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Development of crop coefficient models of castor and maize crops

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ABSTRACT

Castor and maize are the most commonly cultivated crops in the Rajendranagar region of Andhra Pradesh, India. The study aims to develop a crop coefficient (K_c) models for these crops, using Lysimeter measured daily crop evapotranspiration (ET_c) data and daily reference evapotranspiration (ET_0) computed using FAO-56 Penman-Monteith (PM) method. K_c values obtained using relationship $K_c = ET_c/ET_0$, crop coefficient curves were derived as a function of days after sowing and polynomial model was fitted. The performances of the models were tested using performance indicators. The models performed well for both the crops. These models can, therefore, be used for estimating K_c values of castor and maize crops for any day after sowing in the study region.

1. Introduction

Accurate estimation of the crop water requirement (crop evapotranspiration) is a vital part of agricultural planning. The water requirement varies widely from crop to crop and also during the growth period of the crop. Field measurement (with Lysimeter) of crop evapotranspiration (ET_c) is not so easy and it is often expensive and impractical. The most common and practical approach extensively used for estimating crop evapotranspiration (ET_c) is the crop coefficient (K_c) approach (1977, Allen et al., 1998) which consists of multiplying reference evapotranspiration (ET_0) with crop coefficients (K_c) to find ET_c (i.e., $ET_c = ET_0 \times K_c$).

Reference evapotranspiration (ET_0) is defined as the rate of evapotranspiration from a hypothetical reference green grass of actively growing, completely shading the ground, uniform height, and not short of water (Allen et al., 1998). Accurate field measurements of ET_0 are also difficult and it is usually estimated using weather data. There are several empirical or semi-empirical equations are available to assess ET_0 from meteorological data. Depends upon the data availability, climatic conditions of the area and degree of accuracy, we may choose the appropriative empirical equation to estimate ET_0. However, FAO-56 Penman-Monteith (PM) equation, which yields the results nearer to Lysimeter measured data, may be used as the standard method in all climatic conditions to estimate ET_0.

Experimentally determined ratios of ET_c/ET_0 called crop coefficients (K_c) (Allen et al., 1998). The crop coefficients depend on the type of crop and its varieties, crop height, leaf characteristics, soil properties, climate conditions, irrigation methods and so on. Different crops will have different crop coefficients (K_c), even for the same crop K_c varies throughout the growth period due to changes in vegetation and ground cover. The growing period of the crop is generally divided into four phenological stages (initial, development, mid and late) for the purpose of stage-wise development of crop coefficients. The variations in K_c during the growing period are described in the form of a crop coefficient curve.

Initially the concept of crop coefficients (K_c) was introduced by Jensen Marvin (1968) and later many researchers (Doorenbos and Pruitt, 1977; Allen et al., 1998) are carried out investigations and recommended crop coefficient values for various crops grown under different climatic conditions. These values are normally used at places where local data are not available. However, there is a strong need for local calibration of crop coefficients because the climatic conditions in the field differ from the standard conditions.

Shah and Edling (2000) evaluated PM, FAO-Penman and 1963 Penman combination models for their capabilities to predict rice ET using daily weather data. Crop coefficients of rice for the vegetative, flowering, and yield formation stages were found 1.39, 1.51, and 1.43, respectively. Tyagi et al., (2000) developed crop coefficients (K_c) for wheat and sorghum from ET_c measurements and weather data. It was pointed out that actual K_c values are significantly different from those suggested by the UN FAO indicating the need for generating these values at local/regional level. The relationships between standard UN FAO PM and other ET_0 methods were also investigated. Kashyap and Panda (2001) made an attempt to develop regional relationships between the evapotranspiration measured by the Lysimeter and that estimated by the climatological

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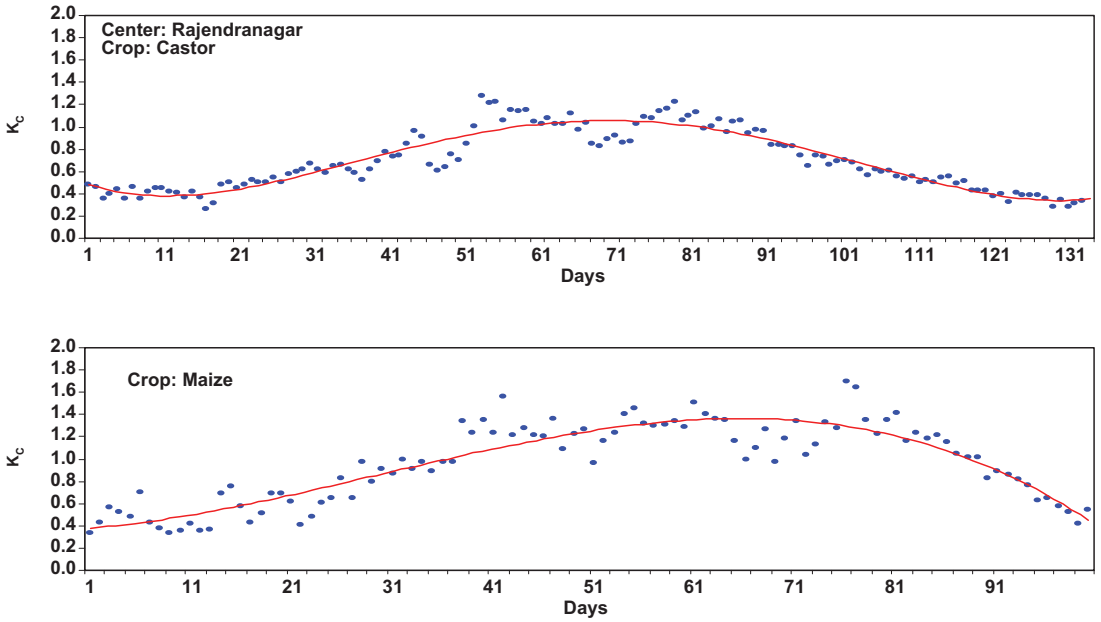

Fig. 1. Variation of daily Kc values.

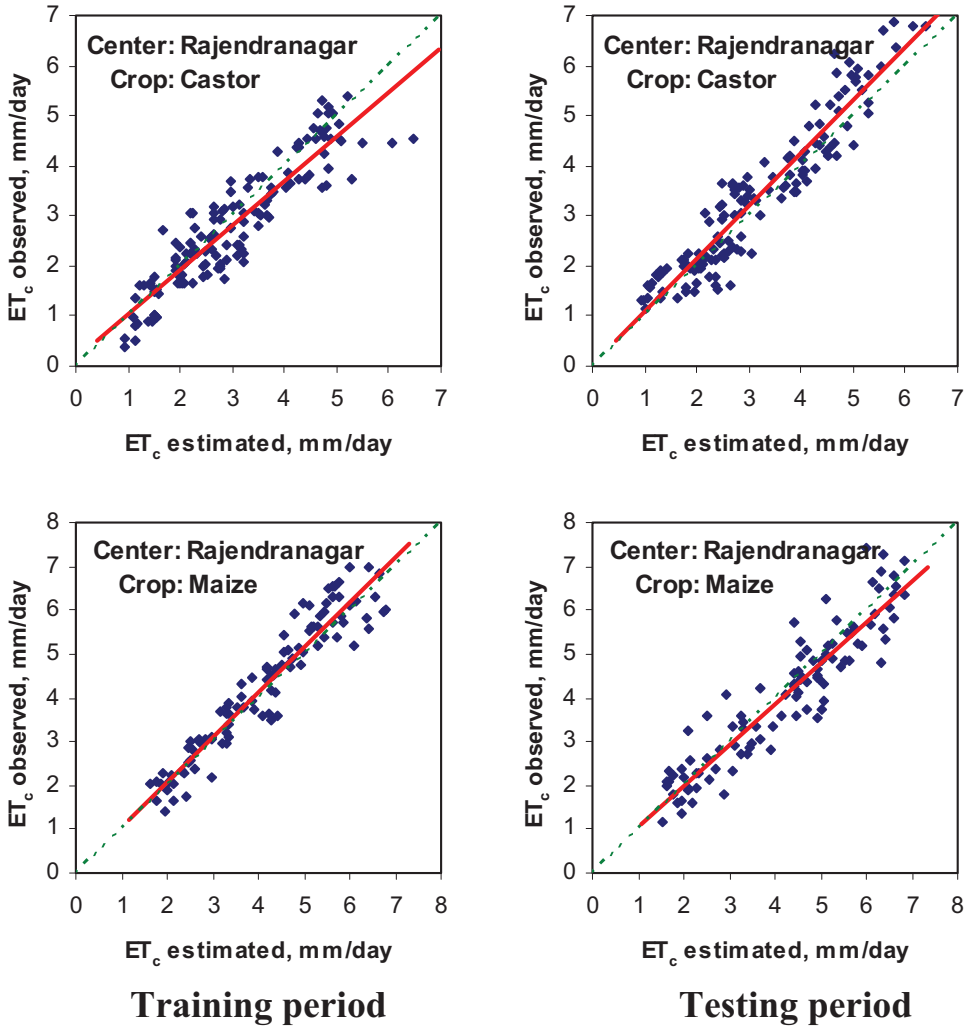

Fig. 2. Scatter plots of daily ETc observed with that estimated using polynomial Kc models and PM ET_0.