Influence of Photoperiod on The Relative Growth Rate of *Hibiscus sabdariffa* L

Wirdhatul Muslihatinn[1] and Ruspeni Daesusi[2]

Abstract*—Red roselle (Hibiscus saddariffa L.) is a short day plant, this plant is only cultivated in a certain time period. There is a need to manipulate the environment where this plant can grow. The objective of this research was to study the influence of day length tothe relative growth rate (RGR) of H. sabdariffa L. Day length treatment was carried out by covering plants by black cover. Day length treatments were given in 8, 9,10, 11 and 12 hours of light exposure. Parameters measured were RGR of height plant, diameter of stem, number, and color of leaves. Harvesting was carried out when the flower crown fell or petals furl (the age of plants reached 3-4 months). The result of this research showed that highest plant was obtained at 10 hours day length (128.20 cm), the largest stem diameter growth rate was obtained at 8 hours (1.79 cm), number of leaves at 10 hours (183.40),and green color of leaves on 12 hours (scale 4). The highest RGR was obtained at 8 hours for all parameters except the height of plant and the color of leaves. Plant height, diameter and number of leaves at 8,9,10, and 11 hours of day length did not show significance difference. This showed that roselle is a short day length plant that grow optimal under 12 hours of day length.

Keyword—***Hibiscus sabdariffa L., day length, RGR***

Abstrak*—Rosela merah (Hibiscus sabdariffa L.) merupakan tanaman hari pendek yang hanya dibudidayakan pada waktu tertentu sehingga perlu dilakukan suatu teknik manipulasi lingkungan tumbuh rosela. Tujuan dari penelitian ini adalah untuk mengetahui pengaruh panjang hari penyinaran terhadap laju pertumbuhan relative (LPR) H. sabdariffa L . Perlakuan panjang hari dilakukan dengan menutup tanaman dengan menggunakan sungkup kain hitam. Perlakuan panjang hari yang diberikan adalah 8,10, dan 12 jam penyinaran. Parameter pertumbuhan yang diukur adalah RGR dari tinggi tanaman, diameter batang, jumlah dan warna daun. Panen dilakukan setelah tanaman rosela menggugurkan mahkota bunganya atau masa tanam mencapai 3 – 4 bulan. Hasil dari penelitian ini menunjukkan bahwa tanaman paling tinggi dihasilkan pada 10 jam penyinaran (128,20 cm), diameter batang terbesar dihasilkan pada 8 jam (1,79 cm), jumlah daun pada 10 jam penyinaran (183,40), dan warna daun paling hijau di hasilkan pada 12 jam penyinaran (skala 4). LPR tertinggi dihasilkan pada semua parameter kecuali tinggi tanaman dan warna daun. Tinggi tanaman, diameter batang, dan jumlah daun pada 8,9,10, dan 11 jam penyinaran tidak berbeda nyata secara signifikan. Hasil penelitian ini mennjukkan bahwa rosela merupakan tanaman hari pendek yang tumbuh optimal pada dibawah panjang hari penyinaran 12 jam.

Kata kunci—***Hibiscus sabdariffa* L., panjang hari penyinaran, LPR**

I. INTRODUCTION

Red roselle (*Hibiscus sabdariffa* L.) is a plant medicinal. It contains compounds such as proteins, carbohydrates, fiber, calcium, phosphorus, iron, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid and other compounds [1]. The parts of red roselle that can be used are leaves, flowers, petals, and seeds. Flower part is used as raw material for healthy drink. Roselle petals can be used and processed into syrup, jelly, tea, and vinegar. Fleshy calyx is used for making jellies and sauces while infusion is used as a refreshing and cooling beverage, antiscorbutic and tender leaves and stalk is eaten as salad. This is also used for seasoning curries and mixed with many indigenous vegetables while cooking. It serves many purposes for people to combat the problem of human beings and animals health. It is used in more than 20 diseases problems of human and animals [2].

Roselle is a short day plant (SDP),with fewer than a certain number of hours of light in each 24 hours period [3]. Roselle can only be cultivated on a certain day and time so the supply of raw materials to produce roselleproducts is not optimal. Availability of flower petals and leaves of roselle as raw materials can be enhanced by inducing growth and flowering.

Flowering and morphogenesis is a process that depends on lighting [4]. Growth and flowering enhancement in some plants can be done by temperature, chemical compounds, and application light radiation treatment [5]. In addition, the light factor affects the synthesis and content of anthocyanin, chlorophyll and other compounds in particular flavonoid metabolites [6] and germination [7].

Light is critical factor for plant growth and development, and the photoperiod can easily be controlled in artificial growing environment [8]. Photoperiod is the plant's response to day length (hours of daylight). Manipulation lighting and day length to plant was done by many researchers to improve growth and development by inducing flowering plants. Even when grown under optimum conditions plant species may differ considerably in growth rate.

Relative growth rate (RGR) is a prominent indicator of plant strategy with respect to productivity as related to environmental condition. Most of these underlying mechanisms deal with mature tissues, whereas the dynamic aspects of the growing plant parts e.g. meristem activity, cell elongation and tissue maturation, are seldom included in RGR analysis [9]

The objective of this research was to study the influence of day length to the RGR of *H.sabdariffa* L.

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II. METHOD

The research was conducted in March-July 2012 in the garden of Biology and Biological Laboratory, University of Muhammadiyah Surabaya.

Seeds were planted directly on the hole in each pit with the size of 40 cm wide x70 cm long x 30 cm height; 25 cm was spacing between boundaries. The treatment was day length using environmental manipulation technique. Plant covered with black cloth. Treatments given were 8, 9, 10, 11, and 12 hours of day light under natural light (sun light). Exposure time were 8 hours of daylight (5.30 am to 13.30 pm without black cloth, and then covering with black cloth 13.30 pm to 5.30 am), 9 hours (5.30 am to 14.30 pm without black cloth, and then covering with black cloth 14.30 pm to 5.30 am), 10 hours (5.30 am to 15.30 pm without black cloth, and then covering with black cloth 15.30 pm to 5.30 am), 11hours (5.30 am to 16.30 pm without black cloth, and then covering with black cloth 16.30 pm to 5.30 am) and 12 hours without cover (control).

Growth parameter was measured once a week until 12 weeks. The parameters observed were plant height, number of leaves, the diameter of the main stem and leaf color. RGR measured showed the height or diameter difference of planlet from initial condition for certain time (cm/cm/week).

Experimental design used was randomized block design, with 5 replicates for each treatment. Data was analyzed by analysis of variance and a comparison of means carried out using Tukey's test.

III. RESULT AND DISCUSSION

Plant height was a parameter of the plant that was often observed, it served also as an indicator of growth used to measure the effect of the environment or the treatment applied. This experiment found that plant height growth was relatively same in the first to the fourth week. In the end of experiments the highest plant (128.20 cm) was obtained at 10 hours day length, while the shortest plant was obtained in the12 hours day length (81.00 cm). Plant height at 8 hours (119.40 cm) was similar to 11 hours (115.90 cm) (Figure 1). The experiments showed alsothat the largest stem diameter growth rate was obtained at 8 hours (1.79 cm), it was the same as the result of 10 hours (1.75 cm), but the smallest stem diameter was obtained at 12 hours (1.27 cm). (Figure 2). The day length effects on the number of leaves in which the highest number of leaves produced on a 10 hours (183.40), while the fewest was obtained in 12 hours (114.40). 9 and 10 hours of exposure gave similar number of plant (178.40 dan 178.60). (Figure 3).

Besides number of leaves, color of leaves used as growth parameter. Number of chlorophyll sometimes correlated with leaves color. Day length causes the difference leaves colors. In the beginning of experiments color leaves was same (scale 2). Pale green leaf color (scale 2) was obtained in 8 hours while the dark green leaf color (scale 4) was obtained in 12 hours. In the end of experiments color leaves was same (scale 3) on 10 and 11 hours (Figure 4).

Results of this study showed that plant height was increasing every week. According to the RGR results obtained (Table 1), The highest RGR was obtained at 8 hours for all parameters except the height of plant (1.81 cm/cm/week), this unite explained final length of plant/initial length/time. and the color of leaves (scale 2) (0.08). Plant height, diameter and number of leaves at 8,9,10, and 11 hours of day length did not show significance difference. The results showed that roselle is short day length plant that grow optimal under 12 hours of day length.

In several species the reserve organ like stem, is dependent on or accelerated by exposure of the leaves to adequate photoperiod. Several author have observed that the process of formation these organ may be enhanching by exposing plant to short days [3][10]. The largest stem diameter was obtained at short day 8 hour. The day length gave the same effect on the number of leaves in which the highest number of leaves produced on short day 8 hours. The results were in agreement with [13] that stated Roselle is photoperiod sensitive and most species will flower when day length are shorter than 12 hours.

Day length is a factor known that influences flower development as well as vegetative growth [3][11][12]. Short day plants grow optimally at a lower light intensity and growth stunted if plants exposed to direct light constantly. In these study, photoperiod affects other agronomic properties such as height plant, stem diameter, number of leaves, and leaf color. The results was in agreement with the results obtained by other research [10] at *Psophocarpu stetragonolobus* D.C. and *H. sabdariffa* L.[11][12].

Light is an important factor for growth and development plant, it causes not only photosynthesis but also affects the morphology called photomorphogenesis. Not all plants require high light intensity. At low light intensity there is accumulation of photosynthate in the trunk so the plants tends to have vegetative growth rather than generative. Carbohydrate content as photosynthate is low in long photoperiods but the effects is varied according to cultivar [14]. Photosynthate accumulation in the trunk can increase the height, diameter at the same plant fresh weight [15][16].

There are several leaves properties influenced by photoperiod such as leaves growth, thickness, stomata density, and chlorophyll [6]. But very low intensity of light could result plant etiolation where the plant will grow faster, with weak trunk, and pale color leaves (not green). This condition means that the growth is not good.

In the condition of high light intensity, the photosynthetic activity of plant tends to increase until a certain level of light saturation. Each type of plant has different light saturation condition. The results showed that roselle grew optimally at 10 hours day light, it provided the highest plant length (128,20 cm) with RGR (1.92 cm/cm/week), the biggest plant diameter (1.75 cm) with RGR (1.22 cm/cm/week), the highest number of leaves (178.60) with RGR (6.71) and no pale color of leaves (scale 3) with RGR (0.13).

Photoperiod controls not only flowering [17] but also seed germination, stem and leaf growth, assimilate portioning and secondary metabolism [3]. And in this study photoperiod influenced height plant, diameter of stem, number and color of roselle leaves.

IV. CONCLUSION

The conclusion of this research is photoperiod has influence in the RGR of roselle. Increasing day length decreased plant height, diameter of stem, number of leaves and provided more green color of leaves. The heightest RGR obtained at the day length of 8 hours (1.81 cm/cm/week for heigh plant, 1.40 cm/cm/week for diameter of stem, and 7.64 leaves/leaves/week) but did not show significant difference compared to 9, 10, and 11 hours. This showed that roselle is a short day length plant that grow optimal under 12 hours of day length.

ACKNOWLEDGEMENT

This research was supported by the grant of Hibah bersaing DP2M DIKTI 2012 No. 0020/SP2H/PP/K7/KL /II/2012.

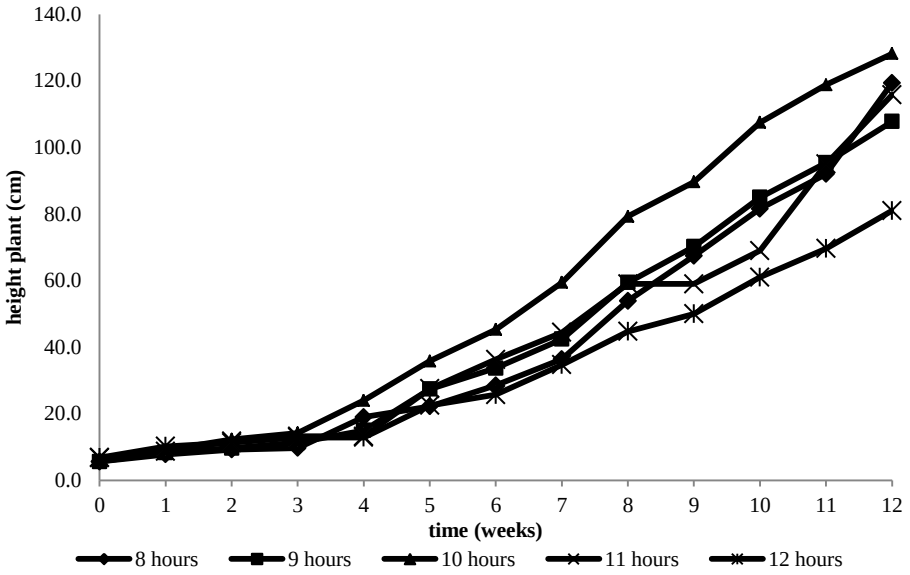

Figure 1. Growth rate of height plant in variation of daylenght

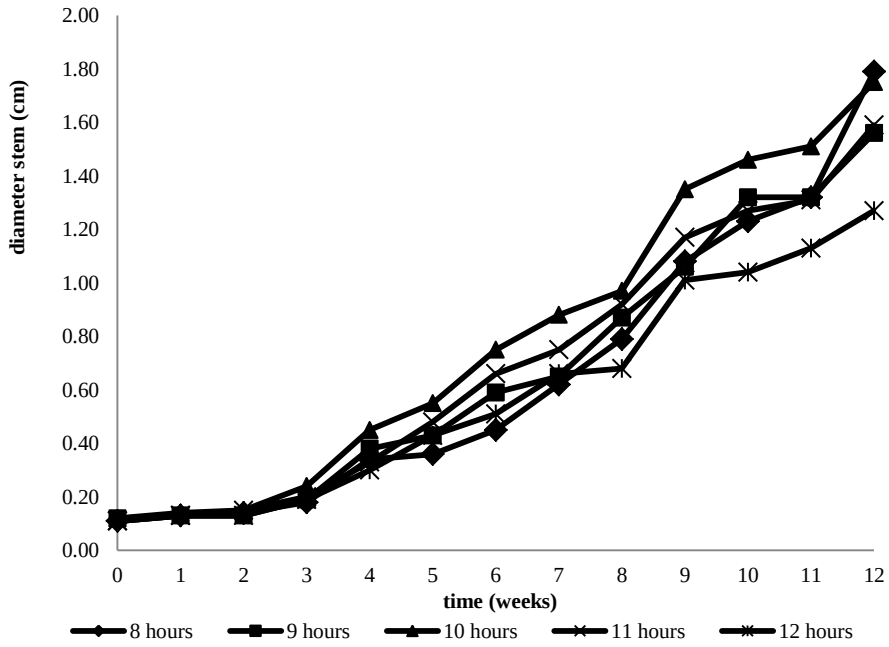

Figure 2. Growth rate of diameter stem in variation of daylenght

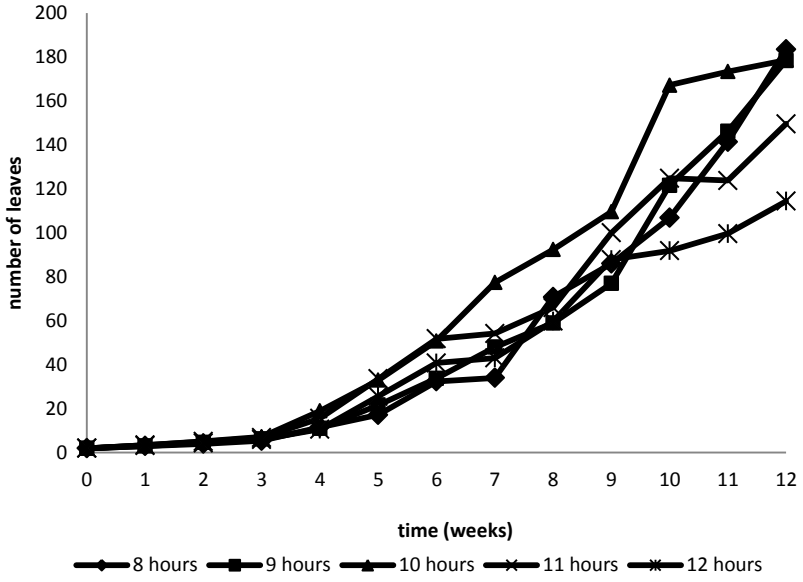

Figure 3. Growth rate of number of leaves in variation of daylength

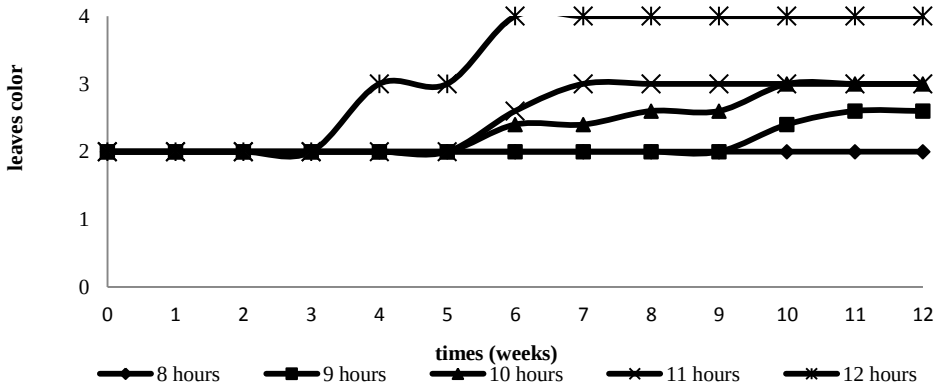

Figure 4.Color of leaves in variation of daylenght

TABEL 1.
EFFECT OF DAY LENGTH TO RGR *HIBISCUS SABDARIFFA* L.

Day length (hours)	RGR parameter Height (cm/cm/week)	Diameter (cm/cm/week)	Number of leaves	leave color
8	1.81[a]	1.40 [a]	7.64 [a]	0.08[c]
9	1.64[a]	1.08[ab]	7.44 [a]	0.11[b]
10	1.92[a]	1.22[ab]	6.71 [a]	0.13 [b]
11	1.48[ab]	1.18[ab]	6.23[ab]	0.13 [b]
12	1.00[b]	0.96 [b]	4.77 [b]	0.17 [a]

The values followed by different letters are significantly different at 5% probability level, according to Tukey's test.

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