

EVAPOTRANSPIRATION FROM WHEAT UNDER SEMI-ARID CONDITIONS IN PUNJAB

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ABSTRACT

Actual evapotranspiration (AET) from wheat irrigated at IW/CPE ratio of 1.0 was measured daily from the weighing lysimeter during rabi 1985-86 and 1986-87. Evaporation (Ep) from USWB class A pan evaporimeter, and potential evapotranspiration calculated by the modified Penman method were compared with AET. The crop season AET amounted to 316 mm in the first and 309 mm in the second year. The AET was found to be 30 mm from sowing to crown root initiation (CRI), 27-40mm from CRI to jointing, 60-80 mm from jointing to heading, 136-146 mm from heading to dough, and 32-45 mm from dough to maturity stages of crop growth during the two-year period. Both PET and Ep remained higher than AET during initial 6 to 7 weeks and again 3 to 4 weeks before harvest. However, AET remained slightly higher than PET and Ep during the maximum growth stage of the crop. Wheat crop resulted in water use efficiency of 11.3 and 13.3 kg grain/ha/mm of water during 1985-86 and 1986-87, respectively.

INTRODUCTION

To make optimum use of the scarce water resources under semi-arid environments, it is imperative that precise estimates of crop water requirements are ascertained. Until recently the evapotranspiration (ET) of the crops has been studied primarily by indirect methods. The use of direct methods employing the lysimetric techniques has rarely been made. Other methods incorporating profile soil water depletion or the field water balance approach have been used by some workers (Shahi, 1976; Lal and Sharma, 1976; Prihar et al. 1976; Kumar et al., 1977). These methods are less accurate than the lysimetric technique as all components of the soil water balance are not directly which may lead to over estimation of the actual ET requirements of the crop. The present study was, therefore, conducted to make direct measurements of actual evapotranspiration (AET) on daily basis using the lysimetric approach and compare it with pan evaporation (Ep) and potential evapotranspiration (PET).

MATERIAL AND METHODS

Evapotranspiration from wheat (Cv. HD-2329) was recorded during rabi, 1985-86 and 1986-87 at Punjab Agricultural University, Ludhiana. The crop was sown on

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4 December, 1985 and harvested on 25 April, 1986 the first year. The corresponding dates during second year were 19 November, 1986 and 14 April, 1987, respectively. Recommended crop cultural practices were followed to raise the crop. The field experiments were designed to study crop response to varying degrees of moisture stress by employing differential irrigation treatments. The actual evapotranspiration (AET) was measured from the unstressed crop receiving irrigations whenever IW/CPE ratio reached unity. Irrigation water (IW) depth of 7.5 cm was applied when CPE (cumulative pan evaporation from the observatory less effective rainfall (since the previous irrigation) reached 7.5 cm. AET was measured daily from two weighing lysimeters (1.3m x 1.3m x 0.7m) located near the centre of the field. The lysimeter had a weighing accuracy of 0.12 mm of water loss. Daily evaporation (Ep) from USWB class A pan evaporimeter was taken from the meteorological observatory located about 100 m south of experimental site. Potential evapotranspiration (PET) was calculated using the method of Penman as modified by Doorenbos and Pruitt (1977). A comparison was made of the estimates of AET, PET and Ep on weekly basis as well as by crop growth stages during the growing season.

RESULTS AND DISCUSSION

The weekly totals of AET, PET and Ep during the 1985-86 crop season are shown in Fig. 1. The AET in the beginning 4 to 5 weeks was low but showed an increasing trend afterwards reaching the peak values after 17 weeks of sowing with a sharp decline afterwards till maturity. A more or less similar trend in AET was observed during rabi 1986-87 (Fig. 2). The comparison of AET with PET and Ep revealed that both PET and Ep remained higher than AET during the first 6 to 7 weeks after sowing. From the period 8 weeks after sowing onwards AET remained generally higher than PET and Ep until about three weeks before the harvest. The ratio AET/PET and AET/Ep exceeding unity during this period indicated that advective energy from the surrounding may be contributing towards evapotranspiration by the crop. Similar response in ET/Ep ratio have also been reported for wheat by other workers (Lal and Sharma, 1976; Kumar *et al.*, 1977; Arora *et al.*, 1988). During the last 3 to 4 weeks large differences occurred between the three parameters with Ep showing the highest and AET the lowest values. This decrease in AET is largely the result of reduced transpirational losses because of senescence and maturity of the crop. Since both PET and Ep are independent of plant phenophase and soil factors, their magnitude depends mainly on the prevailing atmospheric demand for evaporation. These results indicate that PET and Ep are not usually well correlated with AET during early and late crop growth stages. When the crop growth period during April was omitted, the PET and Ep correlated significantly with AET during both the crop seasons. A correlation of 0.88** to 0.94** was observed between AET and PET and 0.79** to 0.87** between AET and Ep during the two crop seasons.

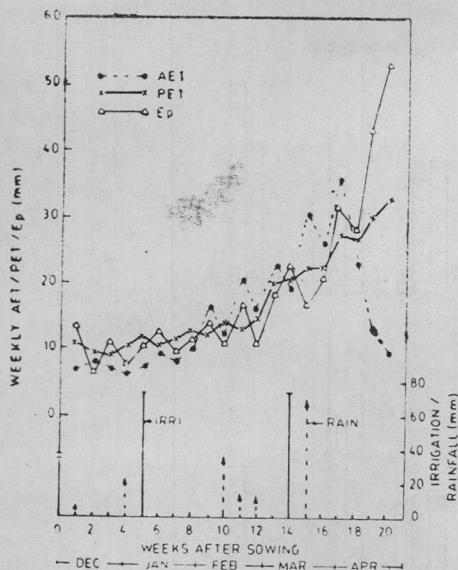


Fig. 1. December 1985-April 1986

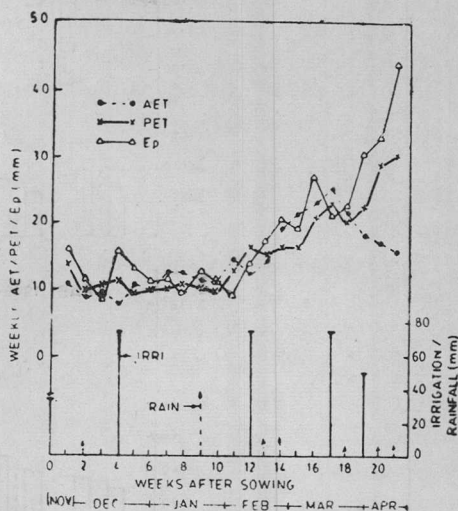


Fig. 2. November 1986-April 1987

Weekly totals of actual evapotranspiration (AET), potential evapotranspiration (PET) and pan evaporation (Ep) during two wheat growing seasons

The cumulative AET, PET and Ep during different growth stages of wheat are shown in Fig. 3. The AET was found to be 30 mm from sowing to crown root initiation (CRI), 27-40 mm from CRI to jointing, 60-80 mm from jointing to heading, 136-146 mm from heading to dough, and 32-45 mm from dough to maturity stages of crop growth during the two year period. The average daily rate of AET was 1.05 mm/day during sowing to CRI, 1.28 mm/day during CRI to jointing, 2.24 mm/day during jointing to heading, 3.89 mm/day during heading to dough and 2.14 mm/day during dough to maturity stage of the crop in the first year. The corresponding values during the second year were 1.42, 1.47, 1.71, 2.98, 2.31 mm/day, respectively.

The crop and ET parameters during the two-year period are summarised in table 1. The seasonal AET amounted to 316 and 309 mm during rabi, 1985-86 and 1986-87, respectively. The PET values exceeded AET by 19-28 mm but Ep values exceeded AET by 59-69 mm during the two crop seasons. Wheat grain and straw yields resulted in water use efficiency of 11.3 and 13.3 kg of grain/ha/mm water in first and second crop season, respectively, whereas 21.4 and 19.7 kg straw/ha/mm water were produced during first and second crop season, respectively. These results indicate that for wheat, on an average, 312 mm of water is required for evapotranspiration under semi-arid conditions of Punjab.

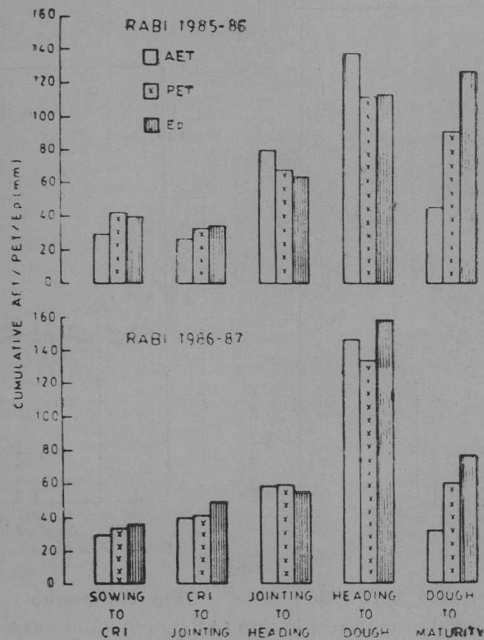


Fig. 3. Cumulative actual evapotranspiration (PET) and Pan evaporation (Ep) for various crop growth stages the two crop seasons

Table 1. Evapotranspiration parameters, crop yield, and water use efficiency for wheat during the two crop seasons

Parameter	Season		Mean
	1985-86	1986-87	
Seasonal AET (mm)	316	309	312.5
PET (mm)	344	328	346.0
Ep (mm)	375	378	376.5
Rainfall (mm)	171	91	131.0
Crop duration (weeks)	20	21	—
Crop yield (kg/ha)			
Grain	3570	4104	3837.0
Straw	6750	6087	6418.5
Water Use Efficiency (kg/ha/mm)			
Grain	11.3	13.3	12.3
Straw	21.4	19.7	20.6

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