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GROWING POTATO SPROUTS UNDER LIGHT EMITTING DIODES

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ABSTRACT: Lighting emitting diodes (LEDs) offer a good tool for use in agricultural applications. Potato sprouts are used for varieties distinctness, uniformity and stability (DUS) tests. The current study investigated the effect of growing potato light sprouts under different LED light qualities and the possibility of using LEDs as light source for growing potato sprouts for DUS tests. The results revealed that white LEDs could be a good source of lighting for growing light sprouts for DUS tests. Red LEDs produced tall thin sprouts with the lowest dry weight. White fluorescent produced the highest anthocyanin content. Varietal differences observed between the tested varieties in length, width, fresh weight, dry weight and anthocyanin content.

KEYWORDS: Light emitting diodes, potato

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important world food crops. It ranks after maize, rice and wheat in terms of world production (FAOSTAT, 2016). The global potato production reached 385.07 million metric tonnes in 2014 (FAOSTAT, 2016). Around world more than 4200 potato varieties are available (Struik, 2008). Sprouting capacity (good, rapid and strong emergence) of the seed tuber is a crucial factor in potato yield production (Krijthe, 1962). Also, sprouting is the visible measure to determine physiological age of potato tuber (Daniels-Lake and Prange, 2008).

Furthermore, Light sprout descriptions is one of the important identification characteristics used in potato varieties distinctness, uniformity and stability testes (DUS) recommended by the 'International Union for The Protection of New Varieties of Plants' (UPOV). According to UPOV guidelines and Houwing *et al*. (1986) a good expression of the light sprout characteristics is obtained under continuous light provided by small incandescent bulbs (6V AC/0.05 A) giving an intensity of 5 to 10 lux.

Light Emitting Diodes (LEDs) technology could be a very useful tool in biological studies and horticultural applications (Nhut and Nam, 2010; Dutta Gupta and Jatothu, 2013). LEDs are cheap, compact, handy, easily available, low heat energy emitting and very efficient due to energy saving and durability. Many studies indicated that LED is better than fluorescent and incandescent lamps as source of lighting in growth chambers (Nhut and Nam, 2010) and plant factories (Goto, 2012). Light quality manipulation using LEDs offers an alternative tool for modifying plant responses. i.e. cucumber seedling quality (Hernández and Kubota, 2014; 2016), Mentha essential oil (Sabzalian *et al*., 2014), production of strawberry fruits, greater accumulation of organic acids and phytochemicals (Choi *et al*., 2015). The current study investigated the effect of growing potato light sprouts under different LED light qualities and the possibility of using LEDs as light source for growing potato sprouts for DUS tests.

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MATERIALS AND METHODS

A factorial design experiment was conducted with two factors (varieties and light sources). Tubers of 15 potato varieties *viz*., Crop 17, Sorrento, Speeda, El Beida, Mandola, Kenza, 05f7405, Nessma, Dounia, Passion, Rainbow, Concordia, FL 2027, Kufri Pukhraj and Spunta were placed on shelves under continues lighting of 5 light qualities i.e. white, red, blue, 75% red/25% blue LED and white fluorescent lamps (**Fig. 1**). The treatments were arranged in three replications with 10 tubers per replication. The light source placed 40 cm above the tubers. Data of light sprouts length, width, fresh weight and dry weight were recorded after 8 weeks. Anthocyanin content in sprout skin (1 mm depth) was determined according to the pH differential method (Lapornik *et al.,* 2005 and Gallik, 2012). Anthocyanin content was expressed as µg/g cyanidin-3-glucoside using Jenway 6305 UV/visible spectrophotometer (Jenway Ltd. UK). The arrangement of the experiment was complete randomized in factorial. Means were compared using least significant difference (LSD at 0.05). Statistics 8 software was used for analyzing data.

Fig. 1. The potato tubers under 5 light conditions; a. white fluorescent, b. red led, c. white LED, d. 75% red + 25% blue LED and e. blue LED.

RESULTS AND DISCUSSION

Morphological differences were recorded under different light sources (**Fig 2**). Red LED lighting significantly produced longer and thinner sprouts than blue, red/blue, white LED or white fluorescent (**Fig. 3**). Supporting results were obtained by Xiaofeng *et al.* (2015) indicated that R/B light increased stem dimeter of potato plants grown *in vitro*. Lee *et al*. (2011) reported that red LEDs enhance the length of *in vitro* grown potato plantlets whereas blue LEDs shorten and thicken it. Also, Poudel *et al.* (2008) stated that grape plants cultured under red LEDs produced the longest shoots with longer internodes. In contrary, Hernández and Kubota (2016) mentioned that cucumber seedlings under blue LEDs were taller than under red LEDs. **Fig. 4** illustrates that red LED gave the lowest sprout dry weight. However, no significant differences were obtained between light sources in sprout fresh weight (**Fig 4**). In this respect, Hernández and Kubota (2016) reported that red light gave the lower fresh and dry weight than blue or any of the combinations between red and blue LEDS. Furthermore, Lin *et al.* (2013) reported that lettuce under red,blue and white LEDs together or fluorescent gave higher shoot and root fresh and dry weights than those treated with red and blue.

Anthocyanin concentration analysis revealed that red light gave the lowest values while white fluorescent induced the highest concentrations (**Fig. 5**). However B and R/B gave intermediate results. Shi *et al.* (2014) suggested that blue light enhance anthocyanin biosynthetic and regulatory genes.

Fig. 2. Sprouts of 15 varieties grown for 8 weeks under 5 different light sources from the left; yellow ball: white fluorescent, white ball: white LED, red ball: red LED, pale blue ball: blue LED and dark blue ball: 75% red + 25% Blue LED.

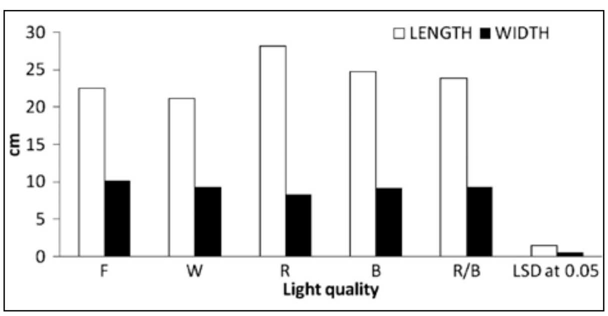

Fig. 3. Effect of light quality (F: white fluorescent, W: white LED, R: red LED, B: blue LED and R/B: 75% red LED + 25% Blue LED) on sprout length and width after 8 weeks.

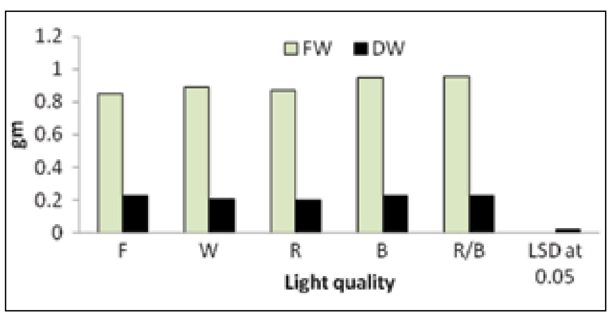

Fig. 4. Effect of light quality (F: white fluorescent, W: white LED, R: red LED, B: blue LED and R/B: 75% red LED + 25% Blue LED) on sprout fresh and dry weight after 8 weeks.

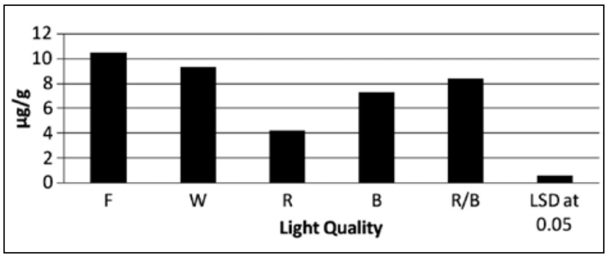

Fig. 5. Effect of light quality (F: white fluorescent, W: white LED, R: red LED, B: blue LED and R/B: 75% red LED + 25% Blue LED) on sprout Anthocyanin concentration in sprout skin(µg/g FW).

Under white LEDs the morphological characteristics were better and represent the varieties descriptions as shape and anthocyanin pigmentation. This finding is in accordance with those obtained by Houwing *et al.* (1986) mentioned that for variety identification light sprouts need to be not very elongation, with moderate chlorophyll and with sufficient anthocyanin pigmentation.

Varietal differences observed between the 15 varieties in response to light sources in sprout length and width (**Fig. 6**). The highest length with lowest width obtained by FL2027 and the lowest length recorded by Mandola, Dounia, Concordia, and Rainbow. However the highest width registered by Concordia.

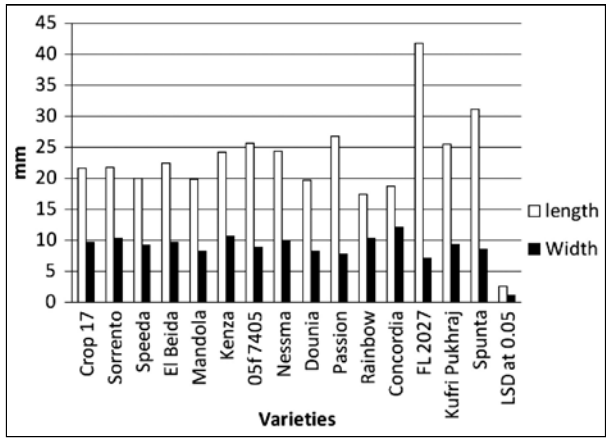

Fig. 6. Differences between varieties in length and width after 8 weeks under different light conditions.

Also, varietal differences observed in sprout fresh and dry weight (**Fig. 7**). Spunta, Kenza and Concordia gained the highest fresh weight. On the other side, the lowest fresh weight was produced by Concordia. Kufri Pukhrajr recorded the highest dry weight, while 05f 7405, Speeda, Mandola produced the lowest dry weight. Concerning difference between varieties in sprout anthocyanin content El Beida formed the highest anthocyanin concentration whereas Nessma and 05f 7405 yielded the lowest one (**Fig. 8**).

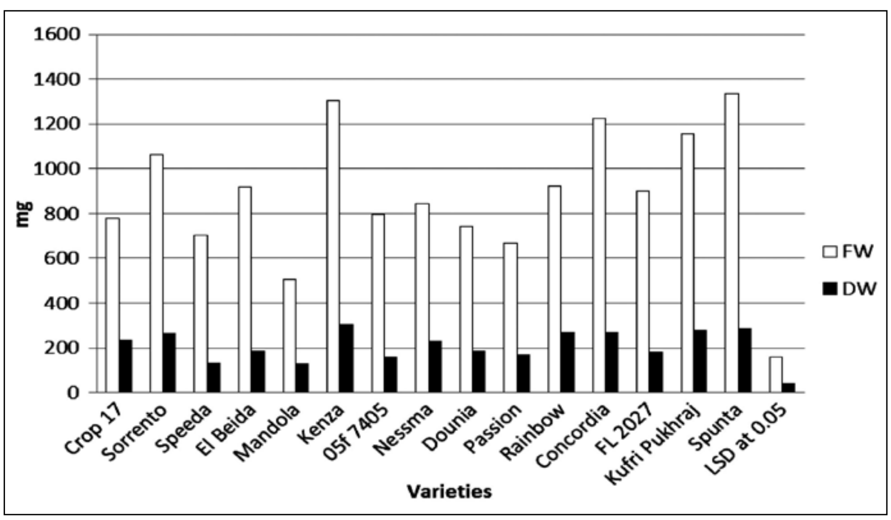

Fig. 7. Differences between varieties in fresh and dry weight after growing 8 weeks under different light conditions.

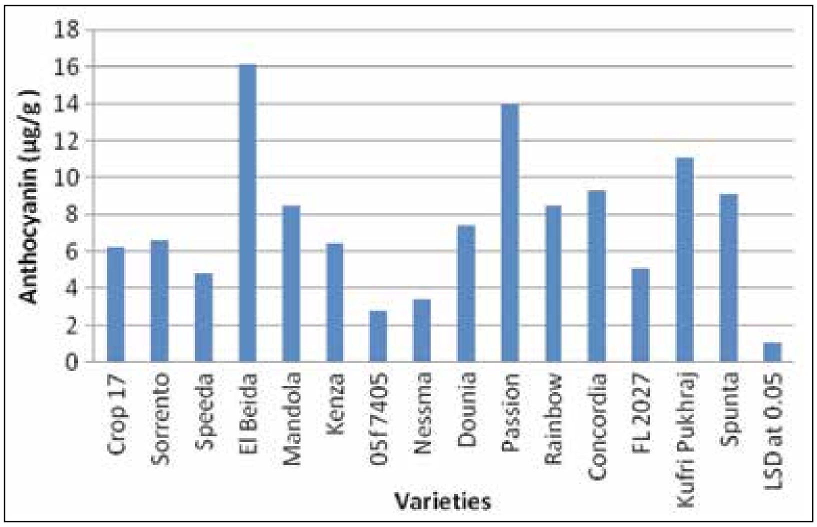

Fig. 8. Differences between varieties in anthocyanin content after growing 8 weeks under different light.

CONCLUSIONS

The obtained results indicated that white LEDs can be used as a lighting source for growing sprouts for DUS tests. Also, the study indicated that light quality play a key factor in physiological response as the effect of red light produced tall thin sprouts with low dry weight.

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