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RESEARCH PAPER

Crop co-efficients through lysimetric observations and its comparison with different approaches of groundnut (*Arachis hypogea*)

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Abstract : In the dryland region, groundnut (*Arachis hypogea*) is grown as a rainfed crop, which is exposed to varying sets of weather conditions in general and rainfall distribution is particular. The acute need of water at critical growth stages, through lysimetric observations and its comparison with different approaches may provide information for decision making in irrigation scheduling the measurement of AET by means of lysimeter and it is essential to establish a relationship between the measured value of AET by in lysimeter and the estimated PET by different empirical formulae. Keeping these points in mind, a research project was planned on estimation of crop evapotranspiration in groundnut crop through lysimeter. From the field study it was seen that the Blaney and Criddle, Thornthwaite and pan evaporation methods did not give correct prediction of PET, due to estimated KC values and did not give correct estimation at various phenophases. For estimation of PET under dryland region at Solapur condition, the modified Penman method is the most suitable. The total seasonal actual evapotranspiration (AET) for groundnut was found to be 391.13 mm. This again necessities the application of protective irrigation to groundnut during peg formation to kernal development stage by the modified Penman method.

Key Words : Crop co-efficients, Evapotranspiration, Groundnut

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INTRODUCTION

Crop evapotranspiration can be estimated by direct measurements of the water loss from a soil (using lysimeters) and vegetation samples or can be estimated by the reference crop evapotranspiration (ET_o) and crop co-efficient (K_c) by Doorenbos and Pruit (1977), Kang (1986) and Kerr *et al.* (1993). Crop evapotranspiration is not easy to measure since specific devices and measurements of various physical parameters or the soil water balance in lysimeters are required. These methods are often expensive, demanding in terms of accuracy of measurement and can only be fully exploited by well-trained research personal.

The crop co-efficient represents crop specific water need and is essential for accurate estimation of irrigation requirement of different crops in the command area (CSSRI, 2000). Crop co-efficient also serves as an aggregation of the physical and physiological, differences between crops (Allen *et al.*, 1994). Although crop co-efficients, in general, are suggested by various researchers for a number of crops grown under different climatic conditions (Doorenbos and Pruitt, 1977), these values are general estimates and can only be used at locations where local data are not available. Crop co-efficients need to be derived empirically for each crop based on lysimetric data and local climatic conditions (Allen *et al.*, 1998). Therefore, there is an acute need for local calibration of crop co-efficient under given climatic conditions since such studies on crop co-efficients are very limited and are not well

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documented for dryland situation.

Keeping these points in mind, a research project was planned on estimation of crop evapotranspiration in groundnut crop through lysimeter and its comparison with the different approaches.

MATERIAL AND METHODS

The present investigation was carried out by laying out experiment on groundnut with objectives to study of the measurement of AET in groundnut and estimation of PET by various methods and its comparison with AET. The daily data of all weather parameters *viz.*, maximum and minimum air temperature, maximum and minimum relative humidity, wind speed, actual sunshine hours and rainfall for the crop growing season were collected from the weather station at meteorological observatory dry farming research unit solapur. The pan evaporation data measured from USWB Class-A pan was collected for this period. These meteorological parameters were used for estimation of potential evapotranspiration (PET) by different methods namely, Blaney Criddle, Thornthwaite, Modified Penman and Pan evaporation. These methods compared with AET in groundnut. Similarly measured AET in groundnut crop was various phenophases as well as meteorological week wise. The actual evapotranspiration was measured by the two weighing type of lysimeters and estimated PET by various methods according to developed crop co-efficient was estimated according to the phenophases of the crop as well as meteorological week wise.

The daily actual crop (ET_c) for each phenophase was obtained using lysimeter data with respect to groundnut crop grown in and outside the lysimeter. The AET values were derived from the difference of weight of the lysimeter in 24 hours, which was recorded daily at 8.30 am. The measured crop co-efficients (K_c) for all the methods for groundnut crops under study was calculated using the relation.

$$K_c = \frac{ET_c}{ET_0}$$

in which, ET_c is the actual crop evapotranspiration mm day^{-1} measured from lysimeter and PET estimated by the Blaney and Criddle, Thornthwaite, E Pan and modified penman method.

RESULTS AND DISCUSSION

A field experiment was conducted at dry farming research unit Solapur. The experiment was conducted with groundnut crop in a field where two weighing type of lysimeters were installed. The experiment was non-replicated and estimation of reference crop evapotranspiration was measured on daily basis. At the same time, the daily weather data recorded at near by observatory were tabulated. The results of the present study are described and discussed in the following paragraphs.

Estimated crop co-efficient by various approaches :

The crop co-efficient (K_c) is the ratio of AET to PET. It clearly means that crop co-efficient is the value which represents the canopy development and radiation trapping, in the course of crop development. The estimated (K_c) values obtained using different approaches tested in this study on phenophase basis as well as meteorological week basis are presented in Table 1 and 2 and Fig. 1 and 2, respectively.

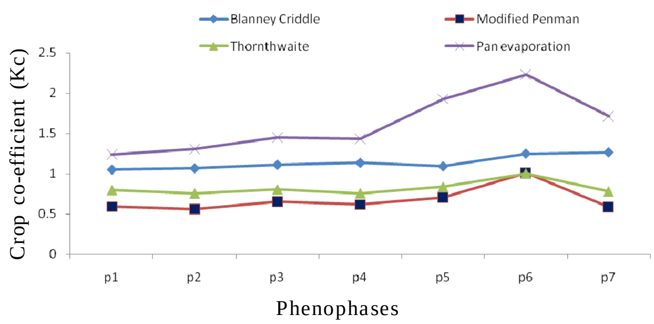

Fig. 1 : Methods during groundnut crop growing season 2010.

The data (Table 1) indicated that the K_c values obtained through Blaney and Criddle and Pan evaporation approach was higher than one through out the crop life cycle as well as meteorological week basis. The comparison of different approaches revealed that the K_c values obtained through Thornthwaite (1948) method was next to Blaney and Criddle (1950) and pan evaporation.

Thornthwaite method next to Blaney and Criddle and pan evaporation. The K_c values through modified penman approach showed lower K_c values throughout the different

Table 1: Estimated crop co-efficient values (K_c) according to different phenophases of the groundnut crop by various methods

Phenophases	Blanney and criddle	Modified penman	Thornthwaite	Pan evaporation
Sowing to emergence (P_1)	1.05	0.59	0.79	1.23
Emergence to vegetative(P_2)	1.06	0.56	0.75	1.30
Vegetative to flowering (P_3)	1.11	0.65	0.80	1.44
Flowering to peg formation(P_4)	1.13	0.61	0.75	1.43
Peg Formation to pod formation (P_5)	1.09	0.70	0.83	1.92
Pod Formation to kernel development (P_6)	1.25	1.01	1	2.23
Maturity (P_7)	1.26	0.59	0.78	1.71

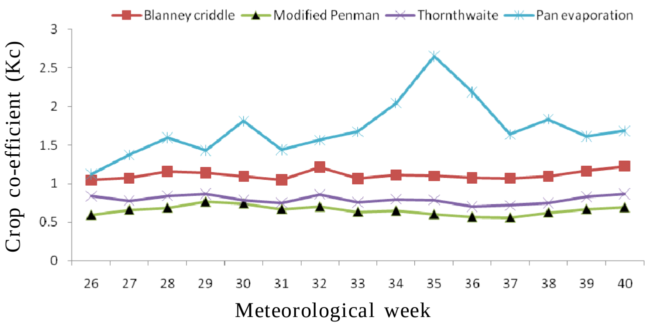

Fig. 2 : Crop co-efficients estimated by various approaches

phenophases as well as through meteorological week wise. The higher K_c values were due to lower PET values estimated through Blaney and Criddle, Modified Penman, Thornthwaite and pan evaporation approaches. The K_c values in different phenophases obtained to various approaches ranged between 1.05 to 1.26, 0.56 to 1.01, 0.75 to 1.00 and 1.23 to 2.23 for Blaney and Criddle, Modified Penman, Thornthwaite and pan evaporation approach, respectively. While these values when estimated on meteorological week basis ranged between 1.04 to 1.22, 0.56 to 0.76, 0.71 to 0.86 and 1.12 to 2.64 for Blaney and Criddle, Modified Penman, Thornthwaite and pan evaporation approach, respectively. The trend indicated that the K_c values increased uniformly and gradually through P_1 (Sowing to emergence) to P_7 (Maturity). The comparison between different approaches showed a similar trend in all the method studied. The crop co-efficient (K_c) graph (Fig. 1) reflects seedling stage with low values and then rising limb during increased growth and peak were the crop attains maximum cover and growth followed by the decreasing limb when leaves start shedding at the end of the growth cycle (Li *et al.*, 2003).

The modified penman was correct estimation of kc suggested by FAO56 Allen *et al.* (1998) according to various phenophases of groundnut. The K_c values for groundnut increased in modified penman method in Peg formation to pod formation stage, due to the need of protective irrigation at this stage. These results are closely related with those of Shih *et al.* (1997).

Temporal variation of crop co-efficients (K_c) for groundnut :

Temporal variation of K_c for groundnut indicates a cyclic variation of K_c throughout the crop growth period. The variation in K_c may be occurrence of rainfall events resulting in increased values of K_c whereas when the soil is dry the less availability of soil water reduced K_c values. The K_c values of groundnut increased during pod formation to kernel development stage due to high evaporative demand. The PET values were affected due to the availability of soil water, method of estimation of PET due to variation in K_c occurred.

Also demonstrated that the measured crop co-efficient for groundnut were higher than the empirical K_c by Blaney and Criddle and the pan evaporation approaches. On the other hand in the later crop growth stages namely, seedling, flowering, pod formation, grain formation and pod development stages. The measured in K_c were higher than those suggested by in FAO 56 Allen *et al.* (1998). Crop co-efficients were found to be vary with the percentage of the ground covered by crops, rate of crop development, time to achieve full ground cover and frequency of precipitation (Jagtap and Jones, 1989). The higher measured K_c values in the various crop stages by Blanney and Criddle and pan evaporation indicated that the error in prediction of PET and crop canopy cover was the least and hence, showed higher K_c than empirical one. On the contrary, the lower measured K_c P_1 (Sowing to emergence) and P_7 (Maturity) growth stages may be attributed to the fact that the lower rainfall observed

Table 2: Estimated crop co-efficient (K_c) values according to different meteorological weeks of the groundnut crop by various methods

Meteorological weeks	Blaney criddle	Modified penman	Thornthwaite	Pan evaporation
26	1.04	0.59	0.83	1.12
27	1.06	0.66	0.77	1.37
28	1.15	0.68	0.84	1.59
29	1.13	0.76	0.86	1.43
30	1.09	0.74	0.78	1.80
31	1.04	0.66	0.75	1.43
32	1.21	0.70	0.86	1.56
33	1.06	0.63	0.75	1.67
34	1.11	0.64	0.79	2.04
35	1.09	0.60	0.78	2.64
36	1.07	0.56	0.69	2.18
37	1.06	0.56	0.71	1.63
38	1.09	0.62	0.74	1.83
39	1.16	0.66	0.83	1.61
40	1.22	0.69	0.86	1.68

due to which limited availability of water for crops at these growth stages.

Conclusion :

Though irrigation facilities are created to a remarkable increase after independence, major area is still under rainfed cropping system. However, the erratic behavior of monsoon stakes the agricultural enterprise at gamble. Judicious use of rainwater to meet the crop water requirement is a need of hour for a step towards stabilized agriculture. This input if taken care of, the productivity of the rainfed crops can be increased substantially. The accurate estimation of evapotranspiration can help in a better way to estimate the crop water requirements in the trance of crop phenophases.

Evaluating the actual crop water requirements and proper irrigation scheduling are the major points to be considered for agricultural planning. The accurate estimation of evapotranspiration can help to determine crop water requirements under existing cropping pattern and climatic condition. Water use efficiency and proper irrigation scheduling basically are governed by crop evapotranspiration, which is a function of potential evapotranspiration (PET) and crop co-efficient (K_c). On the other hand and crop ET (AET) and crop co-efficient varies with the crop and also with its growth stages.

Reference crop ET were estimated and compared with lysimetric observations. The study revealed that among the methods tested, modified penman method was found to be suitable for advocating the irrigation scheduling as it matched well through out the crop season. The Blanney Criddle and Pan evaporation estimation methods under estimated the values when compared with lysimetric data. As these method are based on only air temperature, pan evaporation and other parameters such as radiation, relative humidity, bright sunshine hours, wind factor were not included which also played significant role is affecting the ET, the results obtained through these methods are not comparable.

It can be concluded from the study that the modified Penman method was found suitable and ideal for assessing the crop water requirements.

Following conclusions could be drawn from the result of the study.

– The total seasonal actual evapotranspiration (AET) for groundnut is found to be 401.24 mm at Solapur to be less than the seasonal water requirement of this crop for dryland region.

– The Blaney Criddle, Thornthwaite and Pan evaporation methods do not give correct prediction of PET, due to the estimated K_c values do not give correct estimation at various phenophases.

– For estimation of potential evapotranspiration (PET) under dryland region at Solapur condition the modified Penman method is the most suitable having sound theoretical formulations and more accuracy in estimation as compared with the Blaney Criddle, Thornthwaite and Pan evaporation methods.

– This again necessities the application of protective irrigation to groundnut especially during peg formation to pod formation stage by the modified penman method.

REFERENCES

Allen, J. (1994). An update for the calculation of reference evapotranspiration. ICID Bull. **43** : 35-92.

Allen, R., Percira, L.A., Raes, D. and Smith, M. (1998). Crop evapotranspiration FAO irrigation and drainage, Paper no. 56 Food and Agricultural organisation of the United Nations, Rome, Italy 213 PP.

Blaney, H.F. and Criddle, W.D. (1950). Determining water requirements in irrigated areas from climatological and irrigation data. USDA (SCS) TP–96, 48 pp.

CSSRI (2000). Evapotranspiration estimation and crop co-efficient. Technical report of central soil salinity Research Institute Karnal, India.

Doorenbos and Pruitt (1977). Guidelines for predicting crop water requirement FAO irrigation and drainage paper no. 24 FAO, Rome Italy, pp. 156-179.

Jagtap, S.S. and Jones, J.W. (1989). Stability of crop co-efficients under different climate and irrigation management practices. *J. Irri. Sci.*, **10** : 231-244.

Kang, S.Z. (1986). Calculation and predivision of actual winter wheat evapotranspiration in condition of soil water deficit (in Chinese). *Acta. Univ. Agric. Boreali Occidentals*, **14**(1) : 93-102.

Kerr, G., Pochop, L., Fornstorm, K.J., Krall, J.M. and Brown, D. (1993). Soil water and evapotranspiration estimates for a wide range of rainfed and irrigated conditions. *Agric. Water Mgmt.*, **24** : 147-149 pp.

Li, E.T., Hicks, B.B., Sainty, G.R. and Grauze, G. (2003). Climate and evaporation from crops. *ASAE. J. Irri. & Drainage Div.*, **93** : 61-79.

Thornthwaite, C.W. (1948). An approach towards a rational classification of climate. *Geographical Review*, **38** : 55-94.