scale parameters. **Monthly Weather Rev**., Boston, v. 100, n. 2, p. 81-92, 1972.

SILVA, A. O.; CORREIA, J. S.; BASSOI, L. H.; A. TEIXEIRA, H. C. Evapotranspiração de referência para dimensionamento de sistemas de irrigação em Petrolina, PE. **Brazilian Journal of Biosystems Engineering**, v. 9, n.1, p.30-38, 2015.

SILVA, V. J.; CARVALHO H. P.; DA SILVA, C. R.; CAMARGO, R. TEODORO, R. E. F. Desempenho de diferentes métodos de estimativa da evapotranspiração de referência diária em Uberlândia, MG. **Bioscience Journal**, v. 27, n. 1, p. 95-101, 2011.