

Diurnal Changes of the Net Photosynthetic Rate and Evapotranspiration Rate of Plug Sheets in the Glasshouse

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INTRODUCTION

On-line estimation of evapotranspiration rates (F_w) and net photosynthetic rates (F_c) in situ of plug sheets is important for optimum control of the glasshouse environment and the soil mix moisture for growth of the plugs in a relatively small volume of soil mix.

MATERIALS AND METHODS

Absolute humidities (q_1 and q_2) and CO_2 concentrations (C_1 and C_2) were continuously measured at two heights (z_1 and z_2) above the plug sheets with a hygrometer and an infrared CO_2 analyser, and the weight of a plug sheet (plugs, soil mix, and tray) was continuously measured with an electronic balance. At time t , F_w was estimated based on the difference between the weights of the plug sheet at time $t-\Delta t/2$ and $t+\Delta t/2$. The diffusion coefficient, K , which is common to F_w and F_c , was then calculated using Equation 1. Finally, F_c was estimated using Equation 2. Using this on-line estimation method, F_w and F_c were estimated for the plug sheets (Table 1) under the environmental conditions shown in Table 2. The z_1 and z_2 were, respectively, 20 and 50 mm above the plugs in the present experiment.

Table 1. Description of the plug sheets.

Plant material	Lettuce
Days after sowing	32 days
Leaf area index	6.6
Number of cells	200 cells/sheet
Planting density	1420 plants m^{-2}

Table 2. Description of environmental conditions in the greenhouse.

	Day	Night
Air temperature (C)	20 - 25	10 - 15
Relative humidity (%)	40 - 50	60 - 80
CO_2 conc. ($\mu mol mol^{-1}$)	380 - 400	500 - 550
Wind speed ($m s^{-1}$)	0.1 - 0.5	0.1

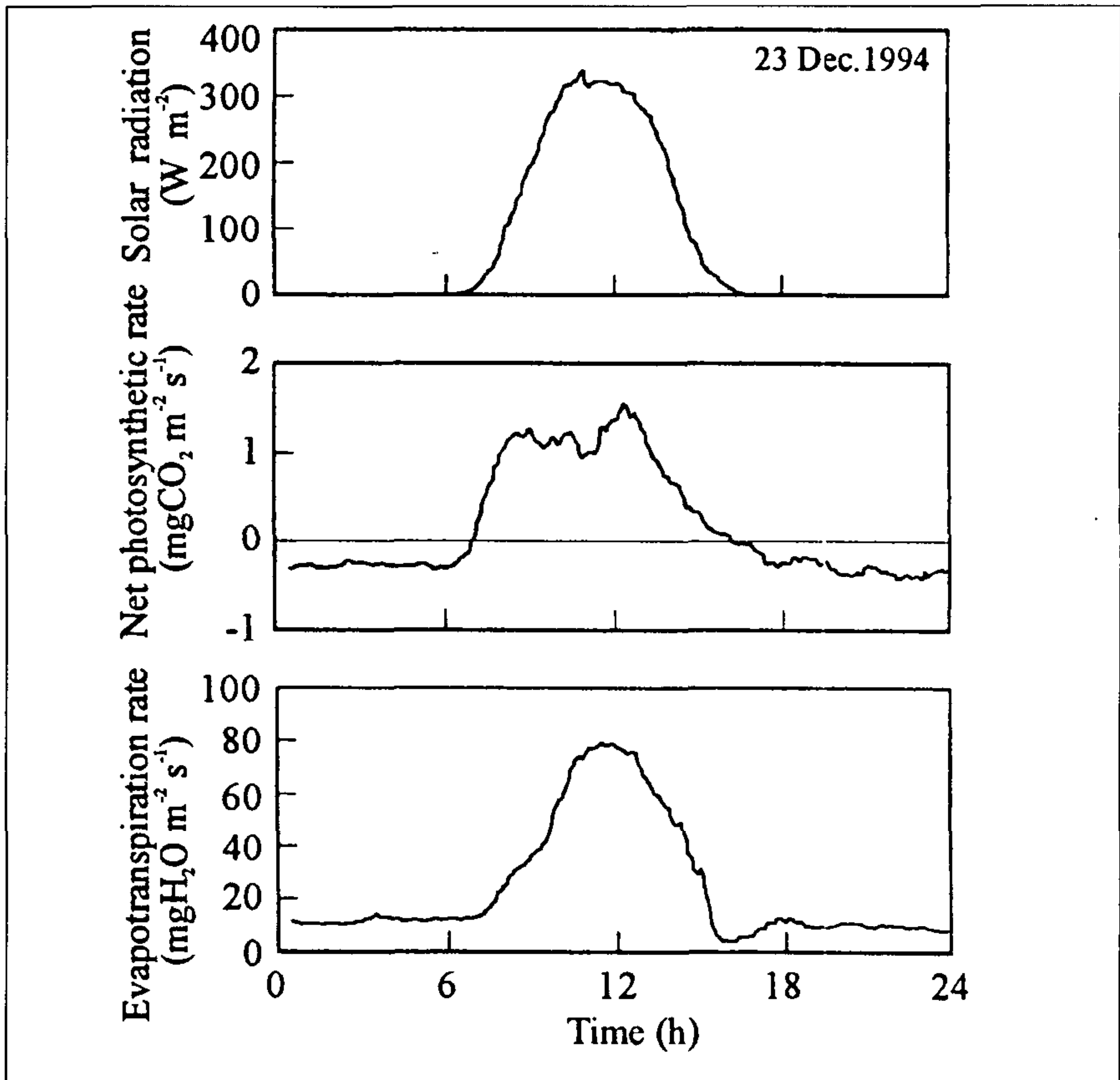


Figure 1. Time courses of solar radiation and net photosynthetic rate and evapotranspiration rate of plug sheets.

RESULTS AND DISCUSSION

Figure 1 shows changes in solar radiation, F_w and F_c for lettuce plug sheets during a measurement day. Figure 2 shows the effects of solar radiation on F_w and F_c of the plug sheets. The results indicate that F_w and F_c are functions of environmental factors including solar radiation, the growth parameters of the plugs, and the physical properties of the soil mix.

The F_w and F_c of plug sheets in the greenhouse were successfully estimated in situ based on the continuous measurements of absolute humidities, CO_2 concentrations, and weights of plug sheets. The application of this method of environmental control of the glasshouse and irrigation scheduling is underway.

$$\text{Equation 1. } F_w = K \frac{q_2 - q_1}{z_2 - z_1} \quad (1)$$

$$\text{Equation 2. } F_c = -K \frac{c_2 - c_1}{z_2 - z_1} \quad (2)$$

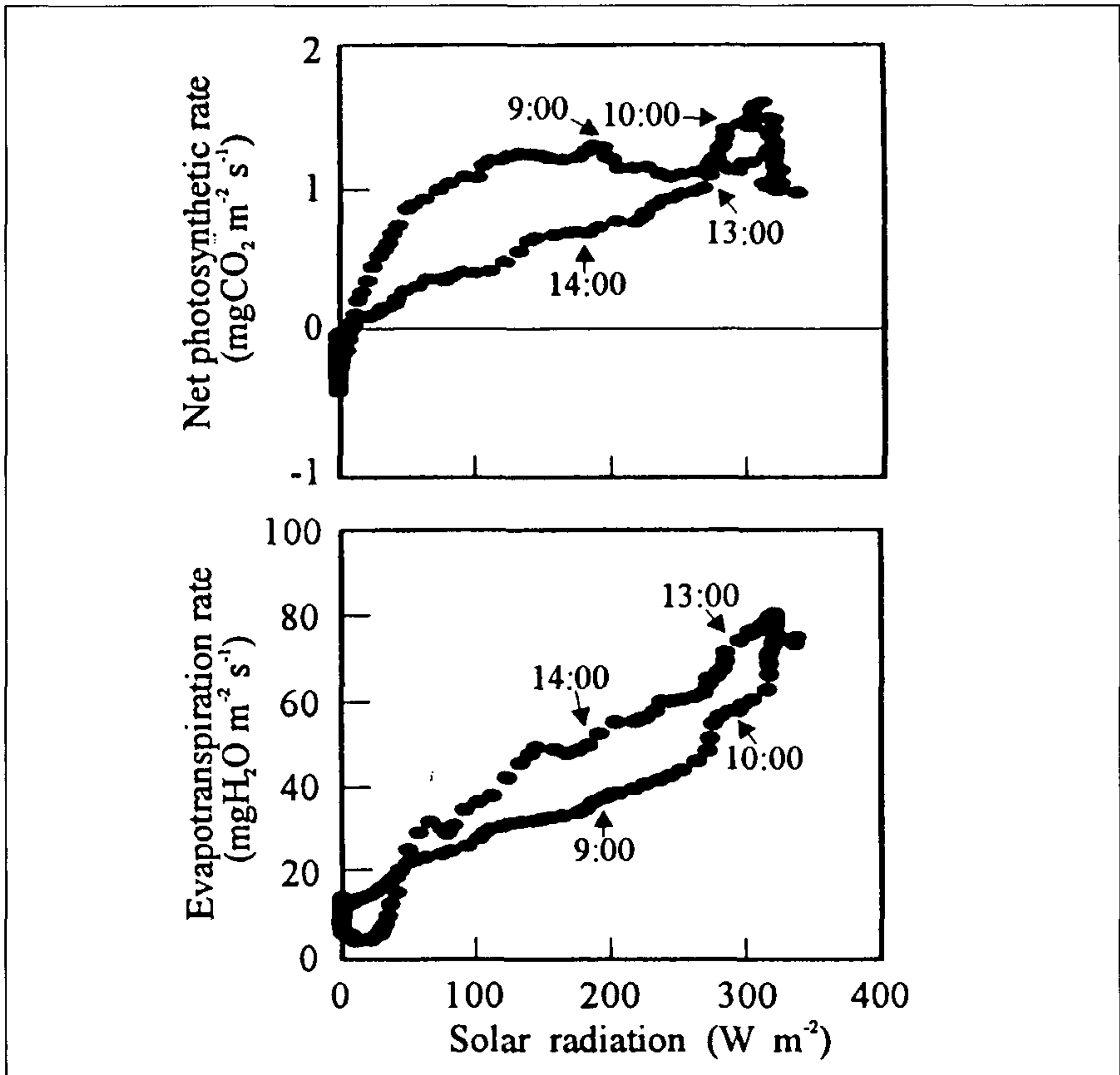


Figure 2. Effects of solar radiation on net photosynthetic rate and evapotranspiration rate of plug sheets.