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Short communication

Estimating potential evapotranspiration in relation to pan evaporation at Ludhiana, Punjab

P. K. KINGRA and S. S. HUNDAL
Department of Agronomy & Agrometeorology
PAU Ludhiana – 141 004

Punjab contributes largely to the Indian agricultural economy and in the process has exploited a considerable part of the existing water resources for irrigation purposes while further exploitation seems to be limited. Thus judicious use of irrigation water is the only way to increase the potentialities of available water resources. Several direct and indirect methods exist to estimate evapotranspiration which include the use of lysimeters, soil water balance and use of empirical formulae. High cost restricts the utility of lysimeters while soil moisture balance method is laborious and time consuming and also needs sophisticated instruments. Thus evaluation of ET by empirical methods has great appeal because ET is estimated from standard climatological data as input The present study was undertaken to evaluate evapotranspiration estimates by the combination method and compare these estimates with pan evaporation.

The weather data for 33 year period (1970 to 2002) was obtained for Ludhiana and Potential evapotranspiration (PET) and Pan evaporation (EP) at Ludhiana were compared. PET was computed using the combination method of Penman (1948) and modified Penman approach (Doorenbos & Pruitt, 1977). Pan evaporation was recorded from the standard US open pan evaporimeter. Regression equations were fitted between PET and EP.

Monthly variations in EP & PET

The monthly EP values (Table 1) indicated that the lowest values of EP were observed for the months of January (48.1 mm) and highest for May (308.8 mm). The same trend was followed by PET computed with Penman method and with modified Penman method. Modified Penman method estimated PET values closer to EP than that of Penman method. Modified Penman method over-estimated the PET as compared to EP throughout the year

Table 1: Monthly values (mean ± s.d.) pan evaporation (EP) and potential evapotranspiration (PET) computed by Penman and modified Penman method

Month	EP (mm)	PET (mm)	
		Penman	Modified Penman
January	48.1 ± 8.5	22.0 ± 4.9	62.8 ± 5.3
February	66.3 ± 12.2	33.7 ± 3.8	92.7 ± 15.6
March	116.5 ± 19.5	75.4 ± 18.2	143.9 ± 10.2
April	212.7 ± 35.2	124.4 ± 37.0	201.5 ± 22.9
May	308.8 ± 58.9	206.9 ± 66.0	268.8 ± 29.2
June	268.1 ± 40.9	216.4 ± 81.0	252.2 ± 31.5
July	162.0 ± 40.8	181.4 ± 73.0	216.7 ± 28.7
August	131.1 ± 22.4	170.7 ± 70.3	193.2 ± 24.3
September	131.4 ± 18.7	129.4 ± 47.7	170.1 ± 16.5
October	119.6 ± 19.9	89.2 ± 24.7	144.3 ± 13.0
November	78.5 ± 13.9	38.0 ± 7.0	89.2 ± 6.3
December	53.5 ± 17.4	21.7 ± 5.8	62.5 ± 7.8

Table 2: Relationship between PET computed with Penman and modified Penman method and Pan evaporation

Sr. no.	Regression equations	R^2	Method
1.	$Y = 0.2688\ X\ 1.1897$ $Y = 0.6765\ X + 13.457$ $Y = 0.7463\ X$	0.72 0.48 0.47	Penman
2.	$Y = -0.0021\ X^2 + 1.500\ X + 1.9603$ $Y = 0.7463\ X + 52.623$ $Y = 1.0192\ X$	0.87 0.81 0.66	Modified Penman

except during April, May & June, where it was lower than EP. Standard deviation of EP and computed PET was found to be lower for winter months but higher for summer months indicating comparatively higher fluctuations in the magnitude of EP and PET in summer months as compared to winter months. Standard deviation in PET with Penman method for summer months was much higher than modified Penman method, indicating higher fluctuations in PET computed with Penman method.

Relationship between PET and EP

The regression relationships of the form y = ax, y = ax + b, $y = ax^2 + bx + c$ and $y = ax^b$. developed with PET computed with each method and pan evaporation are given in Table 2.

In this study, the regression function of the form $y = ax^2 + bx + c$ between PET computed with modified Penman method and EP gave highest R^2 value (0.87) followed by regression function of the form y = ax + b ($R^2 = 0.81$). In case of relationship between PET computed with Penman method and EP, the highest R^2 value ($R^2 = 0.72$) was obtained with the regression function of the form $y = ax^b$. When the data was analysed by regression through origin i.e. y =ax, R^2 values of 0.47 and 0.66 were obtained with Penman and modified Penman method, respectively, which were lower as compared to the R^2 values obtained with regression equation of the form y = ax + b. This difference indicates that PET computed by these methods was biased and this bias was positive when pan evaporation was lower and negative when pan evaporation was on higher side of the scale. Jadhav *et al.* (1999) also studied similar type of relationship between mesh covered pan evaporation and PET computed with Doorenbos and Pruitt method for the Maharashtra region.

PET and EP relationships on a regional level can serve as a tool to estimate the rate of PET from pan evaporation, consumptive water use by various crops and hence irrigation scheduling of the crops can be undertaken in a more judicious manner.

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