The 11th Asian-Australasian Conference on Precision Agriculture (ACPA 11)
October 14-16, 2025, Chiayi, Taiwan

ASSESSMENT OF LIGHT INTERCEPTION CONSIDERING PLANT ARCHITECTURE IS IMPORTANT FOR YIELD PREDICTION IN STRAWBERRY

Asaya Takahashi[1], Daisuke Yasutake[1,2*], Kota Hidaka[3], Shintaro Ono[3], Hiromi Nakai[4], Shigehiro Kubota[1], Gaku Yokoyama[1], Tomoyoshi Hirota[1]

[1] Kyushu University, Japan. [2] Kochi University, Japan. [3] NARO Kyushu Okinawa Agricultural Research Center, Japan. [4] Fukushima Institute for Research, Education and Innovation, Japan.

*Corresponding Author: yasutake@bpes.kyushu-u.ac.jp

Abstract

Crop yield depends on whole–plant photosynthesis, which is limited by the light interception by each leaf and its individual photosynthetic capacity. To date, there are some researches on assessments of yield considering their plant architecture and photosynthetic capacities in tomato and cucumber. However, there are few in strawberry although its cultivars exhibit considerable variation in their plant architecture and photosynthetic capacity. This research gap could significantly hinder accurate strawberry yield assessment and prediction. Thus, this study assessed effects of whole-plant light interception (I_{plant}) and leaf photosynthetic capacities (maximum rate of carboxylation [V_{cmax}], maximum rate of electron transport [J_{max}]) on plant biomass and yield of two strawberry cultivars with different plant heights (*Fragaria* × *ananassa* Duch. 'Koiminori' as a tall cultivar and 'Tochiotome' as a dwarf cultivar). I_{plant} of each cultivar were measured by photodiodes attached to fully expanded leaves to consider plant architecture. V_{cmax} and J_{max} were measured in young and fully expanded leaves. Koiminori exhibited greater plant biomass and yield than Tochiotome, likely due to a larger whole-plant photosynthesis because of the positive correlation between a plant biomass and photosynthesis. I_{plant} of Koiminori was higher than that of Tochiotome while V_{cmax} and J_{max} of Koiminori were lower than those of Tochiotome. These suggest that I_{plant} contributes more significantly to strawberry production than leaf photosynthetic capacity, and that precise prediction of yield necessitates assessment of light interception considering plant architecture in strawberry cultivars.

Keywords: *Fragaria* × *ananassa* Duch., photosynthetic capacity, plant height, strawberry cultivars

INTRODUCTION

Crop yield depends on whole–plant photosynthesis, which is limited by the light interception by each leaf and its individual photosynthetic capacity. To date, there are some researches on assessments of yield considering their plant architecture and photosynthetic capacities in tomato and cucumber. However, there are few in strawberry although its cultivars exhibit variation in their plant architecture and photosynthetic capacity (Menzel, 2022). This research gap could significantly hinder accurate strawberry yield assessment and prediction.

Therefore, this study comparatively analyzed the impact of whole-plant light interception (based on individual leaf light reception) and individual leaf photosynthetic capacity on production characteristics in two strawberry cultivars differing in plant height, a key determinant of plant architecture.

MATERIALS AND METHODS

Two strawberry cultivars (*Fragaria* × *ananassa* Duch. “Tochiotome” and “Koiminori’) were grown in smart greenhouse located at the National Agricultural and Food Research Organization (named GH1, experimtal period; 10/13/2021–6/1/2022) and Ito Plant Experiment Fields & Facilities, Faculty of Agriculture, Kyushu University (named GH2, experimtal period; 10/1/2022–6/23/2023, 10/1/2023–6/16/2024). V_{cmax} and J_{max} were estimated by A-Ci method or one–point method, using a portable open gas exchange system (LI-6400XT, LI-COR). I_{plant} of each cultivar were measured by photodiodes attached to fully expanded leaves at one-minute intervals in GH2 from January 15, 2024, to January 28, 2025, using a photodiode (S1787-04, Hamamatsu Photonics K.K.). PPFD at the top of the canopy was also measured using a quantum sensor (PAR-02D, PREDE). Yield was measured through the experimental periods, and total dry weight (DW) of a plant was measured at the end of each experiment.

RESULTS AND DISCUSSION

The plant heights for Tochiotome and Koiminori were 18.9±3.1 cm and 26.3±3.3 cm, respectively. Throughout the measurement period, I_{plant} was consistently greater for Koiminori than Tochiotome (Fig. 1). Notably, this difference in I_{plant} between the two cultivars became

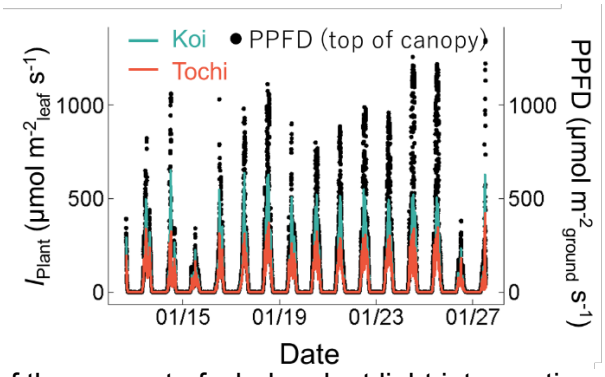

Fig.1 Diurnal change of the amount of whole–plant light interception of Koiminori (blue line) and Tochiotome (red line) and the change of PPFD of upper canopy (black point).

more pronounced during midday when light intensity was high. The taller plant height of Koiminori likely resulted in a less dense canopy, which could facilitate greater light penetration within the canopy. Koiminori exhibited a tendency for higher J_{max} than Tochiotome in GH1. However, V_{cmax} in both GH1 and GH2 and J_{max} in GH2 tended to be higher in Tochiotome compared to Koiminori (data not shown). This suggests that the individual leaf photosynthetic rate was greater in Tochiotome under the same environmental conditions. Both the yield and DW of Koiminori were approximately 1.4 times greater than those of Tochiotome (data not shown). Since DW is positively correlated with the whole–plant photosynthetic rate over the cultivation period, it's plausible that Koiminori had a higher whole-plant photosynthetic rate than 'Tochiotome', and this difference may have been influenced by the differences in I_{plant}.

CONCLUSIONS

I_{plant} could contribute more significantly to strawberry yield than individual leaf photosynthetic capacity, and cultivars with relatively higher plant height may possess higher I_{plant}.

REFERENCES

Menzel, C. M. 2022. A review of productivity in strawberry: do the plants need larger canopies, more flowers, or higher CO_2 assimilation for higher yields? *J. Hortic. Sci. Biotech.* 97(6): 674–696.