STUDY ON EVAPOTRANSPIRATION FROM PASTURE*

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ABSTRACT

Since the observation of evapotranspiration over a long period is difficult, several estimation formulae and concepts for evapotranspiration have been proposed. Indiscriminate applications of these concepts and formulae lead to confusion concerning definitions and their use. Intensive micrometeorological observation data and long term evapotranspiration data were collected and analyzed.

Firstly, potential evapotranspiration, equilibrium evaporation, and potential evaporation were taken as the representative concepts of evapotranspiration. The conditions to which they can be applied were investigated, based on the evapotranspiration data obtained over a field of actively growing pasture with no soil water shortage. The potential evapotranspiration, defined by a vapor-saturated surface condition, can be applied only when the vegetation canopy behaves as a completely wetted surface during dew evaporation, or when the over-passing air is humid. Otherwise, the potential evapotranspiration by this definition becomes greater than the potential evapotranspiration from actively growing pasture under an ample soil water condition. The potential evapotranspiration, defined by a vapor-saturated surface condition, and that defined by a well-watered soil condition cannot be considered to have the same meaning.

Hourly evapotranspiration from pasture is found to fall in a range of 1.0 to 1.26 times as large as the equilibrium evaporation, and on the average, the former is 1.16 times as large as the latter. The potential evaporation, which is defined as 1.26 times as large as the equilibrium evaporation, can be applied only to the pasture canopy which is in a completely wetted condition caused by dewfall. The upper and the lower limits of evapotranspiration from actively growing pasture, without soil water shortage, are found to be expressed by the potential evaporation and by the equilibrium evaporation, respectively.

Secondly, a simple equilibrium evaporation model was developed and tested using evapotranspiration data measured by a weighing lysimeter. In summer, the daily evapotranspiration from pasture can be estimated by the equilibrium evaporation model, with the proportional

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constant equal to 1.14. The distinctive seasonal trend, which may reflect the activity of pasture, is found in the relationship between the daytime evapotranspiration and the daytime equilibrium evaporation. The equilibrium evaporation model is shown to estimate the annual evapotranspiration within 10% accuracy if the appropriate values of the proportional constant are used in the model.

Thirdly, the Thornthwaite and the Penman methods for potential evapotranspiration were tested, using the actual evapotranspiration data measured by a weighing lysimeter. The Thornthwaite method is shown to overestimate summer evapotranspiration and underestimate winter evapotranspiration. Also the method overestimates annual evapotranspiration by about 30%. On the other hand, the potential evapotranspiration by the Penman method agrees well with the actual evapotranspiration in summer and autumn, but the former is greater than the latter in winter and spring. The annual evapotranspiration estimated by the Penman method exceeds the actual evapotranspiration by around 20%. Annual growing cycle of vegetation and climatic conditions play important roles in the determination of evapotranspiration.