Plant Archives Vol. 20, No. 1, 2020 pp. 856-860 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE PHOTOPERIODS INFLUENCE ON TWO CULTIVARS GROWTH AND YIELD OF STRAWBERRY PLANT

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Abstract

Recently in Iraq, strawberry became one of the most importanat and remarkcable fruits. There was many study about photoperiod effect on strawberry in the world but few studies have been devoted to investigating its effects on strawberries in Kudristan-Iraq.

This study examines the impact of photoperiod on growth, flowering and yield of two strawberry cultivars (*Fragaria X ananassa* Duch.). In this experiment, two cultivars of strawberry (Festival and Albion) were covered for 2 hour and 4 hour dui to reducing the exposing to light and the long day period. The study found that most of the vegetative parameters growth were higher in Alboin cultivar in comparison to the festival cultivar short day SD 12 hours. Nonetheless, the number of daughter plant increased considerably at 2 hours coverage for Alboin cultivar. While all the flowering parameters significantly improved at 10 hours for festival cultivar compared to the Alboin cultivar. A substantial increase in some of the fruit parameters were observed at 10 hour for festival cultivar. Nonetheless, the only fruit parameters which improved the most by covering plants for 10 hours for Alboin cultivar was fruit length. Furthermore, fruit fall percentage was recorded the highest level at the control treatment of festival cultivar and the lowest value was at 4 hour treatment of festival, while there was a significant increase in the total soluble solid and acidity at 10 hour treatment for Alboin cultivar, vitamin C and sugar percentage increased considerably at 10 hour for festival cultivar. The highest value of vitamin C was recorded at the 12 hour for festival cultivar and the lowest value of vitamin C was recorded at the control treatment of festival cultivar. The highest value of marketable fruits obtained at 10 hour treatment for festival cultivar whereas the lowest value of marketable fruits percentage obtained at the control treatment of festival cultivar.

Key words : Flowering, Growth, Coverage, *Fragaria X ananassa* Duch., Short day.

Introduction

The strawberry is an herbaceous plant that is classified as a perennial but is often grown as an annual in many production regions. The mature plant consists of leaves, roots, crowns, stolons, flowers and fruit (Trejo-Téllez and Gómez-Merino, 2014). The flowering physiology of most strawberry cultivars is not fully characterized since vegetative growth and flower initiation are both sensitive to several environment conditions including temperature, day length (photoperiod), and their interaction (Heide *et al.*, 2013). Short photo periods were chosen because 'Albion' strawberry was defined as quantitative long-day cultivar (Garcia, 2016).

The seasonal fruiting variety of the strawberry (*Fragaria X ananassa* Duch.) is a short-day plant and produces crop each summer. Through this short period, restricted vegetative growth happens. Consequently, the produced fruit have bad quality and the lowest marketable yield. Thus, the harvest fetches fewer income in market and results in critical loss to farmers (Asrey and *et al.*, 2004) and (Singh and *et al.*, 2007).

The vegetative growth and the dormancy of strawberry plants is declined by the decrease of temperature and photoperiod at the end of summer. Even though the diminution in vegetative growth are morphologically measured, there is no test that is capable of evaluating the reduction in growth potential nor its likely impact on vegetative growth. For estimating this effect biometrically, the correlation of photoperiod and temperature decrease with the vegetative growth

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strawberry cultivars is essential (Roberta *et al.*, 1999). konsin, *et al.*, 2002 found that 50% of the plants flowered subsequent the treatment in a 15 hour photoperiod. The whole plants flowered in shorter photoperiods and there was a great increase in the number of flowers by increasing the treatment duration. however the 12 hours photoperiod inhibits vegetative growth more compared to 13.5 hour photoperiod.

June bearing strawberry cultivars (*Fragaria* x *ananassa* Duch.) are commonly grown for winter production in greenhouses. In these cultivars flowering is induced by a short-day treatment (Heide, 1977; Guttridge, 1985). However, as they are modified to environments where flower initiation is followed by a cold period, they normally become dormant under the same conditions that induce flowering (Darrow, 1936). In dormant strawberry plants the amount of leaf production reduced, developing leaves are small, the petioles are short and finally growth ceases (Jonkers, 1965). Dormant plants may also flower in favorable conditions but the flower emergence is slow (Kronenberg and Wassenaar, 1972), the number of flowers is decreased and the flowers are often poorly developed (Nestby, 1989; Lieten, 1997). Floral induction in strawberry has been thoroughly examined; the short-day treatment (photoperiod usually between 8 and 12 h) required for optimal flowering in different cultivars is known (Guttridge, 1985; Sønsteby and Nes, 1998). However, the possibility of inducing flowering with longer photoperiods in order to avoid dormant condition has been studied to a lesser extent. Therefore, an experiment was carried out to find the optimal daily photoperiod that induces flowering but influences the strength of vegetative growth as little as possible. A treatment in this photoperiod could be used for floral induction without a subsequent cold treatment to remove endo dormancy.

According to Heide, (1977) and Durner *et al.*, (1984), the vegetative growth of strawberry plants is influenced by environmental factors. The decline in the vegetative growth is mostly resulted from temperature changes and alterations in length of the day at the end of summer. In addition, Jonkers, (1965) and Risser and Robert, (1993) expressed that the optimum parameter for evaluating vegetative growth is the measurement of petiole length. Furthermore, the reduction in the temperature and photoperiod cause other impacts on the development of strawberry, for example the dormancy induction, runner production reduction and flower induction (Dennis *et al.*, 1970; Smeets, 1980; Durner and Poling, 1987). Sønsteby and et al 2009 founded that after the first (short day) SD when the number of flowering crowns and the number of inflorescences per plant were more than doubled compared with the SD control.

The objective of current experiment is to explore the impact of short photoperiods on the on two cultivars growth and yield of strawberry plant 'Albion and Festival' when grown in plastic house.

Materials and Methods

This study was conducted in the greenhouse at the middle of October, uniform bare root plant which is a dormant matured plant with a developed root system and several leaf primordia plants of cv. Festival and Albion were planted randomly and standard practice of fertilizer to encourage vegetative growth and pesticide were applied for controlling disease and insects. The experimental design was a completely randomized (CRD) was applied with three replications. The length of the daily photoperiod was 10 and 12 hour at the duration of treatment 90 days. All plants were exposed to 12 hour of sun light or natural light. During photoperiod treatments some of plant parameters were studied. The data were subjected to a two way analysis of variance using the GLM procedure of the SAS statistical computer program (SAS Institute Inc., 1990).

Results

Table 1 exhibits that the vegetative growth parameters like fresh weigh, dry weight and crown diameter were increased significantly at 12 hour treatment SD for festival cultivar while the number of runner, number of daughter plant and chlorophyll pigment percentage increased significantly at the same SD respectively for Albion cultivar.

In table 2, the amount of flowering was also significantly affected by SD 10 hours including number of flower, fruit set and available pollen grain for festival cultivar compared to the Alboin cultivar in the same treatment.

Table 3 shows the fruit parameters such as dry weight, the fresh weight, fruit size, number of fruit increased significantly at SD 10 hour for festival cultivar. Nonetheless, fruit length increased substantially in SD 10 hour treatments for Alboin cultivar. However, the highest value of fruit fall was recorded at the control treatment of festival cultivar and the lowest value was at SD 10 hour treatment of festival.

It is clearly shown in table 4 that TSS, and Acidity increased significantly respectively at SD 12 hours for Alboin cultivar, while vitamin C and sugar percentage increased significantly at SD 12 hours for Festival cultivar.

Table 1: Effect of photoperiod on the growth of the some vegetative parameters of strawberry plants.

Parameters	Festival			Albion		
	Coverage			Coverage		
	Zero	2 hr	4 hr	Zero	2 hr	4 hr
Fresh weigh (g)	59.02 e	94.68 a	90.42 c	59.01 e	90.67 b	82.79 d
Dry weight (g)	22.64 e	36.41 a	33.78 b	18.89 f	25.64 d	33.08 c
Crown diameter (cm)	1.52 e	2.15 a	1.60 c	0.97 f	2.12 b	1.55 d
No. runner	7.47 e	9.33 d	10.07 c	9.34 d	12.38 a	11.04 b
No. daughter plant	9.41 f	16.36 e	19.66 c	16.46 d	20.88 a	20.49 b
Chl %	14.08 e	15.16 b	14.25 c	11.33 f	15.69 a	14.09 d

Table 2: Effect of photoperiod on the growth of the some flower parameters of strawberry plants.

Parameters	Festival			Albion		
	Coverage			Coverage		
	Zero	2 hr	4 hr	Zero	2 hr	4 hr
No. flower	25.81 d	27.72 b	29.25 a	11.18 f	26.80 c	23.37 e
Fruit set %	64.91 c	71.17 b	72.70 a	46.62 f	56.55 e	63.64 d
Available pollen grain%	66.34 e	77.13 c	80.63 a	57.79 f	69.95 d	83.06 b

Table 3: Effect of photoperiod on the some parameters of the strawberry fruit.

Parameters	Festival			Albion		
	Coverage			Coverage		
	Zero	2 hr	4 hr	Zero	2 hr	4 hr
Fresh weight (g)	7.83 d	10.19 b	11.69 a	6.00 f	7.28 e	8.34 c
Dry weight (g)	0.68 e	1.93 c	3.55 a	0.46 f	1.77 d	2.90 b
Fruit diameter (cm)	2.62 c	2.92 b	2.97 a	1.00 f	1.37 e	1.63 d
Fruit length (cm)	1.84 f	1.99 c	1.89 e	1.92 d	2.48 b	2.72 a
Fruit size	74.45 e	97.81 b	98.21 a	67.94 f	75.79 d	84.52 c
No. fruit	1.58 e	2.60 c	3.05 a	1.35 f	2.28 d	2.63 b
Fruit fall %	28.79 a	19.31 d	14.60 f	27.36 b	24.35 c	17.50 e

Table 4: Effect of photoperiod on the some chemical value in strawberry fruits.

Parameters	Festival			Albion		
	Coverage			Coverage		
	Zero	2 hr	4 hr	Zero	2 hr	4 hr
Tss	1.34 e	1.55 b	1.54 c	1.25 f	1.57 a	1.48 d
Vit.C	11.83 e	20.72 a	15.69 d	10.23 f	18.78 b	17.56 c
Acidity %	3.90 f	4.19 c	4.26 b	4.02 e	5.02 a	4.12 d
Sugar %	1.16 f	3.74 a	2.47 c	1.21 e	2.61 b	2.28 d

Table 5 presents that the maximum value of was obtained at SD 12 hour treatment for festival cultivar and the minimum value of ascorbic aside was obtained at the control treatment of festival cultivar. While marketable fruits percentage was the highest at SD 10 hour treatment for festival cultivar, lowest value of marketable fruits percentage was recorded at the control treatment of festival cultivar. In addition, the unmarketable fruits percentage and loss of weight percentage were the highest at SD 10 hr for Alboin cultivar. The unmarketable fruits percentage and loss of weight percentage were at SD 10 hours for Albion cultivar and SD 12 hour for festival cultivar. The highest value of damage fruits percentage was recorded at the control treatment of festival cultivar and the lowest value was recorded of Albion cultivar.

Discussion

As it is clear, the shortest photoperiods caused increasing in most of strawberry plant parameters. The result of vegetative growth agrees with Chouard, (1946), Bailey and Rossi, (1964), Jonkers, (1965) and Risser and Robert, (1993). While, flowering and fruit results is in agreement with konsin, and et al. In addition, some chemical value results agrees with konsin, and *et al.*, (2002). The change of some value of the fruit results comply with Asrey *et al.*, (2004) and Singh *et al.*, (2007). Generally, all the studied parameters responded well by decreasing the length day about 2 hours but the respond is less than 4 hour treatment. The transition between strawberry flowering and vegetative growth is affected by the interaction of several environmental factors, including temperature and photoperiod (Heide *et al.*, 2013). For example, 'CHI-24-1' flowers under long days when temperature is greater than 20°C, but it will also flower under short days (facultative short-day) when temperature is lower than 15°C (Yanagi, Yachi, & Okuda, 2006). The pigment, phytochrome exists in two different forms red light absorbing form which is designated as Pr and far red light absorbing form which is designated as Pfr. These two forms of the pigment are photo chemically inter convertible. When Pr form of the pigment absorbs red light (660-665 nm), it is converted into Pfr form. When Pfr form of the pigment absorbs far

Table 5: Effect of photoperiod on the change of some value of the fruit parameters after storage.

Parameters	Festival			Albion		
	Coverage			Coverage		
	Zero	2 hr	4 hr	Zero	2 hr	4 hr
Vit.C	5.34 f	7.59 a	7.73 b	5.49 e	6.05 d	6.78 c
Marketable fruits %	20.13 f	28.72 b	31.07 a	20.75 e	24.24 d	27.59 c
Unmarketable fruits %	0.88 b	0.80 d	0.79 e	0.91 a	0.79 e	0.81 c
Loss of weight %	0.15 b	0.12 e	0.13 d	0.16 a	0.12 e	0.14 c
Damage fruits %	9.88 a	8.59 c	8.47 d	8.86 b	7.60 f	7.99 e

red light (730-735 nm), it is converted into Pr form. The Pfr form of pigment gradually changes into Pr form in dark. It is considered that during day time, the Pfr form of the pigment is accumulated in the plants which are inhibitory to flowering in short day plants but is stimulatory in long day plants. During critical dark period in short day plants, this form gradually changes into Pr form resulting in flowering. A brief exposure with red light will convert this form again into Pfr form thus inhibiting flowering.

Conclusion

This experiment showed that Plants in 12 h photoperiod had higher value of most flowering and fruiting parameters than the plants in 10 h photoperiod; and but plants in shorter photoperiods maintaining good vegetative growth. 'Albion' strawberry may be successfully induced with a 12 h photoperiod compared with 'Festival' strawberry. A short day treatment in a 12 h photoperiod is to be recommended for cv. Albion and Festival. Moreover, exposing the plants to lower photoperiod positively impacted the growth especially flowering.

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