REOTELY SENSED CANOPY TEMPERATURE BASED
EVAPOTRANSPIRATION MODELS FOR WHEAT

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ABSTRACT

Field studies were conducted on differentially irrigated wheat (Cv. 'Sonalika'), on a sandy loam soil at Indian Agricultural Research Institute, New Delhi to evaluate the surface energy balance evapotranspiration (ET) models which use remotely sensed canopy temperature as an input. Four energy balance ET models were used in this study viz. Jackson et al. (1977) approach; Bartholic et al. (1970) and stability corrected and uncorrected aerodynamic resistance forms of models. To test the model ET was estimated using remotely sensed canopy temperature, with the remaining to ET measured by water depletion method. Aerodynamic resistance forms of ET models performed well as compared to other models. Results indicate that remotely sensed canopy temperature as an input to surface energy balance models, offers a potential method of estimating ET from a cropped surface.

INTRODUCTION

Evapotranspiration (ET) estimation has several practical applications e.g., in agronomy for predicting crop yields and scheduling irrigation, in hydrology for establishing regional water balances etc. The possibility of using remotely sensed canopy temperature in surface energy balance models for estimation of crop ET has been proposed by several investigators (Bartholic et al., 1970; Brown and Rosenberg, 1973; Jackson et al., 1977; Soer, 1980). Stone and Horton (1974) compared the models suggested by Bartholic et al. (1970) and Brown and Rosenberg (1973) and concluded that both the models appeared promising in estimating ET of sorghum. Recently, Gupta and Sastry (1984) showed that Bartholic et al. (1970) model was relatively more suitable as compared to Brown and Rosenberg (1973) model for estimating ET of irrigated wheat. While, Blad and Rosenberg (1976), Heilman and Kanemasu (1976), Hatfield et al. (1984) concluded that the aerodynamic resistance form of energy balance model of Brown and Rosenberg (1973) utilizing remotely sensed canopy temperature as an input would be useful in estimating ET. Sequin and Itier (1983) and Saha et al. (1984) evaluated the simplified model of Jackson et al. (1977)

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which treats aerodynamic resistance factor in energy balance equation a composite constant that can be obtained empirically.

The objective of this experiment was to evaluate the surface energy balance ET models which utilize remotely sensed canopy temperature as an input, for estimating ET in differentially irrigated wheat.

**DESCRIPTION OF MODELS**

The surface energy balance for a crop canopy can be written as (Monteith, 1973):

\[
E = R_n + G - H
\]

(1)

where, \(R_n\) is net radiation, \(G\) is soil heat flux, \(H\) is sensible heat flux and \(E\) is the latent heat flux (ET). All of these expressed in Jm\(^{-2}\cdot s^{-1}\) again, \(H\) can be expressed by:

\[
H = C_p \frac{(T_c - T_a)}{r_a}
\]

(2)

where, \(C_p\) is the volumetric heat capacity of air (Jkg\(^{-1}\cdot °C^{-1}\)), \(T_c\) is canopy temperature (°C); \(T_a\) is air temperature (°C); \(r_a\) is aerodynamic resistance (sm\(^{-1}\)). On a daily scale, the soil heat flux \(G\) can be neglected and Eq. (1) can be written as:

\[
ET_d = R_{nd} - H_d
\]

(3)

Again, according to Seguin and Itier (1983) -

\[
\frac{H_d}{R_{nd}} = \frac{H_i}{R_{ni}}
\]

(4)

where, \(ET_d\) is total daily evapotranspiration; \(R_{nd}\) and \(R_{ni}\) are total daily and instantaneous net radiation respectively and \(H_d\) and \(H_i\) are total daily and instantaneous sensible heat flux, respectively. Substituting Eq. (2) and (4) in Eq. (3), results:

\[
ET_d = R_{nd} - \frac{(R_{nd}) \cdot C_p(T_c - T_a)}{R_{ni} \cdot r_a}
\]

(5)

where, \((T_c - T_a)\) is instantaneous canopy-air temperature difference.

The ET models based on surface energy balance equation used in this study are:

1. **Energy Balance – Regression Model (Model-1):** Jackson et al. (1977) formulated the following model for estimating ET -