REFERENCE EVAPOTRANSPIRATION ESTIMATE FOR THE MUNICIPALITIES OF UNA AND BRUMADO-BAHIA

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

ABSTRACT: The knowledge of evapotranspiration is of paramount importance in determining the the water requirements of a crop. The present work aims at comparing two methods of estimation of reference evapotranspiration (ETo) with the Penman-Monteith method, for the dry and humid seasons of 2018 in two locations in the state of Bahia in the Southwest (Brumado) and in the South (Una). The standard error of the estimation (SSE) and the standard error of the adjusted estimate (SSEa), determination coefficients (R^2) and standard error of the adjusted estimate by origin (SEEao) were applied. Data were collected from an automatic station located in both cities under study. The Priestley-Taylor method obtained better evaluation for dry and wet periods in both cities under study, with emphasis on the wet period. Therefore, this method proved to be the best for the studied cities, being possible to indicate them for estimates of the ETo for the Irrigation programs.

KEYWORDS: climatic variables, Penman-Montheith, irrigation management

ESTIMATIVA DA EVAPOTRANSPIRAÇÃO DE REFERÊNCIA PARA OS MUNICÍPIOS DE UNA E BRUMADO-BAHIA

RESUMO: O conhecimento da evapotranspiração é de suma importância na determinação das necessidades hídricas de uma cultura. O presente trabalho visa confrontar dois métodos de estimativa de evapotranspiração de referência (ETo) com o método de Penman-Monteith, para as estações seca e úmida do ano de 2018 em duas localidades do estado da Bahia, no Sudoeste

[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, (75) 98808-4480, e-mail: raularaujoraul@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.

(Brumado) e no Sul (Una). Aplicou-se valores erro padrão da estimativa (EPE) e o erro padrão da estimativa ajustada (EPEa), coeficientes de determinação (R^2) e erro-padrão da estimativa ajustada por origem (EPEao). Os dados foram coletados a partir de estações automáticas localizadas em ambas as cidades em estudo. O método de Priestley-Taylor obteve melhor avaliação para os períodos seco e úmido em ambas as cidades em estudo, com ênfase para o período úmido. Portanto, este método revelou ser o melhor para os municípios estudados, sendo possível indicá-los para estimativas da ETo para os programas de Irrigação.
PALAVRAS-CHAVE: Variáveis climáticas, Penman-Montheith, Manejo da irrigação

INTRODUCTION

Estimates of reference evapotranspiration (ETo) are of great importance in climatology, constituting one of the main hydric components, being fundamental in irrigated areas to improve the planning and the efficiency of the use of the water resources. A number of indirect methods provide estimates of ETo, of which the Penman-Monteith equation (PM-FAO 56) is the most recommended, because the results indicate safer estimates when compared with other methods (Allen et al., 1998).

For Mendonça & Dantas (2009) to obtain data on the ETo is of fundamental importance for the sizing of systems, irrigation water management and consequently for the production, as well as the knowledge about the estimates methods and the dependent factors.

Ahead of the above, the objective of this study was to compare two methods to estimate the ETo with the Penman-Monteith method, in dry and wet seasons of 2018 in two locations in the state of Bahia, in the Southwest (Brumado) and in the South (Una).

MATERIAL AND METHODS

The work was carried out in two cities of the state of Bahia, in Brumado, coordinates 14° 11' 50"S and 41° 40' 9" W and average altitude 415 m. According to the classification of Köppen, the climate is *BSh* type, with average annual temperature of 23.8 º C and average annual precipitation of 590 mm being included in the Polygon of Droughts. The city economy is focused on extraction of ore, but some agricultural activities are developed, with cotton, beans and cassava being the most significant in the region. Already the city of Una, south of the state

with geographic coordinates of 15 ° 16 '11' 'S and 39 ° 4' 10"W and average altitude of 63 m. The climate is *Af* according to Köppen and Geiger, 24.1 °C is the average temperature and 1577 mm is the average annual rainfall value. The economic base is mainly agricultural, linked to the plantations of cacao, manioc and banana.

Data on climatic variables were obtained through an INMET automatic station, located in the municipalities of Brumado-BA and Una-BA. Calculations of ETo estimation were performed using Penman-Montheith methods (Allen et al., 1998) (1), Hargreaves & Samani (1985) and Priestley-Taylor (1972).

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

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 obtained better results for both the coefficient of determination (R^2) and the standard error of estimate (SEE) and standard error of the adjusted estimate (SEEa) during the period dry for both cities when compared to the Hargreaves & Samani method.

Pereira et al. (2009) when conducting studies in Serra da Mantiqueira-MG found different results to that found in this research. The authors concluded that the Priestley-Taylor method demonstrated high reduction in the static indicators in the dry period when compared to the humid because this is sensitive to climate changes due to its dependence on solar radiation.

Table 1. Coefficient of determination (R^2), standard error of estimate (SEE) and standard error of the adjusted estimate (SEEa), during the dry period in the two study cities.

Penman-Montheith	Una – Period Dry		
	R^2	SEE	SEEa
Hargreaves & Samani	0.6008	0.56	0.54
Priestley-Taylor	0.9862	11.42	11.41
Penman-Montheith	Brumado - Period Dry		
	R^2	SEE	SEEa
Hargreaves & Samani	0.3458	1.09	1.04
Priestley-Taylor	0.9996	0.32	0.32

For the wet period, the Priestley-Taylor method also revealed better results for the variables analyzed (Table 2).

Lucena et al. (2016) found similar results to this research in the comparison between the estimation methods of ETo in Bom Jesus-PI, with Priestley-Taylor demonstrated better performances, being classified as optimal according to the classification of confidence index "c" of Camargo and Sentelhas.

Table 2. Coefficient of determination (R^2), standard error of estimation (ESS) and standard error of the adjusted estimate (SEEa), during the wet period in the two study cities.

Penman-Montheith	Una - Period Humid		
	R^2	SEE	SEEa
Hargreaves & Samani	0.7673	0.75	0.72
Priestley-Taylor	0.9802	42.43	42.41
Penman-Montheith	Brumado - Period Humid		
	R^2	SEE	SEEa
Hargreaves & Samani	0.8666	0.81	0.79
Priestley-Taylor	0.9895	0.64	0.64

Analyzing figures 1 and 2 it is possible to observe by means of forced regression through the origin that the Priestley-Taylor method overestimated ETo in relation to Penman-Montheith for both cities in the two analyzed periods, thus obtaining R^2 values next to 1. Similar results were found by Santos et al. (2017) when comparing the ETo methods in the municipality of Petrolina-PE.

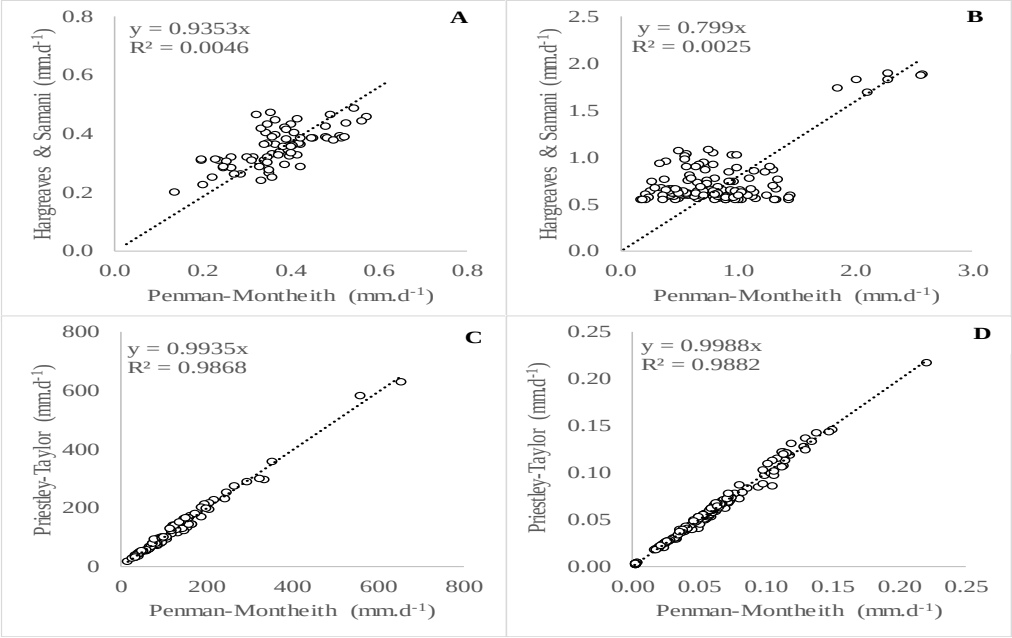

Figure 1. Linear regression between daily values of reference evapotranspiration (ETo) for the dry period, forced by the origin, estimated by the Penman-Monteith method in relation to Hargreaves & Samani and Priestley-Taylor for Una-BA (A and C) and Brumado-BA (B and D).

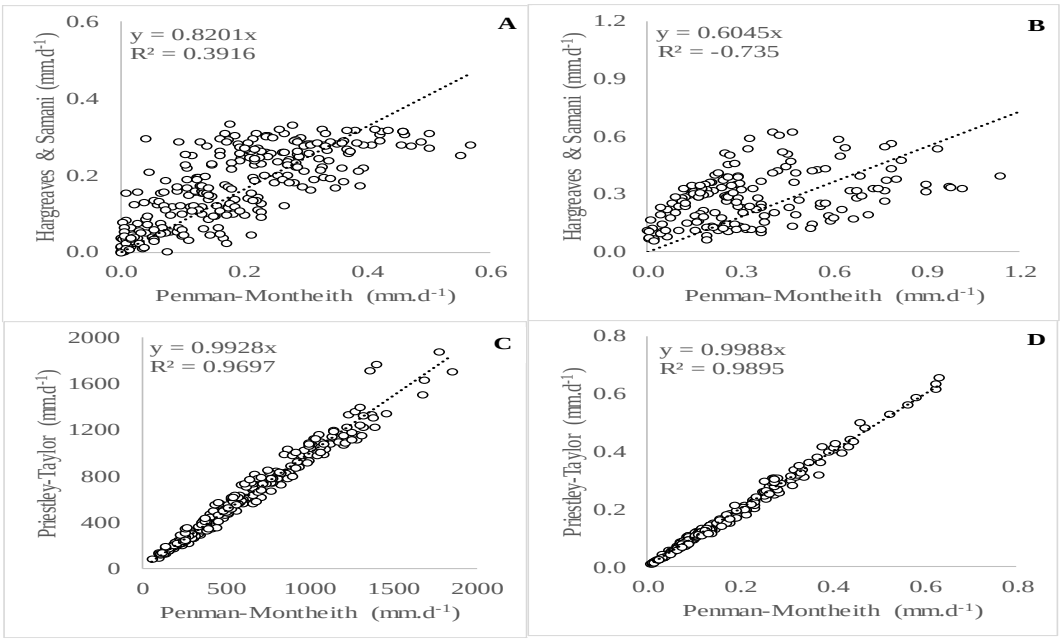

Figure 2. Linear regression between daily values of the reference evapotranspiration (ETo) for the humid period, forced by the origin, estimated by the Penman-Monteith method in relation to Hargreaves & Samani and Priestley-Taylor for Una-BA (A and C) and Brumado-BA (B and D).

CONCLUSIONS

The Priestley-Taylor method obtained better performance in ETo estimates, both for the sites and for the periods evaluated, and it can be indicated to be used in the cities of Brumado-BA and Una-BA for irrigation purposes, among others.

ACKNOWLEDGEMENTS

To CNPq, FAPESB, CAPES and UESB.

BIBLIOGRAPHIC REFERENCES

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).

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.

LUCENA, F.A.P.; SILVA, E.M.; RIBEIRO, A.A.; SIMEÃO, M. LUCENA, J.P.A.P. Comparação entre métodos de estimativa da evapotranspiração de referência no município de Bom Jesus, PI. **Revista Brasileira de Agricultura Irrigada** v. 10, nº.3, Fortaleza, p. 663 - 675, Mai – Jun, 2016.

MENDONÇA, E.A.; DANTAS, R.T. Estimativa da evapotranspiração de referência no município de Capim, PB. **Revista Brasileira de Engenharia Agrícola e Ambiental,** Campina Grande, PB v.14, n.2, p.196–202, 2010.

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**, Santa Maria, 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.

SANTOS, R.D.S.; SOUZA, M.H.C.; VENTURA, K.M.; BASSOI, R.H. Comparação entre métodos de estimativa da evapotranspiração de referência para o município de Petrolina, PE. **Irriga,** Botucatu, Edição Especial, IRRIGA & INOVAGRI, p. 31-39, 2017.