Analysis of photosynthetic simulation by a biochemical model or mathematical model in greenhouse eggplant

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Abstract In the relationship between photosynthesis and environmental factors or biochemical factors or between stomatal limitation and non-stomatal limitation in depression of photosynthesis at noon, photosynthetic simulations by a mathematical model or a regression equation between net photosynthetic rate \( Pn \) and intercellular \( CO_2 \) concentration \( Ci \) or other environmental factors including photosynthetic available radiation \( PAR \), air temperature \( Ta \), ambient \( CO_2 \) concentration \( Ca \) and relative humidity \( Hr \) or FvCB model \( \text{Farquhar-von Caemmerer-Berry} \) biochemical model of leaf...
photosynthesis were analysed. The model examined the response curve of net photosynthesis $Pn$ and intercellular CO$_2$ concentration [Ci] measured under treatments of combined photosynthetic available radiation [PAR] and leaf temperature [T] over a photosynthetic diurnal course measured under 1100 ± 100 μL/L CO$_2$ enrichment in greenhouse microclimates on eggplant Solanum melongena L. F$_1$ hybrid ‘QIEZA-1’. The parameters of $Pn$ [PAR] $Ta$ [Tl] leaf temperature [Ca] [Ci] and $Hr$ were measured with a CI-301PS photosynthesis analyzer. In terms of either response of $Pn$ on $Ci$ or photosynthetic diurnal course the mathematical model imitated measured $Pn$ much better than the FvCB model. The simulation by the mathematical model indicated that photosynthetic diurnal course could be influenced by both a single environment factor and complex ones. The simulation of the FvCB model showed that a dominant role of the rate of carboxylations changed from one to another among $A_i$ [A,$j$] and $A_j$ as $Ci$ increased combined with increase of PAR and Tl. $A_j$ was limited by the amount of activation state and kinetic properties of ribulose-1-5-bisphosphate carboxylase/oxygenase [rubisco]. $A_i$ was limited solely by the rate of ribulose-1-5-bisphosphate [RuBP]. $A_i$ was limited by the rate of triose-phosphate utilisation [TPU]. $C_{ij}$ intercellular CO$_2$ concentration of the change point of dominance from $A_i$ to $A_j$ was a higher under high PAR and Tl than low PAR and Tl. $C_{ij}$ and $C_{ij,j}$ intercellular CO$_2$ concentration of the change point of dominance from $A_j$ to $A_i$ was influenced more strongly by Tl than PAR. The FvCB model also indicated that the limiting carboxylation rate was $A_j$ in the early morning and toward evening and it was $A_i$ in the late morning and at noon. Period of $A_i$ limitation might be extended by cloudy weather and CO$_2$ injection once per day. $A_j$ limitation occurred with application of CO$_2$ injection twice a day.

**Key Words** greenhouses, eggplant, CO$_2$ enrichment, photosynthetic diurnal course, biochemical model of leaf photosynthesis
5 CO2 CO2 enrichment CO2 ambient
20 min CO2 1000 ~ 1200 µL/L CO2 2 ~ 3 d
1 Ce 1050 µL/L Ce 950 µL/L

1.2

Cl-301PS PAR T Ta TL
3 ~ 4 3 PAR TL CI-301PS PAR TL
I 1600 µmol/m2 s B6. 6 °C 29. 6 °C III 1600 µmol/m2 s 20. 0 °C 500 µmol/m2 s 20. 0 °C CO2

1.3

C3 FvCB Rubisco Hans

2.1

Pn Ci FvCB

Pn = 2 \times 10^{-10} \cdot Ci^3 + 3 \times 10^{-7} \cdot Ci^3 + 6 \times 10^{-5} \cdot Ci^2 + 0. 0975 \cdot Ci = 5. 9798

2.2 FvCB

CO2
因子（光强、气温、饱和气压差、空气相对湿度）进行逐步回归分析发现，四元一次四互作加效应回归模拟方程（1）经测验呈极显著水平，相关度达到 0.9375。
短的限制时段(图34)。多云天气下，由于日照强度较低，短的限制时段延长。阴天天气的日照强度更低，短的限制时段延长至全日程。在所有日变化进程中，只有冬季0次增施120的出现短的限制时段。

图34增施与不增施120下温室茄子实测光合速率%&或数学模型模拟%&的日进程。

图C4温室茄子秋冬春实测光合速率%&日进程与5617模型模拟同化速率!

图D45617模型中120增施温室茄子羧化速率的日进程(1'0EEFGFEG00)。

近0E-来，光合气孔限制和非气孔限制的关系，一直是植物光合午睡现象研究中的焦点问题【。

等在%/01.2031.叶片发生光合中午降低现象时!/4降低的现象【。

本试验研究采用5617模型模拟温室茄子光合日变化(图D M图/)

△ Fig. 5 Diurnal course of photosynthesis Pn measured and Pn' imitated by mathematical model or A imitated by Farquhar's model in greenhouse under CO2 enrichment or ambient on eggplant

△ Fig. 6 Correlations between assimilation A imitated by FvCB's model and diurnal photosynthesis Pn measured in greenhouse eggplant in the autumn, winter and spring

△ Fig. 7 FvCB □□□ CO2 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□...
鲁比的浓度处于变化的节点。

在晴天上午和中午前后

1.2.2.1 晴天上午和中午后

1.2.3.1 晴天上午和中午后

鲁比的浓度处于变化的节点。


参考文献:

