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Full Length Research Paper

Photoperiod effects on propagation of strawberry

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The effect of photoperiod on multiplication of commercial strawberry cultivars was investigated at the Malaysian Agricultural Research and Development Institute (MARDI) Station in Cameron Highlands. Two strawberry cultivars, Camarosa and Camaroga, were grown under a plastic rain-shelter supplemented with three levels of photoperiod, 12 (normal day length of Cameron Highland), 15 and 17 h. The result showed that photoperiod, cultivars, photoperiod × cultivars had significantly affected on a number of runners per plant and increased the length of runner and number of plantlets per runner and per plant. 15 h long-day were found to be very efficient in multiplying the strawberry plant under which the number of plantlets per plant had significantly increased to about 19.79 as compared to about 7.4 under the 12 h photoperiod. The result also showed that cultivar Camaroga was capable to produce a significant number of about 17.31 plantlets per plant compared to about 13.06 in Camarosa. The analysis of photoperiod × cultivar interaction indicated that the highest number of about 22.06 plantlets per plant was obtained from Camaroga, grown under the 17 h photoperiod. This study indicated that propagating performance in Camaroga is better than Camarosa under Cameron Highland climatic condition.

Key words: *Fragaria* × *ananassa*, photoperiod, propagation.

INTRODUCTION

Under the normal practice, strawberry plants are comercially grown from the plantlets which are proliferated at the runner nodes of the adult plants. Therefore, the number of the runners produced by the adult plants is one of the major parameter that must be taken into consideration when propagating the strawberry. The growth of runner is a result of cell division and elongation in the internodes (Nishizawa and Hori, 1993).

The environmental condition is recognized as one of the major factors effecting runner production in strawberry. It was demonstrated that under the short day photoperiod, strawberry produced more crown than the runner. The runners began to proliferate when the day length was 12 h or longer with the temperature of above 10°C, and the runner production was very effective under the 15 h day-length photoperiod when the temperatures was not less than 22.7°C (Darrow, 1966).

It was also found that the number and length of strawberry runner were not only dependent on the photoperiod but also dependent on the variety factor and the interaction of the two factors (Pipattanawong et al., 1996). Serce and Hancock (2005) showed that *Senga Sengana* cv and *Tioga* cv gave the highest number and length of runner per plant under the long day photoperiod but the production was dependent on the genotype.

Cameron Highland is located in the tropics where the long day photoperiod is absent, and with the frequent cloudy weather condition, making the long day photo-period in Cameron Highland fewer. Therefore, a study was carried out with the aims to i) assessing the effects of photoperiod, cultivar and their interaction on the runner and plantlets production of strawberry, and ii) determining the runner and plantlets production in two commercial cultivars of strawberry grown under three different photo-

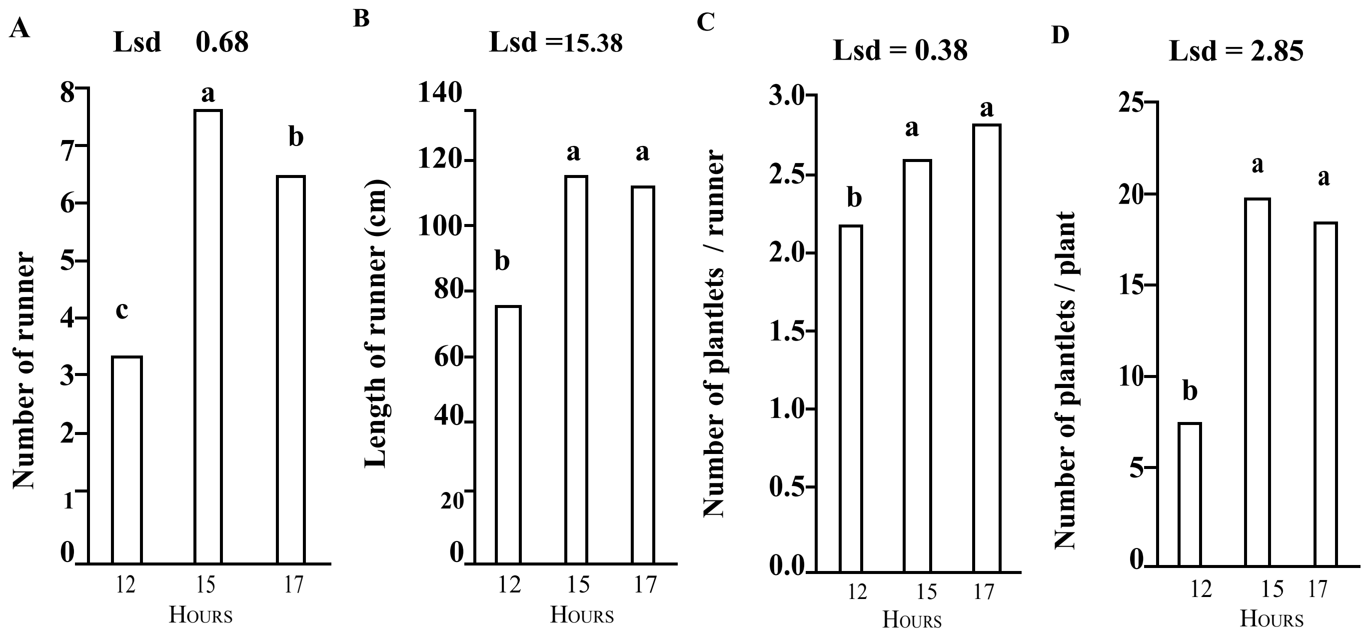

Figure 1. The effect of photoperiod on number of runner (A), length of runner (B), number of daughter plant per runner (C) and number of plantlets per plant (D). Bars with different letters indicate significant difference (P < 0.05) in the same chart.

periods in Cameron Highland, Malaysia.

MATERIALS AND METHODS

Experimental design and plant material

The experiment was conducted at the Malaysian Agricultural Research and Development Institute (MARDI) Station in Cameron Highland, Malaysia, located at an altitude of 10,000 m above sea level, latitude 4°28'6.75"N and longitude 10°23'6.83"E. Two strawberry cultivars, Camarosa and Camaroga, were used. The uniform runner cuttings obtained from the adult plants were grown in nursery for plantlets propagation. A total of 594 plantlets of 3.5 leaves stage were transplanted in 15 cm diameter plastic pots containing 2 kg mixed growing media of coco peat and perlite at 9:1 ratio. All plants were placed under 400 m^2 plastic rain-shelter, watered and fertilized through the fertigation system. Pest and disease control were made using the standard practice applied in Cameron Highland.

The plants were exposed to three photoperiod levels, 12 (normal day length of Cameron Highland), 15 and 17 h by using 100 W fluorescent bulbs with an overall light density of approximately 50 lux. A total of 18 plants per experimental unit were arranged in a split plot factorial randomized completed block design (RCBD). Each treatment consists of three replications. The numbers and length of the runner, the number of the plantlets per runner and number of the plantlets per plant were measured at three and half months after treatment.

Statistical analysis

Analysis of variance (ANOVA) was used to determine the significant difference among the treatment and the multiple range test of Duncan ($p > 0.05$) for the significant separation of means among the treatments was calculated by using the MSTAT-C program.

RESULTS

The effect of photoperiod on the number of runner per plant is shown in Figure 1A. The number of runner had increased by 222.54 and 190.04% under 15 and 17 h long-day respectively, compared to those under the normal photoperiod. The highest number of runner was obtained from the plant grown under the 15 h photoperiod with an average of 7.6 runners per plant (Figure 1).

Overall, the result showed that photoperiod also increased the average runner length (cm) where the longest runner with nearly 114.65 cm was seen in plant grown under the 15 h photoperiod (Figure 1B). However, the runner length under the 15 h long-day was not significantly different with the length under the 17 h long-day.

The 15 and 17 h photoperiods had significantly increased the number of plantlets per runner to an average of 2.58 and 2.81 respectively comparing to about 2.17 by the 12 h photoperiod (Figure 1C). However, the number of plantlet per runner exposed to 15 h photoperiod was not significantly different with the number under 17 h photoperiods.

The number of plantlets per plant had also significantly increased to an average of 19.79 and 18.38 under the 15 and 17 h photoperiods respectively as compared to about 7.4 under the normal (12 h) photoperiod (Figure 1D). But, the number of plantlets per plant was not significantly different between the 15 and 17 h photoperiods treatments.

Figure 2 shows the effect of different cultivars on the multiplication of runner and plantlets in strawberry. It demonstrated that the number of runner per plant was

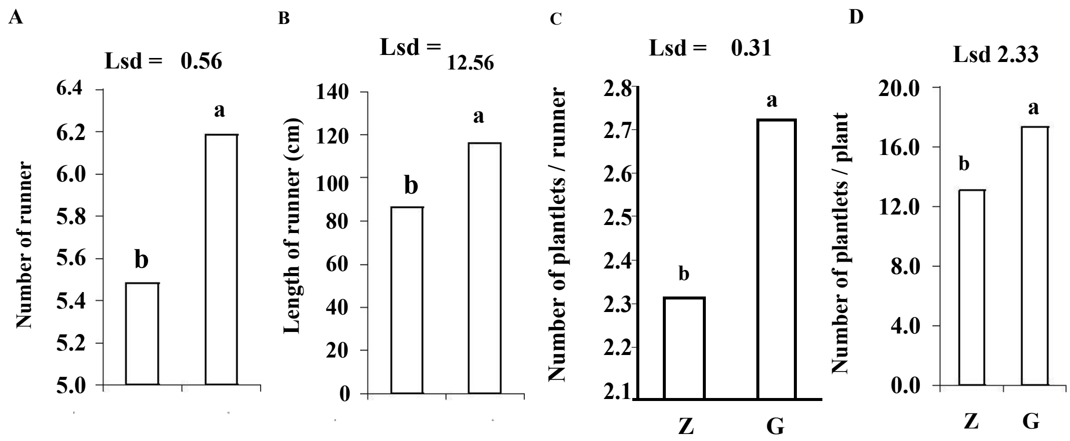

Figure 2. Shown the different between cultivars on number of runner (A), length of runner (B), number of daughter plants per runner and number of daughter plants per intact plant (D). Bars with different letters indicate significant difference (P < 0.05) in the same chart. Z = Camarosa cultivar, G = Camaroga cultivar.

significantly higher with an average of 6.19 in cultivar Camaroga compared to about 5.48 in cultivar Camarosa Figure 2A). Cultivar Camaroga also surpassed the Camarosa in terms of the runner length, where the (average length of about 115.8 cm was found in Camaroga as compared to about 86.4 cm found in Camarosa (Figure 2B).

The numbers of plantlets per runner and plantlets per plant were also significantly higher in Camaroga than those in Camarosa (Figures 2C and D). The average number of plantlets per runner in Camaroga and Camarosa were about 2.72 and 2.31 respectively, meanwhile, the number of plantlets per plant in the two cultivars were about 17.31 and 13.06 respectively.

Overall, the interaction of photoperiod × cultivar had significantly increased the runner and plantlets multiplica-tion in strawberry (Figure 3). A significant highest average number of about 8.09 runners per plant was ob-tained from Camaroga grown under the 15 h photoperiod (Figure 3A). However, the number of runner in Camaroga was not significantly different between those grown under the 15 and 17 h photoperiods (Figure 3A).

The interaction effect of photoperiod × cultivar has also showed that the runner length of Camaroga was superb than Camarosa. Under the 15 and 17 h photoperiod, the average runner length of Camaroga reached nearly 130.90 cm per plant as compared to those in Camarosa of about 98.40 cm under the same photoperiods (Figure 3B).

The effect of photoperiod × cultivar interaction on the plantlets number per runner is shown in Figure 3C. It displayed that the most significant high number of about 3.17 plantlets per runner was produced by Camaroga when grown under the 17 h photoperiod. The number of plantlets per plant had also increased significantly under the 15 and 17 h photoperiods (Figure 4). The highest number of about 22.60 plantlets per plant was obtained from Camaroga, grown under the 17 h photoperiod. Meanwhile, the significant low number of plantlet per plant with about 7.03 and 7.76 has been shown by Camarosa and Camaroga respectively when grown under the 12 h photoperiod (Figure 3D).

DISCUSSION

The result of this study clearly indicated that the photo-period had increased the number and length of runner per plant, the number of plantlets per runner and the number of plantlets per plant of strawberry. However, such effects are highly dependent on the cultivar of strawberry. Photoperiod in fact plays an important role in initiating runner bud proliferation (Darrow, 1966) and in differentiating the runner axillary buds of strawberry (Hytönen et al., 2009). The long day photoperiod led to increase in the level of endogenous gibberellins which encouraged bud proliferation in the plant (Taylor et al., 1994); this difference in peduncle length was attributed to the greater number of epidermal cells which indicated that cell division and length of the internodes is prolonged under LD conditions (Nishizawa and Hori, 1993; Nishizawa, 1994). This data is in agreement with the previous report by Snsteby et al. (2006) Nishiyama et al. (2003) and Konsin et al. (2001).

A little difference in the runner and plantlets produc-tions among the 15 and 17 h photoperiod treatments in this study might be due to the reason that the 15 and 17 h above the normal (12 h) photoperiod in Cameron Highland gave the same effect on the runner and plantlet production, disregarding the difference of the extra hour length added to the normal photoperiod. The result of this study found that the runner and plantlet productions of

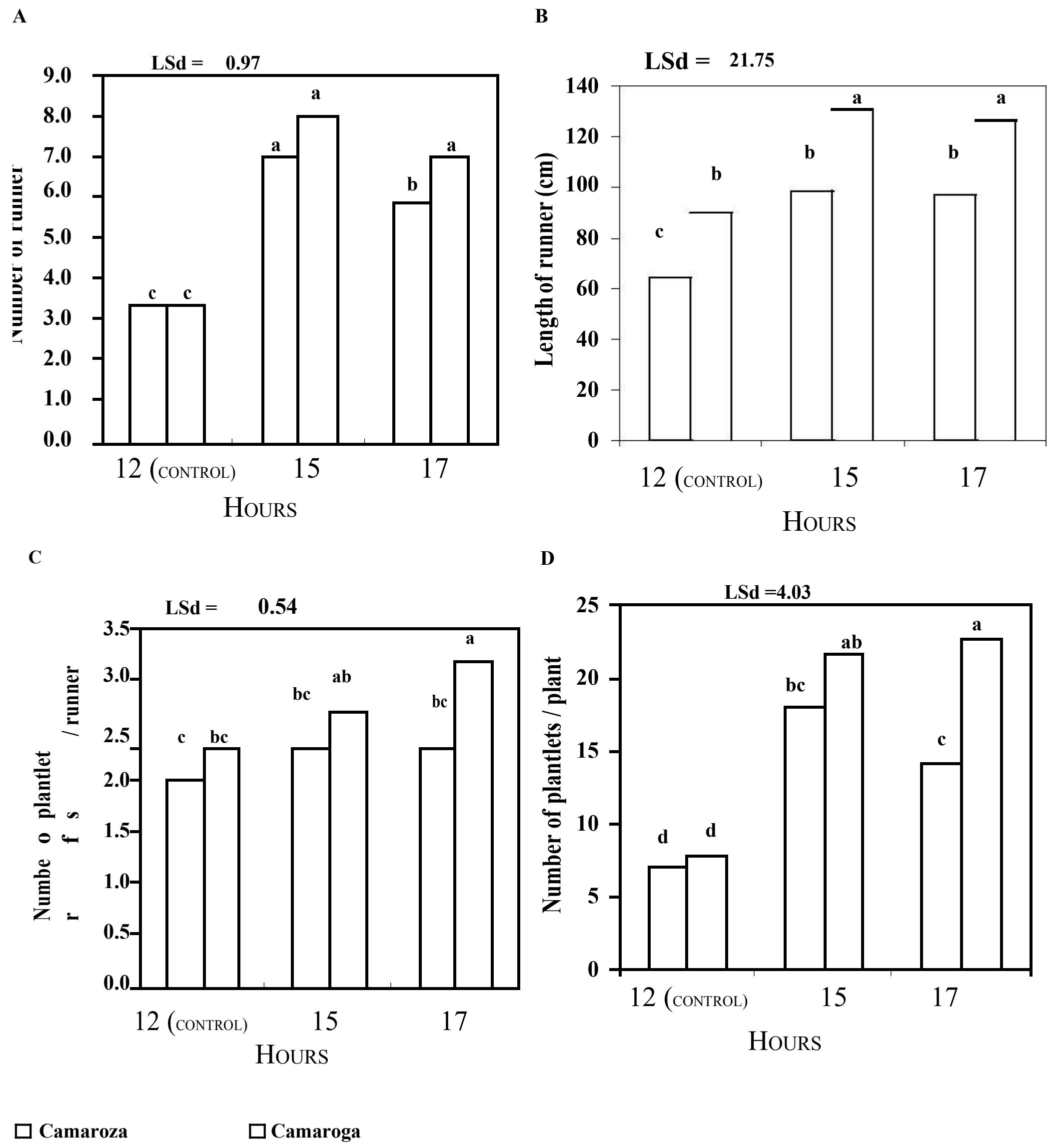

Figure 3. The interaction between photoperiod and cultivars on number of runner (A), length of runner per plant (B), number of daughter plant per runner (C) and number of daughter plant per intact plant (D). Bars with different letters indicate significant differences (P < 0.05) in same chart.

Camaroga are better than Camarosa, which confirms that the two varieties consist of two different genetic resources. Since the present cultivated strawberry varieties are believed to be derived from a diverse genetic resources of the wild parents of Fragaria chiloeniss and Fragaria virginiana (Serce and Hancock, 2005), therefore, it can be assumed that the different response to the photoperiod by the two cultivars is probably due to the different of their origin and stock.

Conclusion

It can be concluded that the 15 and 17 h photoperiods can induce the increase in number and length of runner per plant and the number of plantlet per runner and plantlet per plant of strawberry in Cameron Highland. However, cultivar Camaroga of strawberry showed a better performance than cultivar Camarosa for runner and plantlet production under Cameron Highland climatic condition.

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