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Short Communication

Crop water requirement estimation using pan evaporimeter for high density apple plantation system in Kashmir region of India

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Climate, water and soil are fundamental resources for crop production. For efficient crop production, it is essential to utilize these resources efficiently. The maximum potential yield of a crop is determined primarily by the climate and the genetic potential of the crop. However, the availability of water in quantity and time at different stages of growth has a profound effect on the upper limit of a crop's productivity. A judicious assessment of the water requirement of the crops is crucial for irrigation scheduling and planning of farm irrigation systems. In addition most of the precipitation in J&K region takes place in winter and in early spring months, leaving rest of the period almost dry. Apple is an important fruit crop of Jammu and Kashmir. Due to the uneven distribution of rainfall, the success of high density apple plantation system in the region is very low. To cope up the issue for farmers' perspective pan evaporation method is best suitable option and doesn't require any equation or models. Ahmad *et al*. (2017 a & b) has computed reference evapotranspiration at different locations in Kashmir valley following Allen *et al*. (1998) approach. Use of class-A pan evaporation to estimate reference evapotranspiration (ET_O) has been most common in regions which lack the resources of the large amounts of weather data necessary for the mathematical models (Cobaner, 2013). The climate-based irrigation scheduling approaches have been used by many researchers due to simplicity, data availability, and higher degree of adaptability at the farmer's field (Srivastava et al., 2010; Kumar, 2017). Keeping the above points in view the present study was undertaken to ascertain the water requirement of apple.

The present study was conducted for Srinagar (Lati. 34° 44' N and Long. 74°). Weather data for year 2017 and 2018 were obtained from Agrometeorological observatory of SKUAST-K station located in Srinagar. The crop evapotranspiration (ETc) was estimated using daily pan evaporation data recorded with the help of USWB class A pan evaporimeter by using the formula (Mata *et al*. 2014).

$$ETc = \frac{Ep \times Kc \times Pc \times AA \times AC}{IE}$$

Where,

Ep = Pan evaporation (mm); Kc = Crop coefficient; Pc = Pan Coefficient; AA = Area allotted per plant (m^2); AC = Area shaded by canopy at noon (%); IE = Irrigation efficiency of system (85%) taken as decimal

Crop coefficients for the growing season (Apr, 0.50; May, 0.75; Jun, 1.0; Jul, 1.10; Aug, 1.10; Sep, 1.10) were used from FAO (1977). The daily irrigation requirement through drip (litre $plant^{-1}$ day^{-1}) was calculated by subtracting the effective rainfall amounts from the calculated ET_0 values. Effective rainfall was calculated using the guidelines from FAO. Also water requirements were calculated at 100% ETc, 75% ETc and 50% ETc.

The results showed that the apple crop requires maximum water during mid-season stage. The average daily pan evaporation ranged from 3.36 to 4.57 mm in 2017 and 2.63 to 6.08 mm in 2018 during the growing period of apple. It is also observed that pan evaporation values go higher during summer months because of no precipitation and higher temperatures leading to moisture deficit periods. Crop evapotranspiration values (ETc) ranged from 1.47 to 6.84 in 2017 and 2.10 to 7.08 in 2018. Plants used the highest amount of water in July and August during both the years. It was further observed that crop evapotranspiration values exceeded pan evaporation measures from June onwards during both the years (Fig. 1). The average daily irrigation requirement based on pan evaporation method ranged from 1.47 litre $plant^{-1}$ day^{-1} in the month of April to litre $plant^{-1}$ day^{-1} in the month of July for the year 2017 and 1.25 litre $plant^{-1}$ day^{-1} to 7.08 litre $plant^{-1}$ day^{-1} in April and July months respectively for the year 2018 (Fig. 2). Monthly

Table 1: Monthly water requirement at three ETc levels (100%, 75% and 50%) for high density apple plantation (2017 and 2018).

Year/Month	ETc	Total irrigation (litre)		
		100% ETc	75% ETc	50% ETc
		2017		
April	44.2	17.4	13.2	8.6
May	103.2	78.4	59.1	32.4
June	152.0	133.8	100.3	66.1
July	201.2	186.8	139.7	92.8
August	167.0	159.4	119.1	79.5
September	62.5	55.5	41.4	27.3
Total	**730.3**	**631.3**	**472.8**	**306.7**
		2018		
April	37.6	13.4	10	6.7
May	90.8	74.5	55.7	37
June	181.3	170.5	127.6	84.8
July	219.6	197.7	134.5	89.5
August	169.0	109.7	82.3	54.1
September	72.6	72.4	53.9	35.8
Total	**770.9**	**638.2**	**464.0**	**307.9**

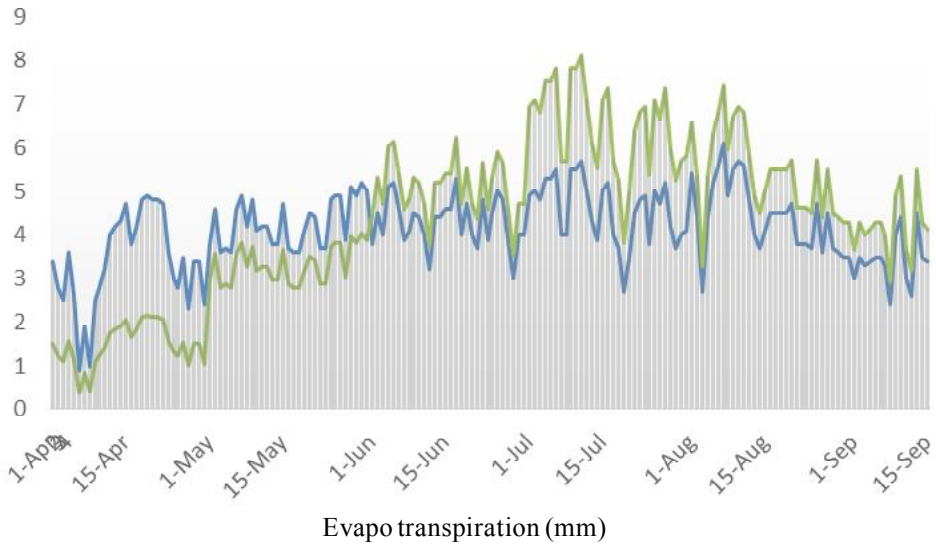

Fig 1 : Daily pan evaporation and crop evapotranspiration values

crop evapotranspiration ranged from 44.2 mm to 201.2 mm in 2017 and 37.6 to 219.6 mm in 2018. Monthly irrigation amount applied through drip under 100% ETc ranged from 17.4 liters to 186.8 liters and 13.14 liters to 197.7 liters in 2017 and 2018, respectively (Table 1). It is therefore clearly observed that water use by plants during vegetative phase is less and when leaves are fully expanded and fruits are on the plants, water use is much higher and towards the end of growing season water use decreases. Ahmad *et al*. (2017 a) also suggests that water requirement by the apple crop is minimum during the initial stage and maximum during mid-season stage. Zanotellia *et al.* (2019) also observed higher

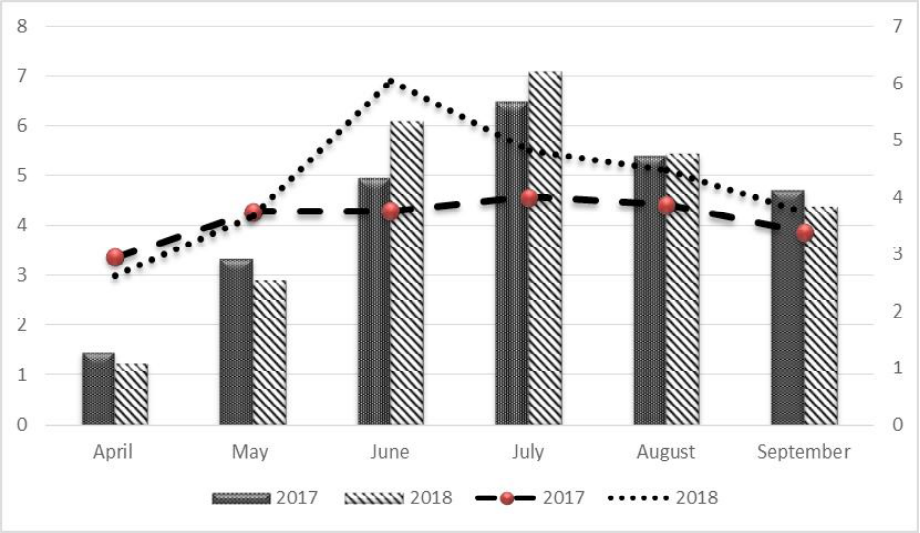

Fig. 2 : Average daily water requirement (litre plant $^{-1}$ day^{-1}) for apple during the growing period

water requirement in mid-season in apple based on Kc values. Phad *et al.* (2019) in their study also reported that ETo increases from January and reaches its maximum towards the summer months because of higher temperatures and wind speed. Pan evaporation method for estimation of daily water requirement in apple appears to be an easy and efficient method for high density plantation system. The method appears to be farmer friendly and reliable for very precise calculation of water requirement without the use of any models or heavy calculations. Pan evaporation method for estimation of water requirement has been successful in saffron (Ahmad *et al.,* 2017), wheat (Kingra *et al.,* 2009) and most of the solanaceous vegetable crops (Ahmad *et al.,* 2019).

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