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Development of growth-stage-specific crop co-efficient for different crops of Parbhani district

■ **TARATE SURYAKANT BAJIRAO AND HARISH W. AWARI**

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See end of the Paper for authors' affiliation

Correspondence to :

TARATE SURYAKANT BAJIRAO
Department of Soil and Water Conservation Engineering, College of Technology, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. NAGAR (UTTARAKHAND) INDIA
Email : taratesuryakant01@gmail.com

■ **ABSTRACT :** A study was carried out to develop crop wise crop co-efficient (K_c) of different crops for Parbhani district of Maharashtra state. The development of regionally based and growth-stage-specific crop co-efficients (K_c) helps in irrigation management and provides precise water applications for this region. Crop wise crop co-efficient of each of the crop was determined by using 32 years climatic data. The crop co-efficients were determined by following the detail procedure given in FAO 56. The result shows that amongst the various crops grown in the study area some of the values corresponded and some did not correspond to those from FAO-56. Hence, there is strongest need of development of crop wise crop co-efficient of different crops in order to determine crop water requirement.

■ **KEY WORDS :** Crop water requirement, Climatic data, Crop co-efficients

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Development of crop co-efficient (K_c) is the ratio of crop evapotranspiration (ETc) to reference evapotranspiration (ETo) can enhance ETc estimation in relation to specific crop phenological development stages. Evapotranspiration is one of the major components of the hydrologic cycle and its accurate estimation is of paramount importance for many purposes, such as hydrologic water balance study, design and management of irrigation system, crop yield simulation, water resources planning and management. In India, total irrigated area is only one-third of total cropping area but produces about two-third of total agricultural production. So, to fulfil the future demand, it is necessary to increase the total irrigated area and also increase the efficiency of irrigation systems. Considering the current water resources problems and rapid increase in its demand, proper planning and management of water resources is of immense importance to increase agricultural production. One of the basic components of the hydrologic cycle, evapotranspiration (ET), needs to be estimated accurately as it plays a significant role in regional and global climates and its estimation is of great importance in assessing ground water recharge, predicting crop yield, planning land use, etc. (Zhan and Feng, 2003). India, for example, receives about 400 M ha m water in the form of precipitation, of which 65 per cent (260 M ha m) is lost through evapotranspiration (ET). Thus, accurate estimation of ET is of paramount importance for many studies, such as hydrologic water balance, irrigation system design and management, water resources planning and management (Bandyopadhyay *et al.*, 2009).

Determination of actual crop evapotranspiration (ETc) during the growing season has a potential advantage to attain proper irrigation scheduling. Crop co-efficient (K_c) is widely used to estimate crop water use and to schedule irrigations (JonghanKo *et al.*, 2009). The concept of K_c was introduced by Jensen *et al.* (1990) and further developed by the other researchers (Doorenbos and Pruitt, 1975 and 1977; Burman *et al.*, 1980 a and b and Allen *et al.*, 1998). The methodology was developed to provide growers with a simple ETc prediction tool for guiding irrigation management decisions. The use of on-site micro climatological data and crop co-efficients enables the determination of crop water use and dissemination of such information to growers in a reliable, usable and affordable format (Jonghan *et al.*, 2009). Values of K_c for most agricultural crops increase from a minimum value at planting until a maximum Kc is reached at about full canopy cover.

Crop co-efficient values for a number of crops grown under different climatic conditions have been suggested by Doorenbos and Pruitt (1977). These values are commonly used in places where locally measured data are not available. Allen *et al.* (1998) have suggested that the crop co-efficient values need to be derived empirically for each crop based on the local conditions.

■ METHODOLOGY

Study area :

Parbhani district is located in the Maharashtra state of India. The climate of the study area is characterized as semi-arid and tropical. Parbhani is intersected by 19^0 16’ N latitude and 76^0 47’ E longitude and located at an altitude of 409 m above mean sea level. It comes under moderate to moderately high rainfall zone with an average annual rainfall of 955 mm. The soil of the command area is medium deep black clay. The mean maximum and minimum temperature of the study area is 44.6^0C and 21.8^0C, respectively. The mean relative humidity ranges from 30 to 98 per cent.

Data collection :

The daily climatic data for 32 years (1983-2014) were collected from IMD recognized observatory located at Department of Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The data in respect of phenological growth stages of these crops and crop duration were collected from field observations.

Crop co-efficient :

Crop wise crop co-efficient was developed by following the guidelines given by Allen *et al.* (1998).

K_c initial :

The crop co-efficient for the initial growth stage was derived from the following Fig. A which provides estimates for K_c initial as a function of the average interval between wetting events, reference evapotranspiration (ET_o) and importance of wetting event.

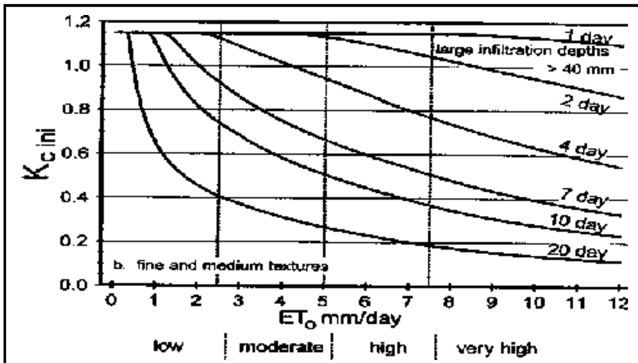

Fig. A : Average K_c initial as related to the level of reference evapotranspiration and the interval between irrigation

$K_c$mid :

For specific adjustment in climates where RH_{min} differs from 45 per cent or where U_2 is larger or smaller than 2.0 m s^{-1}, the $K_c$mid values from the FAO 56 are determined by using equation:

$$K_c\ mid = K_c\ (mid)_{FAO56} + [0.04\ (U_2 - 2) - 0.004\ (RH_{min} - 45)]\ (h/3)^{0.3}$$

where,

$K_c(mid)_{FAO56}$ = Value of K_c mid taken from FAO-56,

U_2 = Mean value for daily wind speed at 2m height,

RH_{min} = Mean value for daily minimum relative humidity during the mid-season growth stage,

h = Mean plant height during mid-season (m).

K_c end :

The K_c end values of FAO-56 are typical values expected for average K_c end under the standard climatic conditions. For specific adjustment in climates where RHmin differs from 45 per cent or where U_2 is larger or smaller than 2.0 m s^{-1} the K_c end values from the FAO 56 are determined by using following equation. For more arid climates and conditions of greater wind speed will have higher values of K_c end. More humid climates and

Table 1 : Comparison of developed and FAO-56 crop co-efficients

Sr. No.	Crops	Crop co-efficient					
		Initial		Mid-season		Late season	
		Developed	FAO-56	Developed	FAO-56	Developed	FAO-56
1.	Sorghum	0.30	0.30	1.05	1.05	0.57	0.55
2.	Wheat	0.33	0.30	1.16	1.15	0.43	0.40
3.	Chick pea	0.34	0.40	1.00	1.00	0.37	0.35
4.	Groundnut	0.35	0.40	1.19	1.15	0.66	0.60
5.	Sunflower	0.31	0.35	1.06	1.00	0.41	0.35
6.	Maize	0.30	-----	1.28	1.20	0.69	0.60
7.	Sugarcane	0.34	0.40	1.30	1.25	0.68	0.75
8.	Pigeonpea	0.30	------	1.12	1.15	0.37	0.30
9.	Cotton	0.20	0.35	1.16	1.20	0.50	0.50
10.	Vegetables	0.35	-------	1.19	1.15	0.86	0.80

conditions of lower wind speed will have lower values of K_c end.

$$K_c \text{ end} = K_c (\text{end})_{FAO56} + [0.04 (U_2-2) - 0.004 (RH_{min}-45)] (h/3)^{0.3}$$

where,

$K_c(\text{end})_{FAO56}$ = Value of K_c end taken from the FAO-56,

U_2 = Mean value for daily wind speed at 2m height,

RH_{min} = Mean value for daily minimum relative humidity during the end-season growth stage,

h = Mean plant height during end-season (m).

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Development of crop co-efficient :

Crop co-efficient were developed by following the guidelines given by FAO-56 (Allen *et al.*, 1998). The crop co-efficient of wheat, sugarcane, pigeonpea, sorghum, chick pea (Gram), maize, cotton, sunflower, groundnut and vegetables were developed.

The developed stage wise crop co-efficient varies slightly with crop co-efficient suggested in FAO-56 (Allen *et al.*, 1998) which are presented in following Table 1.

Kc value is generally very small at the initial growth phase because of low crop cover and most water consumption is from soil evaporation. During the rapid development period, leaf area increases rapidly and causes a rapid increase in the K_c value. The K_c value reached maximum when crops fully developed, and remained stable over a period of time. As the crop matured, the K_c value start to decreasing due to foliage senescence. Similar work related to the present investigation was also carried out by Angela *et al.* (2014); Doorenbos and Pruitt (1977); Sikka *et al.* (2009) and Yanjun *et al.* (2013).

Conclusion :

This research was aimed for determination of exact crop co-efficients (K_C) of different crops for Parbhani district. Irrigation scheduling can then be improved for private consultants and growers to avoid water over use and to more precisely meet the crop water demand to produce greater yields, crop quality, and enhanced water use efficiency. The seasonal K_C values varied from 0.3 to 1.5 for sorghum, 0.33 to 1.16 for wheat, 0.34 to 1.3 for sugarcane, 0.3 to 1.12 for pigeonpea, sorghum, 0.34 to 1.0 for chickpea (Gram), 0.3 to 1.28 for maize, 0.2 to 1.16 for cotton, 0.31 to 1.06 for sunflower, 0.35 to 1.19 for groundnut and 0.35 to 1.19 for vegetables. The development of regionally based K_C helps tremendously in irrigation management.

Authors' affiliations:

HARISH W. AWARI, Department of Irrigation and Drainage Engineering, College of Agricultural Engineering and Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

■ REFERENCES

Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. (1998). Crop evapotranspiration – Guidelines for computing crop water requirements. Irrig. Drain. Paper 56, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Angela, Anda, Jaime, A., Teixeira, da Silva and Gabor, Soos (2014). Evapotranspiration and crop coefficient of common reed at the surroundings of Lake Balaton, Hungary. *Aquatic Bot.*, **116**: 53–59.

Bandyopadhyay, A., Bhadra, A., Swarnakar, R.K., Raghuwanshi, N.S. and Singh, R. (2009). Estimation of reference evapotranspiration using a user-friendly decision support system: DSS ET. *Agric. & Forest Meteorol.,* **154–155** (2012) : 19– 29

Burman, R.D., Wright, J.L., Nixon, P.R. and Hill, R.W. (1980a). Irrigation management-water requirements and water balance. In: Irrigation, Challenges of the 80's, Proc. of the Second National Irrigation Symposium, *Am. Soc. Agric. Engr*, St. Joseph, MI, pp. 141–153.

Burman, R.D., Nixon, P.R., Wright, J.L. and Pruitt, W.O. (1980b). Water requirements. In: Jensen, M.E. (Ed.), *Design of farm irrigation systems*, ASAE Mono., *Am. Soc. Agric. Eng.*, St. Joseph, MI, pp. 189–232.

Doorenbos, J. and Pruitt, W.O. (1975). Guidelines for predicting crop water requirements. Irrig. And Drain. Paper No. 24, Food Agric. Org., United Nations, Rome, Italy. 168 pp.

Doorenbos, J. and Pruitt, W.O. (1977). Guidelines for predicting crop water requirements. Irrig. Drain. Paper 24, 2nd ed. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Jensen, M.E., Burman, R.D. and Allen, R.G. (1990). Evaporation and irrigation water requirements. *ASCE manuals and reports on eng. practices No. 70*, Am. Soc. Civil Eng., New York, NY, 360 pp.

JonghanKo, Giovanni, Piccinni, Thomas, Marek and Terry, Howell (2009). Determination of growth-stage-specific crop coefficients (Kc) of cotton and wheat. *Agric. Water Manage.*, **96** : 1691–1697.

Sikka, Alok K., Sahoo, D.C., Madhu, M. and Selvi, V. (2009). Determination of crop coefficient of Tea. *J. Agric. Engg.*, **46**(3) : 41-42.

Yanjun, Shen, Shuo, Li ,Yaning, Chen, Yongqing, Qi and Shuowei, Zhang (2013). Estimation of regional irrigation water requirement and water supply risk in the arid region of Northwestern China 1989–2010. *Agric. Water Mgmt.,* **128** (2013) : 55– 64.

Zhan, Z. and Feng, Z. (2003). Estimation of land surface evapotranspiration in the western Chinese Loess plateau using remote sensing. In: Int. Geoscience and Remote Sensing Symp. (IGARSS), 4, pp. 2959–2961.