Effect of different light spectrums on growth and development of Silver birch (*Betula pendula* Roth) *in vitro* cultures

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Introduction

Light emitting diodes (LED) offer many advantages over conventional fluorescent lighting as a light source for *in vitro* cultures. LEDs are energy efficient, produce less heat and the spectral composition can be adjusted to specific requirements. Currently indoor farming systems utilise adapted LED lighting spectrums for various crop species, whereas there are limited solutions for micropropagation of woody tree species. Our aim was to develop an innovative LED lighting system specifically adapted for *in vitro* propagation of silver birch (*Betula pendula* Roth) clones.

Methods

10 silver birch (*Betula pendula* Roth.) clones were cultivated *in vitro* on solidified (plant agar 6,0 g·L^{-1}) Woody Plant Medium (WPM) supplemented with 0,06 M Sucrose and 0,1 mg·L^{-1} Zeatin. Culture medium pH was set to 5,8 before autoclaving. Cultures were grown for 5 weeks under LED lighting with three different spectral compositions (Fig.1.): 1) Red + Blue (RB) 2) Red + Green + Blue (RGB) 3) Red + Orange + Yellow + Green + Blue (RGBYO) and fluorescent tubes (FL) as control lighting. Photon flux density was constant at 115±5 µmol·m^{-2}·s^{-1} with 16/8h (day/night) photoperiod. Ambient temperature was set to 25^{o}C. To evaluate the effect of different light spectrums, we compared plant growth parameters (main shoot and total shoot length, number of internodes, length of 3rd internode, fresh and dry weight, average leaf area and leaf area of a single plant, photosynthetic pigment concentration, chlorophyll A fluorescence) and multiplication index.

Results

There were no significant differences of total shoot (fig.2a.) and main shoot length (fig.2b.), number of internodes, length of 3rd internode, fresh and dry weight, photosynthetic pigment concentration and multiplication index (fig.2c.) between FL and LED luminaires. Plants grown under RB spectrum had significantly lower fluorescence parameter Fv/Fm values (fig.2d.) compared to plants grown under control lighting (FL) and significantly lower leaf area of a single plant (fig.2e.) and average leaf area (fig.2f.) compared to FL, RGB, RGBYO. Although no significant differences were detected for multiplication indices of RGBYO and RB, RGBYO plants had significantly higher main and total shoot length than RB plants. Our initial results suggest that *in vitro* cultures of Silver birch grown under LED lighting with various spectral compositions perform equally well under fluorescent lamps. Overall the use of a narrower spectral composition (RB) resulted in a reduction of plant growth, compared to the control lighting (FL) and LED lighting with a broader spectral composition. We suspect that broad spectrum LEDs could outperform traditional fluorescent lamps under lower photon flux density, if unnecessary spectral regions are removed. Additional data is needed to support this hypothesis.

	Blue	Green	Yellow	Orange	Red	Far-red	Red:Blue	Red:Far-red
FL	17%	25%	7%	36%	4%	11%	0,24:1	0,36:1
RB	23%	0%	0%	2%	73%	2%	3,2:1	36,5:1
RGB	18%	22%	0%	1%	57%	2%	3,2:1	28,5:1
RGBYO	17%	17%	3%	5%	56%	2%	3,2:1	28:1

Fig.1. Spectral composition of luminaires

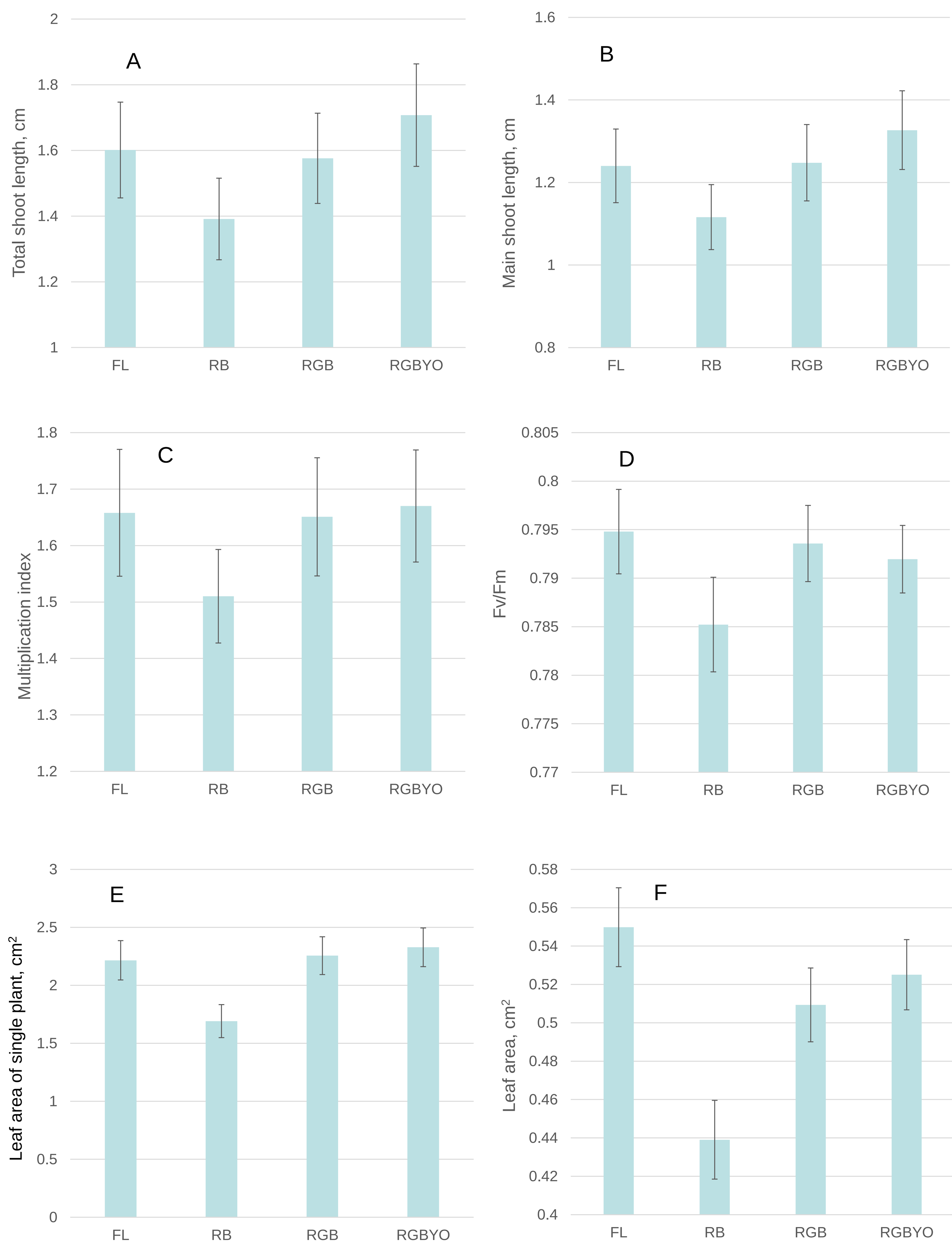

Fig. 2. Growth parameters (total shoot length (a), main shoot length (b), fluorescence parameter Fv/Fm (d), Leaf area of single plant (e), average leaf area (f)) and multiplication index (c) of Silver birch in vitro cultures grown under different spectral compositions

Fig.3. 5-week old *In vitro* cultures of silver birch clone 589-805 grown under different spectral composition lightings.

NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020
EIROPAS SAVIENĪBA
Eiropas Reģionālās attīstības fonds
IEGULDĪJUMS TAVĀ NĀKOTNĒ

European Regional Development Fund project (No. 1.1.1.1/18/A/138)
Development of specially adapted LED luminaires for efficient and energy-efficient tree propagation and rootstock process