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Comparison of reference crop evapotranspiration methods in western part of Maharashtra state

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ABSTRACT

The Penman-Monteith equation presented by Food and Agricultural Organization (FAO56- PM) is considered as the standard method to estimate ET_r and hence in this study, commonly use methods. viz. Modified Penman FAO-24, Hargreaves-Samani, FAO-24 Pan Evaporation, Blaney -Criddle, and FAO Radiation methods. The comparision were made on the basis of the least root mean square error and regression analysis. Out of six methods Hargreaves-Samani was found to be the most suitable method. As r^2 and RMSE between this method and Penman-Monteith method compared with other method were compared with it.

Keywords: Pomegranate (*Punica granatum* L.) reference crop evapotranspiration, climatic data and semi-arid region.

Pomegranate (*Punica granatum* L.) is a deciduous to evergreen fruit crop gaining popularity in arid and semi-arid regions of India and is commercially grown for its sweet-acidic fruit. At present more than 1.25 lakh hectare area is covered in India under pomegranate of which 0.87 lakh hectare areas is in Maharashtra state alone. The productivity level is still low (<11.2 t ha^{-1}) in India as compared to the major pomegranate producing countries like Israel, Iran, Morocco, Egypt, Afghanistan, Spain, Turkey etc. It requires supplementary irrigation and water is a limiting factor for commercial cultivation in arid and semi-arid regions. In Maharashtra pomegranate is predominately grown in the districts of Solapur, Ahmadnagar, Pune, Nasik, Sangli, Satara and Osmanabad. In the pomegranate growing area of Maharashtra, water is scare commodity and hence there is a need to apply water according to water requirement of the crop. Pomegranate is a sensitive fruit crop to water stress. Reference crop evapotranspiration is the major component of water requirement. Therefore, there is a need to estimate reference crop evapotranspiration for proper irrigation design and it eventually production of pomegranate increased.

There are different methods for estimating ET_r; some requiring huge data but considered as accurate and other requiring less data but considered as approximate. The analysis of the performance of the various methods revealed the need for formulating a standard method for the computation of ET_r. For this reason, the FAO Penman-Monteith method (Allen *et al.*, 1998) has been recommended as a standard. Therefore, in this study it was planned to estimate ET_r by different methods and compare those with ET_r values estimated by Penman-Monteith method recommended by FAO as the most accurate one but needs data on many climatological parameters.

MATERIALS AND METHOD

The daily records of climatic parameters were collected from Indian Meteorological Department, Pune and Dryland Agricultural Research Center, Solapur. The daily reference crops ET_r were estimated by different methods for the years (1983-2007). The computer program was written in FORTRAN to calculate reference crop evapotranspiration (ET_r) by using Penman-Monteith, modified Penman, Hargreaves-Samani, FAO Pan Evaporation, Blaney-Criddle and FAO Radiation models using weather data collected from above stated sources.

The linear regression analysis was performed by considering the ET_r by Penman-Monteith as the independent variable and ET_r of the remaining five methods as dependent variable to investigate the suitability for computing ET_r under limited climatic parameters vis-a-via Penman-Monteith method. Similarly, root mean square error (RMSE) between Penman-Monteith method as standard method and other methods was calculated, to use this as an indicator of accuracy of other methods compared to Penman-Monteith method.

RESULTS AND DISCUSSION

The meteorological data of 24 years at the Solapur district of western part of Maharashtra covering the period of January 1984 to December 2007 were analyzed for the calculating reference crop evapotranspiration (ET_r) by different methods. The average weekly values of ET_r by

*Present adrress: Pomegranate research station, Solapur

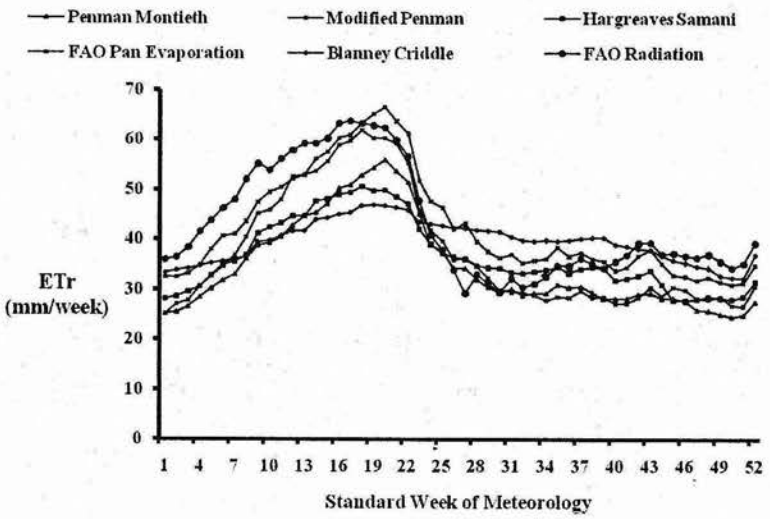

Fig. 1: Average weekly reference evapotranspiration (ETr) for Solapur district (1984-2007)

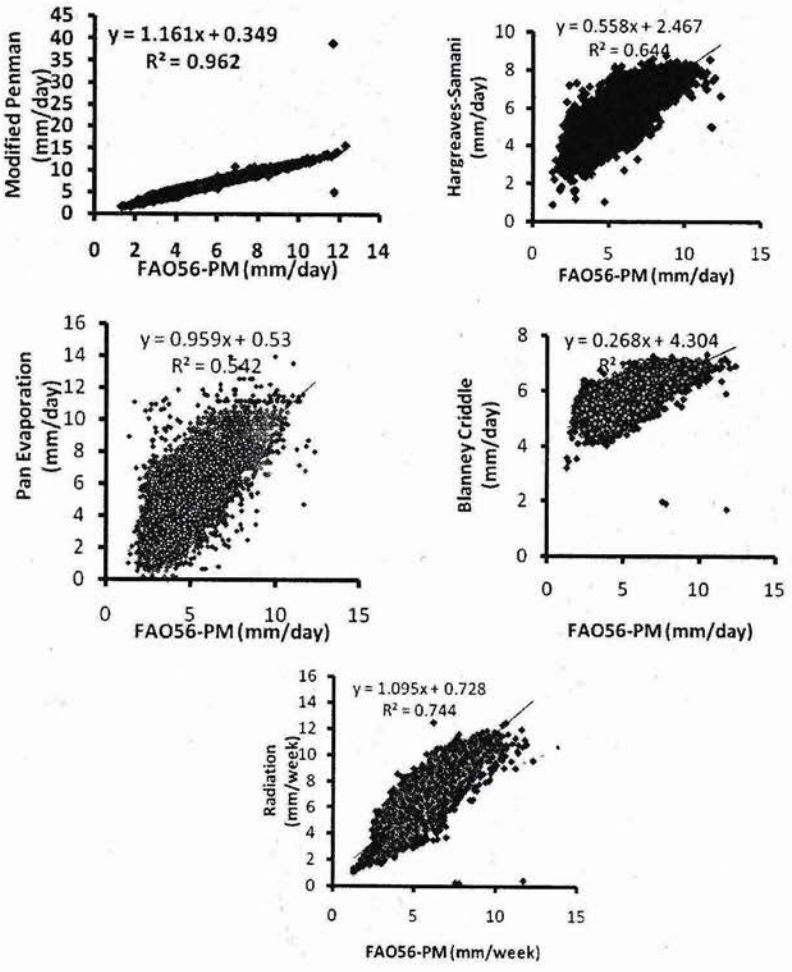

Fig. 2: Daily basis regression analysis of ET_r estimates of (a) Modified Penman (b) Hargreaves Samani (c)Pan Evaporation, (d) Blanney Criddle (e) Fao Radiation method for average weekly ET_r at Solapur district, (mm/day)

different methods are shown in Fig. 1. It is revealed that from the figure, the trend of the estimated ET_r values over the year are in proximity among the different methods, however, none of the methods showed the same results.

The daily basis regression analysis between PM and other methods are shown in Fig. 2. The coefficient of regression (r^2) between Penman-Monteith method and Modified Penman FAO-24, Hargreaves-Samani, FAO-24 Pan Evaporation, Blaney-Criddle and FAO Radiation method are 0.962, 0.644, 0.542, 0.447, 0.744 and 0.985, respectively. This showed that the methods were closely related to P-M method as r^2 between ET_r by P-M method and these methods were more than 0.50. Only Blanney-Criddle method was not closely related with P-M method. When considering the availability of input data, use of these methods are suggested as practical methods for estimating ET_r methods, if the FAO56-PM equation cannot be used due to the complexity of its input parameters.

The performance of the methods compared to P-M method was analyzed by computing the root mean square error of the daily ET_r values between FAO56-PM and other methods. The lower values of root mean square error implies the better performance of the applied method. These values were 1.25, 1.025, 1.43, 1.46 and 1.78 $mmday^{-1}$ for modified Penman, Hargraeves-Samani, Pan Evaporation, Blaney-Criddle and FAO Radiation methods, respectively. The lowest value (1.025) of RMSE was found between ET_r of Hargreaves-Samani and ET_r of P-M methods where as the highest values was observed for ET_r by Radiation method.

Thus, ET_r estimates by Hargreaves-Samani method were found acceptable with P-M method for Solapur district of westran part of Maharashtra state.

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