A Computer Program for Simultaneous Calculation of Reference and Crop Evapotranspiration by Three Methods

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ABSTRACT

A computer program is developed for computing reference evaporation (ETo), crop coefficient (kc) and crop evapotranspiration (ETc) under various regional and climatic conditions. The program requires for input basic climatological data (temperature, humidity, wind speed and sunshine duration data) that are routinely available at most weather and agricultural research stations. The program calculates ETo simultaneously by three different methods (Blaney-Criddle, radiation and modified Penman methods) and generates results on screen and in output files that can be easily converted into graphs. The program has a large built-in database for essential global parameters needed for calculations such as distribution of extra-terrestrial radiation, maximum possible daily sunshine hours and other information and mathematical relations. The database also covers crop information needed for calculation of kc and ETc such as seasonal and stage lengths for a variety of field crops. The program is designed such that most required data are input in a single file and line inputs are very limited for convenient usage. Extensive testing of the program under various conditions showed very stable performance, consistency and reproducibility, and revealed that the program is capable of providing accurate estimates of reference evapotranspiration, crop coefficient and crop evapotranspiration for many crops. The program is believed to provide a convenient tool for use both by growers and in pertinent scientific applications.

Key words: reference evapotranspriration, crop evapotranspriration, crop coefficient, irrigation.

INTRODUCTION

The ability to estimate crop evapotranspiration (ETc) represents one of the basic elements required for successful planning and management of irrigation systems. Irrigation scheduling is based in principal on data of daily ETc and soil characteristics Kovda *et al.*, (1973); Hansen *et al.*, (1980); (Withers and Vipond, 1980). It has long been acknowledged that actual evapotranspiration (ET) is a function of both the weather and the soil's physical properties and that prevailing environmental conditions significantly determine the limitation of crop production (Pruitt, 1960); (Penman, 1963); Pruitt *et al.*, (1972); (Slatyer, 1967); (Kramer, 1983). The amount of water available for ETc is strongly correlated with the amount of dry matter production (Taylor, 1965); Pruitt *et al.*, (1972); (Black, 1981). When designing water management or irrigation projects, the use of climatological and meteorological data, soil characteristics information and crop parameters becomes particularly valuable. In many cases, justification for supplemental irrigation depends on crop production-evapotranspiration relations (USDA-SCS, 1967); (Withers and Vipond, 1980); Hansen *et al.*, (1980).

Throughout the past 60-70 years, numerous studies on parameters influencing ET were conducted and attempts were made to materialize these parameters into mathematical functions that allow for quantitative estimation of ETc (e.g. Blaney and Criddle, 1947); (Blaney and Criddle, 1962); (Olivier, 1961); (Stanhill, 1965); (Jensen, 1966) among many others). Several of these attempts were successful and resulted in the formulation of equations or the development of techniques for ET determinations and measurements.

Among the earliest developed formulas were those of (Blaney and Criddle 1947), Penman (1948), (Thornthwaite 1948), and (Olivier 1961). Several years later, new methodologies were developed involving the use of evaporation pan data and measurements (Hargreaves, 1968) or field lysimetry.

The methods of Blaney-Criddle (Blaney and Criddle, 1947); (Blaney and Criddle, 1962), Thornthwaite (Thornthwaite, 1948) and Olivier (Olivier, 1961) are empirical methods based essentially on temperature, which implies the advantage of requiring only the more commonly measured data- and hence usability in most areas- and the simplicity of calculation. The empirical nature of these equations, however, may markedly limit the scope of their applicability and usefulness

. Evapotranspiration is a function of the effect of the total energy environment on the plant. Obviously, neither temperature nor humidity alone is a measure of the total energy, although they are significantly influenced by it. Empirical equations are therefore most appropriate if applied to climatic zones similar in general to those for which they were originally derived. One approach to resolve the limitation problem is done by calibration of these equations for locations where they are applied against other, more sophisticated equations, or against field measurements (e.g. evaporation pans or lysimeters).