Effect of supplementary light on growth, yield and fruit quality of two tomato cultivars grown in high-tech glasshouse

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Abstract

Two tomato (*Solanum lycopersicum*) cultivars 'Dafnis' and 'Cluster' were grown in a high-tech glasshouse at the National Research and Development Center for sustainable agriculture (ESTIDAMAH), Riyadh, Saudia Arabia during the 2017-2018 season to evaluate the effect of supplementary light on tomato growth, yield, fruit quality and water use efficiency. Supplementary light was introduced by high-pressure sodium lamps (PAR, 210 µmol m^{-2} s^{-1}) for 6 h (12:00-6:00 am). Results reveal that supplementary light significantly increased plant height of both 'Dafnis' (13%) and 'Cluster' (18%) in comparison to natural light. However, number of leaves $plant^{-1}$ did not show significant differences between treatments. Notably, the interaction between light and the two tomato cultivars did not differ in term of total yield. On the other hand, total fruit number $plant^{-1}$ was significantly improved up to (63.4%) and (68.4%) under supplementary light for 'Dafnis' and 'Cluster', respectively, while supplementary light significantly reduced average fruit weight by 41% in both cultivars. According to the effect of treatments on fruit quality, results show that titratable acidity and total soluble solids were significantly enhanced by supplementary light application, while vitamin C did not differ. Obviously, water use efficiency (kg m^{-3}) was significantly reduced (20%) while energy usage increased (54%) with supplementary light application. In conclusion, supplementary light application under high-tech greenhouse showed favorable effects in terms of tomato growth, quality and water use efficiency, however, further work should be done to optimize plant fruit yield.

Keywords: supplementary light, tomato, yield, quality, water use efficiency, photosynthetic active

INTRODUCTION

Sustainable horticulture is a challenging task since the world-wide increase in population, accompanied by increasing food demand, and the current consensus is that we must move toward more sustainable practices (Page et al., 2014). This challenge leads to a need for higher production yield in agriculture that in turn raises energy demand of the agricultural industry. Therefore, greenhouse cultivation became the main supplier of year-around production of fresh vegetable worldwide (Hemming et al., 2019). In hot dry climate conditions, the scarcity of water is one of the most limiting factors for agriculture in the arid and semi-arid regions. In Saudi Arabia, the total yearly water consumption is about 18,639,000 million m^3, about 83.7% water is used for agriculture production (Ministry of Water and Electricity, 2013). In addition, plant production in the greenhouses is strongly affected by high solar radiation, resulting in high temperature exceeding plant favorable conditions which increase the cooling load, energy and water consumption. Moreover, evaporative cooling systems in greenhouse consumes more water than plant consumption especially during the long summer season (De Gelder et al., 2012). Therefore, efficient use of

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