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Estimation of Stomatal Conductance using Crop Water Stress Index based on the Thermal Image at a Leaf Scale

Hoejeong Jeong[1], Jae-Hyun Ryu[1], Sang-il Na[2], and Jaeil Cho[1]
[1]Department of Applied Plant Science, Chonnam National University, Gwangju, Republic of Korea
[2]Climate Change and Agro-Ecology Division, National Institute of Agricultural Sciences, Rural Development Administration, Wanju, Republic of Korea

In 1980s, Crop Water Stress Index (CWSI) is suggested to indicate the water stress of crops. CWSI is based on the leaf energy balance, which is closely related to leaf temperature. To calculate CWSI, meteorological factors such as air temperature and vapor pressure deficit should be measured besides leaf temperature. As recent technology has been developed, leaf temperature can be easily observed by thermal camera or infrared thermometer. Stomatal conductance (g_s, mmol m^{-2} s^{-1}) is one of the critical factors to understand crop photosynthesis and water demand. In addition, the behaviors of g_s can represent the biotic and abiotic plant stresses. In abnormal condition, such as drought, insects or disease, g_s getting lower. The observation of g_s will make better to evaluate and predict crop growth and conditions. Therefore, the time series data of g_s is useful for the monitoring of crop growth and the quick detection of abnormal crop condition in smart-farming system but there are some limitations to measure g_s continuously and easily.

We assume that there is some relationship between CWSI and g_s because both has strong relation to leaf temperature. Thus, the aim of this study is to investigate possibility of estimation of g_s using CWSI which is derived from thermal image. Through the data collected from literatures, negative correlations between CWSI and g_s were revealed. The slope of correlation was changed according to crop types. In addition, as a result of simulation, there is almost linear negative relationship between CWSI and g_s, and the slope was determined by maximum stomatal conductance (g_{s_max}). Field measurement in this study was also demonstrated to identify such correlation. Further, various methods to measure CWSI were tested. This relationship will contribute to not only monitoring of crop stress for irrigation scheduling in smart farm system but also estimating evapotranspiration, photosynthesis, and crop yield.