

Leaf Gas-exchange Model Parameterization for Estimating Photosynthesis in Onion

S.E. Lee*, K.H. Moon, M.J. Shin, S.Y. Oh, K.S. Choi and J.J. Ahn
Research Institute of Climate Change and Agriculture, NIHHS, RDA

양파 광합성 예측을 위한 잎의 기체교환모형 모수 추정

이성은, 문경환, 신민지, 오서영, 최경산, 안정준
국립원예특작과학원 온난화대응농업연구소

Abstract

Process-based model (PBM), based on the interactions between endogenous physiological processes and many environmental factors, can be a powerful tool for estimating crop growth and productivity. Carbon acquisition and biomass accumulation are the main components in PBM, so it became important to understand and integrate gas exchange process in crop model. This study aimed to assess the applicability of FvCB model (a leaf model of C_3 photosynthesis proposed by Farquhar, von Caemmerer, and Berry (1980)) in onion (*Allium cepa* L.). For parameterization, two early-maturing onion cultivars, 'Singsingball' and 'Thunderball' from temperature gradient plastic film house, were used in measuring leaf net CO_2 assimilation rate (A), and then, parameter estimation was carried out for four parameters including V_{cmax} (maximum rate of carboxylation), J_{max} (maximum rate of electron transport), TPU (rate of triose phosphate utilization), and R_d (Dark respiration rate). The gas-exchange model calibrated in this research is expected to be able to explain the photosynthetic responses of onion under various environmental conditions ($R^2=0.95$).

Objectives

This research was conducted to assess the applicability of leaf gas-exchange model in onion (*Allium cepa* L.) for estimating the growth and yield of onion.

Materials & methods

- Subject: *Allium cepa* L. cv. 'Singsingball' and 'Thunderball'
- Experimental site: Temperature gradient tunnel
- Measuring unit: LI-6400XT photosynthesis system
- Parameter: CO_2 concentration, photosynthetically active radiation, leaf temperature, net CO_2 assimilation rate

Results

Table 1. Parameters estimated for application of leaf gas exchange model in onion

Parameter	V_{cmax}	J_{max}	TPU	R_d
Mean \pm S.D.	118 \pm 21	217 \pm 26	17.3 \pm 2.9	4.0 \pm 1.6

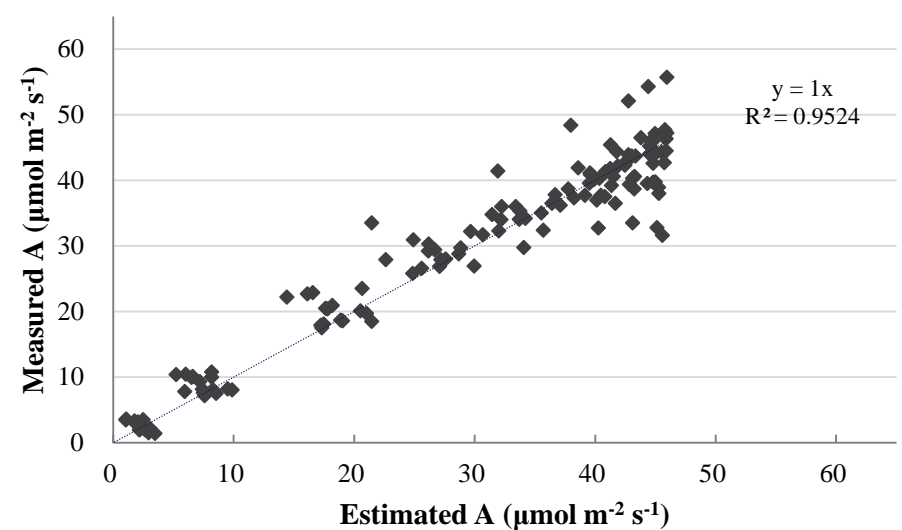


Fig. 1. Parameterization of leaf gas-exchange model for onion leaves. Measured and predicted net CO_2 assimilation rates (A) were compared.

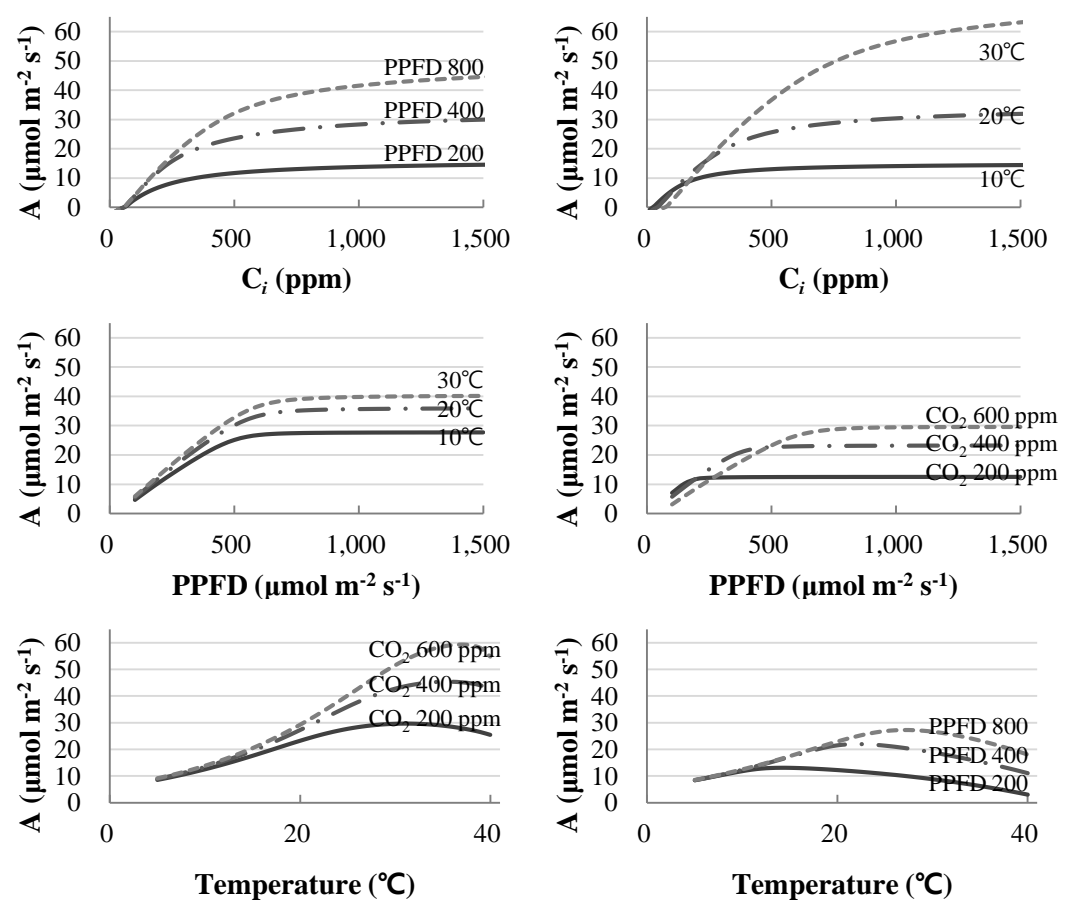


Fig. 2. Estimated net CO_2 assimilation rates (A) by leaf gas-exchange model for onion leaves (Photosynthetic photon flux density=1,500 $\mu mol m^{-2} s^{-1}$, air temperature=25°C, RH=60%, wind=0.5 $m s^{-1}$).