Correlation of Evaporation Values of Different Evaporimeters with Consumptive Use of Water by Wheat*

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ABSTRACT

Studies were conducted on the farm and the meteorological observatory of the Gujarat Agricultural University, Junagadh campus, during winter season of 1969-70 to study the correlation of evaporation values of four different types of evaporimeters viz., the US Weather Bureau Class I Open Pan Evaporimeter, Piche Evaporimeter, Sunken Screen Open Pan Evaporimeter and Can Evaporimeter with the consumptive use of water by wheat in the field. The Sunken Screen Open Pan Evaporimeter and Can Evaporimeter showed a significant correlation, which indicated close agreement between actual consumptive use of water by wheat crop in the field and estimates of evaporation from these two gadgets. Hence, these two gadgets seem to hold promise to serve as guides in respect of scheduling irrigation for wheat farmers.

INTRODUCTION

ALTHOUGH irrigation has been practised for several centuries, evaluation of a rapid, precise and simple method for measurement of water use by crop plants and for scheduling irrigation has remained a challenge for irrigation workers. A great deal of knowledge has been gained about the physiology and physics of water loss by plants on account of better understanding of the fundamental relationship among soil, water and climatic elements. Several formulae have been putforth to work out evapotranspiration rates (Thornthwaite, 1948 and Penman, 1948). Many of these formulae have been tested at IARI, New Delhi and other places. It has been generally observed that these are not so useful for day to day irrigation practices (Abdel-Aziz, Taylor and Aschroft, 1964, and Singh, Dastane and Yusuf, 1970). Besides, the use of these expressions involve not only need of precision devices for measurement of various meteorological components but also the technical know-how. The evaporimeter integrates all the meteorological elements causing evaporation of water giving them their natural weightage in a given climate water-plant-continuum.

Bathakal and Dastane (1968) estimated evaporation by different methods and compared them to actual water use rates by wheat. They found that the evaporation rates from the US Weather Bureau Class-I Open Pan Evaporimeter were very close to the consumptive use

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of water by crops. Similar results were also reported by Singh *et al*, *(1970)*. According to Dastane (1967), water allocation and scheduling of irrigation based on data of the Pan Evaporimeter is likely *to increase* agricultural production at least by 15-20 per cent. No information on this aspect was available for Gujarat and hence, the present investigation was undertaken.

METHODS

This study was conducted on the farm of the Gujarat Agricultural University, Junagadh campus, during winter season of 1969-70 on *Kalyan Sona* wheat. The studies on evaporimetry were carried out at the meteorological observatory of the farm.

The soil of the experimental plot was shallow in depth (60 cm) and clay in texture. Its field capacity varied from 17.1 to 24.6 per cent at *different* depths. The wilting point varied from 10.7 to 12.2 per cent while the bulk density varied from 1.22 to 1.30, respectively in different soils layers. Depthwise values of these soil moisture constants are presented in Table 1.

TABLE—1

Values of soil moisture constants at different soil depths.

	Soil depth (cm)			
Particulars	*0-15*	*15-30*	*30-45*	*45-60*
Field capacity	24.60	19.90	19.40	17.10
Permanent wilting point %	10.70	14.00	14.20	12.20
Bulk density g/cu cm	1.30	1.27	1.98	1.72

Different types of evaporimeters viz., *the US Weather Bureau* Class-I Open Pan Evaporimeter, Piche Evaporimeter, Sunken Screen Open Pan Evaporimeter and Can Evoporimeter located at the meteorological observatory of the farm were included in the study to correlate their values of evaporation with the rates of consumptive use of water by wheat grown under the field condition. The actual consumptive use of wheat under field condition was estimated on the basis of magnitude of moisture deficit in the soil as per formula given by Dastane *(1967 a)*. Soil samples were drawn before and after each irrigation while moisture content was determined by gravimetric method. The specifications of the Sunken Screen Open Pan Evaporimeter and the Can Evaporimeter were as per description by Dastane (1967) and Sharma and Dastane (1970), respectively. The observations were also recorded as per procedure adopted by them. Correlation coefficients between the actual water use rates Y and the evaporation from different evaporimeters X were worked out for different gadgets.

RESULTS AND DISCUSSION

Data on total evaporation X from different evaporimeters located at the meteorological observatory of the farm and consumptive use of water Y by wheat under field conditions and the ratios of evaporation from different evaporimeters to consumptive use of water by wheat in the field on the basis of different physiological stages of crop growth are presented in Table 2.

TABLE—2

Relationship between consumptive use of water (mm) by wheat under field conditions and evaporation from different evaporimeters and ratios of evaporation from different evaporimeters to consumptive use of water by wheat.

Period	*Stages of crop growth*	*Consumptive use of water by wheat in field mm (Y)*		*Evaporation mm*							
				U.S. Weather Bureau Class-I Open Pan Evaporimeter (X)		*Piche Evaporimeter (X)*		*Sunken Screen Open Pan Evaporimeter (X)*		*Can Evaporimeter (X)*	
		Total	*per-day*	*Total*	*per-day*	*Total*	*per-day*	*Total*	*per-day*	*Total*	*per-day*
24-11-69 to 12-12-69	Crown root initiation	24.3	1.3	122.3 (5.0)	6.4	166.3 (6.8)	8.7	53.0 (2.2)	2.8	137.0 (5.2)	7.8
13-12-69 to 28-12-69	Late tillering	23.0	1.4	10.2 (4.4)	6.3	1631.4 (7.1)	10.2	44.0 (1.9)	2.7	92.7 (4.0)	5.7
29-12-69 to 5-1-70	Late jointing	23.2	2.9	45.5 (1.9)	5.6	74.1 (3.1)	9.2	41.0 (1.7)	5.1	77.8 (3.3)	9.7
6-1-70 to 12-1-70	Boot	29.6	4.2	36.9 (1.2)	6.1	62.4 (2.1)	10.4	39.8 (1.3)	6.6	93.9 (3.2)	13.4
13-1-70 to 26-1-70	Flowering	26.7	2.0	89.6 (3.3)	6.4	137.3 (5.1)	9.9	30.3 (1.1)	2.1	96.0 (3.5)	6.8
27-1-70 to 5-2-70	Milk	44.7	4.5	88.9 (1.9)	8.9	124.6 (2.7)	12.5	58.2 (1.3)	5.8	151.0 (3.1)	15.1
6-2-70 to 17-2-70	Dough	50.8	4.2	100.4 (1.7)	8.3	140.0 (2.7)	11.6	62.0 (1.2)	5.1	163.0 (3.1)	13.5
18-2-70 to 4-3-70	Maturity	49.6	3.5	103.4 (2.0)	7.4	125.4 (2.5)	8.09	71.4 (1.4)	5.1	153.7 (3.0)	10.0
Total		271.9		688.2		993.5		389.7		965.1	
'r' value		0.162		0.052		0.052		0.738		0.822	
'r' test		N.S		N.S		N.S		Sig.		Sig.	
Regression		—		—		—		Y=6.23 + 0.57 (X)		Y=5.04+0.24 (X)	

N.S.=Not significant, Sig.—Significant at 5%

Note:- Digits in parentheses are the ratios of evaporation from different evaporimeters to consumptive use of water by wheat....

It is indicated that the values of total evaporation from the Sunken Screen Open Pan Evaporimeter were lower (389.7mm) than the values from the US Weather Bureau Class-I Open Pan Evaporimeter (688.2 mm). This might be due to the sunken installation of the former gadget and provision of a separate stilling well outside the evaporation pan. The results are in confirmity with studies conducted by Sharma and Dastane (1970).

The studies on correlation of the values of consumptive use of water by wheat in the field and the evaporation from the Sunken Screen Open Pan Evaporimeter and Can Evaporimeter (Table 1) showed a significant correlation. The values of correlation co-efficients obtained were 0.738 and 0.882, respectively. The regression equations worked out for the Sunken Screen Open Pan Evaporimeter and the Can Evaporimeter were $Y=6.23+0.57X$ and $Y=5.04+0.24X$, respectively. Similar high correlation was also reported by Sharma and Dastane (1970).

The ratio between the evaporation from the Sunken Screen Open Pan Evaporimeter and consumptive use of water by wheat was very narrow as compared to similar ratios obtained with the US Weather Bureau Class-I Open Pan Evaporimeter, the Can Evaporimeter and the Piche Evaporimeter. The average ratios of evaporation from the Sunken Screen Open Pan Evaporimeter and the US Weather Bureau class-I Open Pan Evaporimeter to consumptive use of water by wheat were 1.5 and 2.7, respectively. These ratios obtained in the present study seem to be higher as compared to those observed by Sharma and Dastane (1968) which were 0.99 and 1.24, respectively, for wheat under Delhi conditions. The higher values in this study may be due to the fact that the evaporimeters were installed in the meteorological observatory in the present study whereas they were placed in the wheat field for the studies conducted by Sharma and Dastane.

The ratios of the Sunken Screen Open Pan Evaporimeter and the Can Evaporimeter ranged between 1.1 to 2.2 and 3.0 to 5.2., respectively. These ranges are narrow as compared to the ratios of the US Weather Bureau Class-I Open Pan Eavporimeter and the Piche Evaporimeter which ranged between 1.2 to 5.0 and 2.1 and 7.1, respectively. This shows that the Sunken Screen Open Pan Evaporimeter and the Can Evaporimeter can be more satisfactorilly used for estimating water loss by wheat. It is apparent that use of these gadgets might go a long way in improving water delivery practices in the command areas and make them crop oriented for increased production.

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