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Pure Blue Light Effects on Growth and Morphology are Slightly Changed by Adding Low-level UVA or Far-red Light: A Comparison with Red Light in Four Microgreen Species

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Highlights

- Pure blue light can promote elongation as shade-avoidance response
- Response to blue light containing low-level UVA or FR varies with plant species
- Adding low-level UVA or FR limitedly affects blue light effects on elongation

Abstract

To explore the action mode of blue light on elongation growth of microgreens, the growth and morphology traits of arugula (*Brassica eruca* L., 'Rocket'), cabbage (*Brassica oleracea*, unknown variety name), mustard (*Brassica juncea*, 'Ruby Streaks'), and kale (*Brassica napus*, 'Red Russian') seedlings were compared under four light quality treatments: (1) R, "pure" red light (660 nm); (2) B, "pure" blue light (450 nm); (3) BU, "unpure" blue light created by mixing B with a low level of UVA (≈ 7.5% photosynthetic photon flux); and (4) BF, "unpure" blue light created by mixing B with a low level of far-red light (≈ 10% photosynthetic photon flux). Continuous (24-hour) light-emitting diode lighting with either 100 or 50 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photosynthetic photon flux density at ≈ 23 ℃ was used with the above treatments. After 11 to 14 days of light treatment, B vs. R promoted elongation growth as demonstrated by a greater stem extension rate, hypocotyl length, or petiole length in the tested microgreen species, except for mustard. The promotion effects on elongation were stronger under lower vs. higher light for cabbage and kale, and cotyledon size was also reduced by B vs. R light in most cases, which suggested that stem elongation under pure blue light appeared to be one of the shade-avoidance responses in de-etiolated seedlings. BU vs. B inhibited elongation growth for some species at 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in most cases, but BU vs. R did not, except for mustard at 50 $\mu mol \cdot m^{-2} \cdot s^{-1}$. BF vs. B increased stem extension rate, and hypocotyl length for arugula and mustard, and petiole length for arugula, but not in other cases. If considering all plant traits together using principle component analysis, BU and BF effects were similar to B, but different from R. This suggests that after adding UVA or far-red light, the pure blue light effects on growth and morphology are slightly changed, with varying sensitivity among species.

Keywords: morphology trait, stem extension rate, hypocotyl length, shade-avoidance response, de-etiolated seedling

1. Introduction

Stem elongation is one of the most important plant growth traits for horticultural production. For example, increasing stem (or hypocotyl) elongation can benefit the harvesting of microgreens, and grafting of rootstock, but inhibiting stem elongation can create compact bedding plants and dwarf vegetable transplants thus improving their market quality. Light adjustment technology has become one of the environment-friendly ways to modify plant morphology in greenhouse production (Demotes-Mainard et al., 2016; Mah et al., 2018), since plants need light not only for photosynthesis, but also for regulation of their growth and development.

Previous studies have clearly indicated that at least two photoreceptor systems, i.e., phytochromes, activated by red light and deactivated by far-red light, and blue light receptors, cryptochromes, are involved in the mediation of elongation growth by light (Cosgrove, 1981). Although both red and blue light can mediate stem elongation (Laskowski and Briggs, 1989; Hoenecke et al., 1992; Huche-Thelier et al., 2016), many