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DIURNAL ENERGY BALANCE STUDIES OVER WHEAT BY EDDY CORRELATION TECHNIQUE

1. Energy balance studies help to understand the response of plant communities to environmental stress. The eddy correlation (EC) technique is a direct method of calculating energy balance components, sensible heat (H) and latent heat (LE) (Swinbank 1951) and more accurate than other methods based on the measurement of vertical gradients (Kanemasu *et al.* 1979).

2. The experiment was conducted in the post monsoon (rabi) season of 1992-93 at college farm to study the diurnal trends of energy balance at various growth stages of wheat crop. Wheat (*Triticum aestivium L.*) variety HD 2189 was sown on an area of ~ 3.0 ha (275 m E-W by 110 m N-S) in N-S direction at 22.5cm row distance. The field pro vided necessary fetch required for micro-meteorological measurements. The soil was vertisol and clayey in texture. The recommended agronomic practices were followed.

2.1. The Rn was measured by net radiometer (REBS Inc. Seattle. USA) at 2m height above ground. The soil heat flux was measured at 5cm depth with two sets of soil heat flux plates (REBS Inc. Seattle. USA). One plate was installed within the rows and the other between the rows. The averaging soil temperature thermo-couples (Copper-constantan) were buried at 1 and 4 cm depths to estimate the heat storage in the layer. The surface soil heat flux (G) was estimated by employing combination method (Tanner 1960).

2.2. The H and LE were computed by eddy correlation technique. The vertical temperature fluctuations (T′) were measured with a fine wire Chromel-Constantan thermocouple (0.0125 mm). The vertical wind velocity fluctuations (w′) were measured with one dimensional sonic anemometer (Campbell Sci. Inc.. Utah. USA. model CA 271T). The vapour density fluctuations (q′) were measured by Krypton Hygrometer (Campbell Sci. Inc., Utah. USA, model KH 20). All the sensors were connected to a 21 X micrologger (Campbell Sci. Inc.. Utah. USA). All fluctuations were recorded with an execution interval of 0.2 sec. and averaged over 10 minutes interval.

2.3. H was corrected since the specific heat of air is a function of specific humidity (Brook 1978). Oxygen and density effect corrections were applied to LE (Tanner and Green 1989). The closure error (δ = Rn − H − LE − G ≠ 0) was calculated for all data sets.

3. The peak Rn ranged between 497.6 to 667.3 Wm^{-2} from CRI to hard dough stage. The corresponding LE ranged between 180.6 to 321.4 Wm^{-2} and was partitioned upto 36 to 53% of peak Rn, whereas, H ranged between 2 to 39% of Rn (Table 1). The soil heat flux (G) varied between 10 to 23% of peak Rn. The δ ranged between 3 to 44% of peak

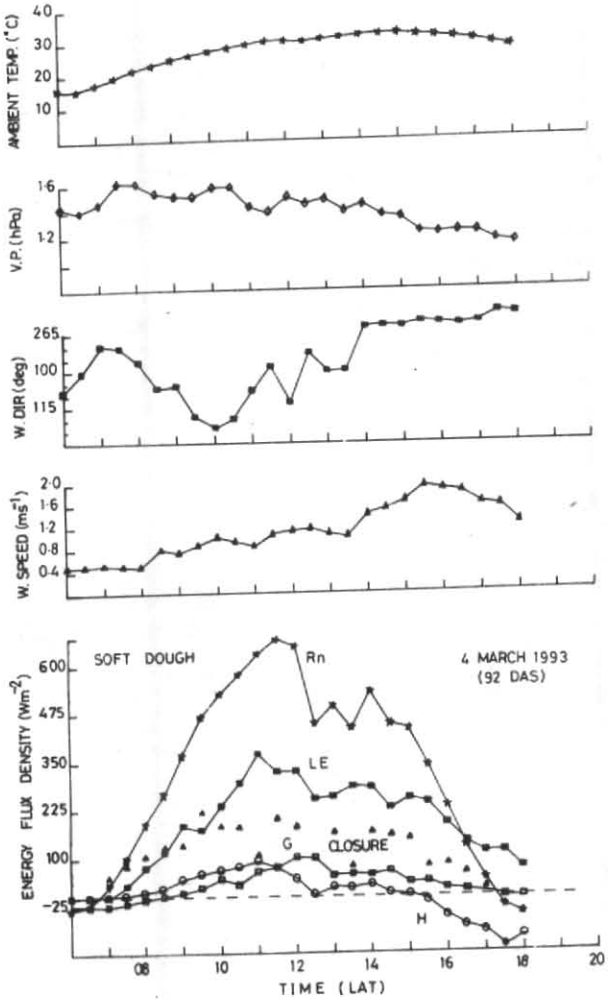

Fig. 1. Diurnal pattern of temperature (°C), vapour pressure (hPa), wind speed (ms^{-1}), wind direction (deg.) and energy balance components on 4 March 1993 (92 DAS)

TABLE 1

Energy balance components relative to peak Rn at various growth stages of wheat

Growth stages	G/Rn	H/Rn	LE/Rn	δ/Rn	Remarks
CRI	0.23	0.17	0.41	0.19	clear sky
Tillering	0.15	0.05	0.36	0.44	cloudy sky
Jointing	0.16	0.19	0.53	0.12	clear sky
Heading	0.10	−0.02	0.51	0.41	mild SHA
Flowering	0.14	0.10	0.50	0.26	clear sky
SD	0.11	0.11	0.48	0.30	cloudy sky
HD	0.18	0.39	0.40	0.03	clear sky

Rn. The mild sensible heat advection (SHA) was observed at noon time at heading stage. SHA was observed at all growth stages of wheat in evening hours (1545 h onwards) though it varied in duration and intensity.

3.1. During the crop growing season Rn reached its maximum of 667.3 Wm^{-2} at 11.5 h at soft dough stage (Fig. 1). Both Rn and G followed the familiar parabolic trend. The total Rn for the day was 28.3 $MJm^{-2}d^{-1}$. G reached its maximum of 99.9 Wm^{-2} at 12.0 h. The clouds appeared between 12.5 to 14.5 h and therefore, Rn and LE were showing different peaks. LE reached its peak of 368.3 Wm^{-2} at 11.0 h and LE for the whole day was 16.2 $MJm^{-2}d^{-1}$. The ambient air temperature was more than 30.0°C, LE was gradually decreasing at higher ambient air temperature. This may be due to critical growth stage of the crop where earheads and awns are predominant transpiring surfaces instead of leaf stomata.

H attained maximum of 89.6 Wm^{-2} at 11.0 h. The SHA of 246.4 Wm^{-2} was observed between 15.5 to 17.0 h, which reduced the total H to a very low value of 0.3 $MJm^{-2}d^{-1}$. The closure error ranged between 4.3 to 218.1 Wm^{-2} with its highest value at 9.5 h corresponding to the decrease in LE.

4. The δ was maximum at the tillering stage when clouds were observed. It was higher at heading stage when mild SHA was observed. At soft dough stage also δ was higher when clouds were observed. Thus, EC technique underestimated LE under cloudy or SHA conditions resulting in higher δ, indicating the limitations of the instrumentation.

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