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Effects of Light Quality during Cultivation and Cutting on Rooting of Cuttings of *Gynura bicolor* DC.

Chihiro Satoh, Arisa Noguchi, Hiroko Nakatsuka and Wakanori Amaki

Department of Agriculture, Tokyo University of Agriculture, 1737 Funako, Atsugi, Kanagawa 243-0034, Japan

amaki@nodai.ac.jp

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Summary

Gynura bicolor DC. is a perennial plant belonging to the genus *Gynura* of the Asteraceae family, said to be native to Southeast Asia. Usually, this plant is propagated by cuttings. We investigated the light quality effects for mother plant cultivation before cutting and during cutting on the rooting of the cuttings in *Gynura bicolor*. Cuttings prepared from plants grown under white fluorescent light were placed under different light quality conditions, and the production of adventitious roots was compared. However, no statistically significant difference was observed. On the other hand, the light quality during cultivation greatly affected the rooting of cuttings. Rooting of cuttings taken from plants grown under white mixed light emitting diode (LED) and blue LED monochromatic lights were delayed. Cuttings of plants grown under red LED monochromatic light rooted faster, and the average root weight was more than three times that under mixed white light and blue light.

INTRODUCTION

Gynura bicolor DC. is a perennial plant in the Asteraceae native to Southeast Asia (Ikeda, 1988). In addition to being used as a traditional vegetable in southern China, in Japan it is cultivated as a local vegetable in Ishikawa Prefecture (Japanese local name: Kinji-sou), Aichi Prefecture (Shikibu-sou), Okinawa Prefecture (Handama), and Kumamoto Prefecture (Suizenjina). Rich in vitamin A, it also contains considerable amounts of vitamin B_2 and vitamin C. Therefore, *Gynura bicolor* is known as a functional health vegetable along with its antioxidant action (Do *et al*., 2020; Hsia *et al*., 2021). Abaxial side of the leaves is reddish purple with anthocyanin and has a characteristic scent associated with volatile components.

Usually, this plant is propagated by cuttings (Takeshita, 1998). The rooting of cuttings is relatively easy. However, the conditions necessary for rooting in this plant have been largely unexplored. In experiments using sweet basil (*Ocimum basilicum* L.), it is known that changing the light quality at the time of cultivation and the light quality at the time of subsequent cutting in water affects the rooting of cuttings (Yamada *et al*., 2015; Abe, 2019). Therefore, we investigated the light quality effects for mother plant cultivation before cutting and during cutting on the rooting of cuttings in *Gynura bicolor*.

MATERIALS AND METHODS

Cultivation of material plants

Cut-leaf vegetables of *Gynura bicolor* were purchased from a market, and the shoot apex was adjusted to a length of about 8 cm as for cuttings. The cuttings were inserted into a vermiculite (M size) filled a cell box (36 cell-type, Sakata Seed Co. Ltd.; 1 cell size is the top side 41 mm and depth 40 mm) and propagated. After rooting, they were transplanted into 6 cm pots and then 9 cm pots filled with a mixture of Metro Mix 360 JPN (Sungro Horticulture, Canada): akadama clay soil (S-size) = 1:1, according to their growth. For fertilization, 1.3 g of granular chemical fertilizer (Hardened IB-Compound (IB-S1); N-P_2O_5-K_2O-MgO = 10-10-10-1, Jcam Agri Co., Ltd.) was applied to the 6 cm pot and 2 g to the 9 cm pot once a month. The growth conditions were 23±1℃, 16 hours illumination/8 hours darkness with white fluorescent lamps (FLR40S-EX-N/M-H, Toshiba Lighting & Technology Co., Ltd.), photosynthetic photon flux density (PPFD) of 80 μmol·m^{-2}·s^{-1}.

Effect of light quality on rooting of plants cultivated under white fluorescent light

Pot plants where the main shoot had grown about 10 cm long were placed at 23 ± 1℃, under white fluorescent lamps. Illumination condition was at 80 μmol·m^{-2}·s^{-1} PPFD and 16 hours light irradiation / 8 hours darkness. When the main shoot had grown to about 30 cm, cuttings of 8 cm in length were prepared on August 14, 2022. Five cuttings per treatment were inserted in a 200 ml tall glass beaker with tap water. There were four light conditions of white mixed light of blue + green + red LED, blue LED (peak wavelength: 470 nm) light, green LED (530 nm) light, and red LED (630 nm) light, 80 μmol·m^{-2}·s^{-1} of PPFD and 16 hours light /8 hours dark at 24±2℃. These LEDs used in these experiments were manufactured by Stanley Electric Co., Ltd. for testing purposes and is not commercially available. On

August 29, 2022, the total weight of adventitious roots produced from each cutting was measured using a precision electronic balance (GH-200, A&D Co., Ltd.).

Effect of light quality on rooting of plants cultivated under different light quality

Plants were cultivated as previously described except the light source was LEDs with different light quality and that the white fluorescent lamp was used for light irradiation after the cuttings were inserted in water. However, the plants grown under green LED light grew poorly, and cuttings could not be taken, so this plot was omitted from this experiment.

Four cuttings per plot were inserted in a 200ml tall glass beaker with tap water. In this experiment, they were placed under dark at 23±1℃ until August 21, 2022. After that, it was kept under white fluorescent light for 16 hours of illumination / 8 hours of darkness (PPFD: 80 μmol·m^{-2}·s^{-1}). On August 29, 2022, the total weight of adventitious roots produced from each cutting was measured.

RESULTS AND DISCUSSION

Cuttings taken from plants grown under white fluorescence light were placed under different quality of light. However, when the light quality after cutting was changed, there was no statistically significant difference in the fresh weight of roots (**Fig. 1**).

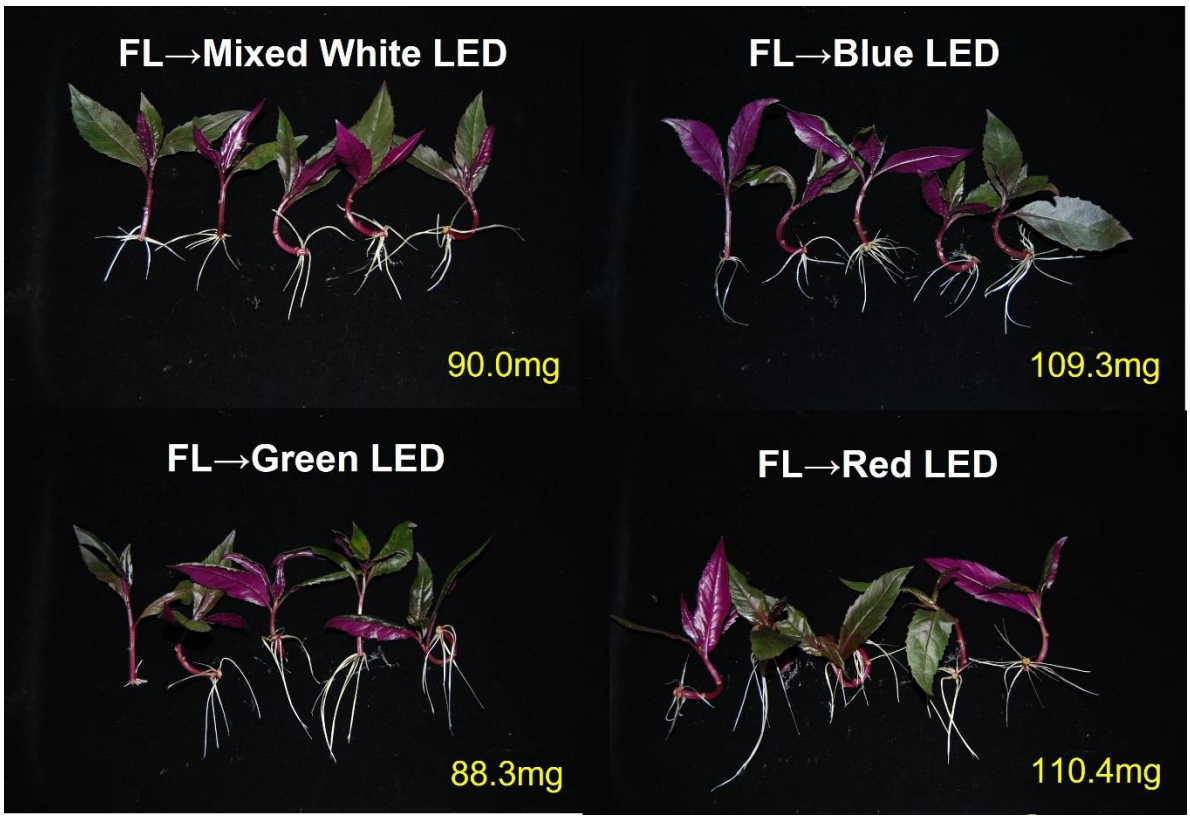

Figure 1. Rooting under different light qualities of cuttings prepared from plants grown under white fluorescent light. FL: White fluorescent light, LED: Light emitting diode. (The data numbers in the bottom right of each image indicate the average total root fresh weight of each plot).

The light quality during cultivation of mother plants greatly affected the rooting of cuttings (**Fig. 2**). Rooting of cuttings taken from plants cultivated under mixed white light and blue monochromatic light was delayed, and the rooting of individual cuttings was uneven. However, cuttings of plants grown under red light rooted faster and the average root weight was more than three times that under mixed white light and blue light.

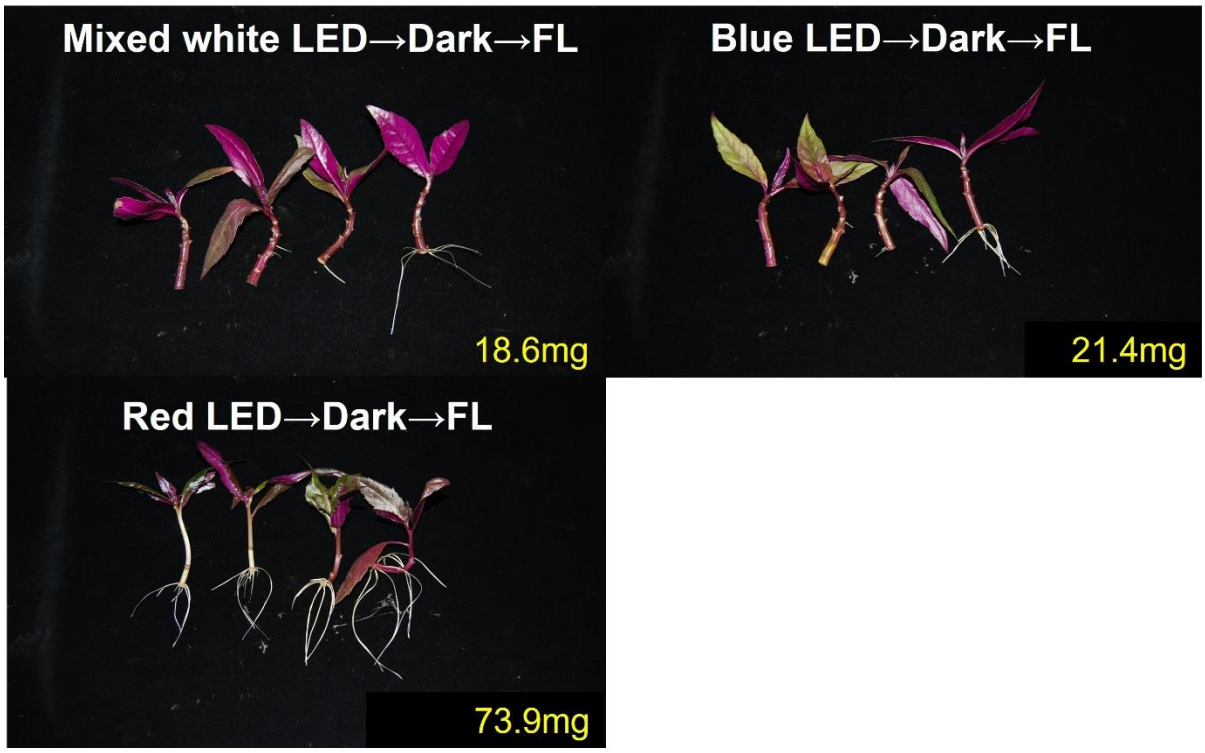

Figure 2. Rooting under white fluorescent light of cuttings prepared from plants grown under different light qualities. FL: White fluorescent light, LED: Light emitting diode, Dark: Meaning put under darkness for 1 week after cuttings. (The data numbers in the bottom right of each image indicate the average total root fresh weight of each plot).

Root fresh weight in cuttings from stock plants under different light qualities was lower compared to white light. In a preliminary experiment, cuttings of *Gynura bicolor* started rooting within a week when the cuttings were inserted on vermiculite, but when they were inserted in water, rooting started after 10 days. Assuming that this was caused by the exposure to light, we performed a one-week dark treatment. However, the dark treatment resulted in delayed rooting. It may be that the physical environment of the rooting part (cut end of stem) of the cuttings is inferior in water cuttings.

Rooting of cuttings was strongly affected by the light quality, and that the light quality during cultivation has a stronger effect. It is presumed that metabolic reactions such as plant hormones that promote rooting were activated in the plants cultivated

under red monochromatic light. Similar results have been observed for rooting in sweet basil cuttings (Yamada, 2015; Abe, 2019). In sweet basil, blue light inhibited rooting and red light promoted it (Yamada, 2015). It has also been shown that the addition of appropriate concentrations of auxin to the tap water in which cuttings are caused to promote rooting, while the addition of gibberellin inhibits it. Furthermore, it has also been clarified that the addition of uniconazole, a gibberellin biosynthesis inhibitor, promotes rooting (Abe, 2019).

In conclusion, considering from the results mentioned above of sweet basil, it is suggested that the light quality of the irradiation light during the cultivation of *Gynura bicolor* plant changes in biosynthesis of auxin and gibberellin and /or sensitivity to such plant hormones.

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