INFLUENCE OF SUPPLEMENTARY ILLUMINATION ON YIELD AND QUALITY OF GREENHOUSE BELL PEPPER (*Capsicum annum* L.)

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INTRODUCTION

Bell pepper (*Capsicum annum* L.) is an important vegetable crop in the world and one of the most intensively cultivated greenhouse vegetables in Sri Lanka (Anon, 2012).Even though bell pepper is grown under controlled environmental conditions, a very high percentage of fruit abscission observed amongst immature fruits is a major problem in popularizing this crop amongst farmers (AVRDC, 1986). Environmental stresses such as heat, drought, and low light conditions or failure of pollination/fertilization (Wien *et al.,* 1989a; Aloni *et al.,* 1996) are reported as potential causal factors that may induce abscission. Also, studies conducted by Aloni *et al*., (1996) stated that high light intensities decrease abortion rates while lower intensities increase abortion in young fruits of bell pepper. Though bell pepper is a day neutral plant, tomato that belongs to the same family (*Solanaceae*) as bell pepper has already responded to the supplementary illumination exhibiting enhance yield (Lu *et al*., 2012). Further research conducted in Sri Lanka has also shown that supplementary illumination can help in reducing fruit drop in gherkin (Karunarathne; 2014). Therefore, this research was undertaken to investigate the influence of enhancing light intensity (during cloudy/rainy weather) and extending day light duration on the growth and yield of bell pepper, the impact of supplementary lighting on immature fruit drop of bell pepper and to assess the cost effectiveness of supplementary lighting in commercial bell pepper cultivation.

METHODOLOGY

The experiment was conducted using the bell pepper variety, "Aristotle" under glass house conditions at the Dodangolla Experimental Station of the University of Peradeniya, located in the Mid-country Intermediate Zone, Sri Lanka during February to July 2015 (*Yala* season). Three treatments were assigned; T_1 – supplementary lighting to extend day length by 4 hours during 5.00 a.m. to 7.00 a.m. and 6.00 p.m. to 8.00 p.m., T_2 – supplementary lighting under rainy/cloudy weather from 7.00 a.m. to 5.00 p.m. using Light Emitting Diodes (LEDs = 15390 lux) and T_3 – control (without having artificial lighting) in a Completely Randomized Design with three replicates per treatment. Crop management was done according to the recommended practices (Weerakkody *et al.*, 2008). Plant height, inter-nodal length, leaf area, number of leaves, number of nodes and stem thickness were measured as vegetative parameters. The cumulative new fruit emergence and fruit drop were counted once a week and yields were recorded weekly as number of total fruits, their height, diameter, girth (cm) and yield per plant (g). Internal greenhouse environmental parameters such as light intensity, temperature and relative humidity were also recorded daily. Data were analyzed using Statistical Analysis System (SAS package) while mean separation was done with Least Significant Difference (LSD) at $P \leq 0.05$.

RESULTS AND DISCUSSION

There was no significant difference ($P \leq 0.05$) among light treatments on any of the vegetative growth parameters (plant height, number of leaves, leaf area, number of nodes, intermodal length and stem thickness) and cumulative new fruit emergence of greenhouse grown bell pepper (data not presented).

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Mean temperature inside the greenhouse was 31±2 ˚C while the relative humidity inside the greenhouse varied in the range of 60-85% at daytime during the period of study. Over the growing season, the total number of supplemental lighting hours given under rainy/cloudy condition (T_2) was 35.42 hours. The average light intensity under natural light (control) was 36,456 lux, under rainy or cloudy condition 1305 lux and time at which extend the day length 3285 lux.

The impact of different light treatments (T_1, T_2) on number of fruits dropped per plant was significant ($P \leq 0.05$) in 7th week after transplanting; however there was no significant difference among light treatments on fruit drop thereafter. Hence, light treatments (T_1, T_2) did not reduce fruit drop significantly, compared to control (Figure 1) which is clearly explained by the similar light intensity levels prevailed among the different light treatments 7th week after transplanting due to absence of rainy or cloudy conditions.

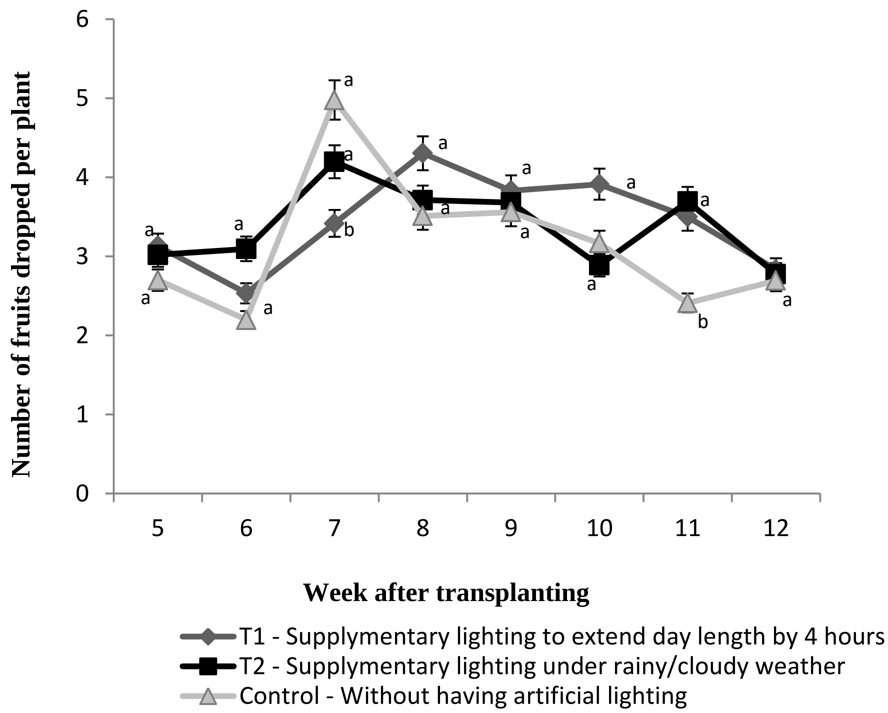

Figure 1. Variation of number of fruits dropped per plant under different light treatments.

Although there were variations, no significant treatment differences were observed in relation to new fruit emergence. The lowest rate of fruit emergence was recorded in plants treated with supplemental lighting to increase day length (T_1) while the highest value was recorded in plants treated with supplemental lighting under cloudy conditions (T_2). Therefore, expected boost in net assimilation under supplemental lighting, favoring source-sink relationship (Aloni *et al*., 1996) for formation of more fruits and retaining them without dropping immature fruits seemed not possible and potentially the former could have been a result of greater rate of maintenance respiration under hot and humid greenhouse conditions (Wien *et al*., 1989a; Aloni *et al*., 1994).

Supplemental lighting used under cloudy condition (T_2) showed significantly higher yield per plant, compared to supplemental lighting used to increase day length (T_1) (Figure 2). However, there was no significant difference in yield per plant between the supplemental lighting used treatments and control (Figure 2).

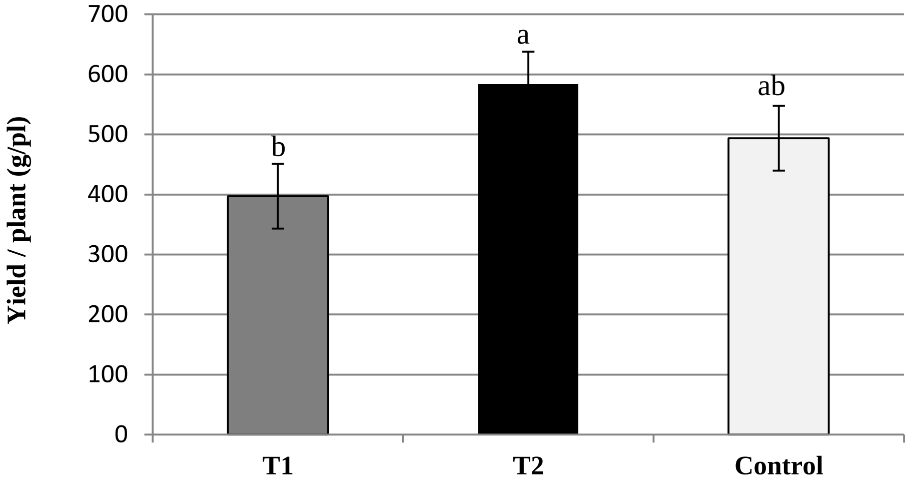

Figure 2. Effect of supplemental lighting on total yield.

Among the two light treatments, supplemental lighting under cloudy/rainy condition (T_2) found as the most cost effective treatment due to the significant yield increase shown in T_2 when compared to supplemental lighting used to increase day length (T_1). Therefore, supplemental lighting under cloudy/rainy weather (T_2) can be considered as the most cost effective solution to address the problem of immature fruit drop of bell pepper.

CONCLUSIONS AND RECOMONDATIONS

Supplemental lighting under rainy/cloudy weather (T_2) significantly contributed to higher fruit yield when compared to supplemental lighting used to extend the day length (T_1). However, no significant treatment effect of supplemental lighting on any of the vegetative growth parameters (plant height, number of leaves, leaf area, number of nodes, intermodal length and stem thickness),cumulative new fruit emergence and fruit drop was obvious in greenhouse bell pepper variety, “Aristotle” used in this study. Cost effectiveness of supplemental lighting under cloudy/rainy condition (T_2) was greater when compared to extended day length using LEDs (T_1). Supplemental lighting under rainy/cloudy weather would be the most cost effective solution to reduce immature fruit drop of greenhouse bell pepper. In future experiments, avenues of enhanced control of environmental conditions inside the greenhouse need to be used in order to limit fluctuations in flowering, fruiting and general growth of the plant. Further improvements for this methodology can be made possible by repeating the study in *Maha* season in Mid-Country Intermediate Zone using different light sources such as fluorescent lamps, metal halide lamps and horticultural grade LEDs that are specially designed for protected agriculture.

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