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Effect Of Choline Chloride (CC) On 'Monroe' Peach Fruit Quality And Leaf Characteristics

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Abstract: The effect of choline chloride (CC) were evaluated on fruit quality of 'Monroe' peach over 2-year period in a commercial orchard. Spray treatments of CC (0, 1000, 2000 and 3000 ppm) were applied to 7, 21 and 30 days before commercial harvest (DBH). Some fruit quality parameters fruit weight (g), fruit flesh firmness (N), soluble solids content (SSC, %), titratable acidity (TA, %), fruit colour (CIELab), sugars, ethylene production, respiration rate were assessed for per treatments. All treatments were increased fruit size and fruit weight. In the applications of CC the most determined results have occurred on colourness which is the one of significant quality parameter in peaches and they had positive effect on the development red colour. Treatments of CC have been increased of total sugar contents.

Choline chloride (CC)'in 'Monroe' Şeftalisinde Meyve Kalitesi ve Yaprak Özellikleri Üzerine Etkileri

Anahtar Kelimeler
Choline chloride
Şeftali,
Monroe
Meyve kalitesi
Renklenme

Özet: Choline chloride (CC)' in 'Monroe' şeftalisinde meyve kalitesine etkilerini incelemek amacıyla, bu çalışma 2 yıl süreyle şeftali bahçesinde yürütülmüştür. Bu amaçla, CC' nin 3 farklı dozları (0, 1000, 2000, 3000 ppm), tahmini hasat zamanından 7, 21 ve 30 gün önce şeftali meyvelerine sprey şeklinde uygulanmıştır. Meyvelerde bazı kalite özellikleri meyve ağırlığı (g), meyve eti sertliği (N), SÇKM (%), titre edilebilir asitlik (%), meyve rengi (L*, a*, b*), şeker içeriği, meyvelerin etilen üretimi (µl kg^{-1} h^{-1}) ve solunum hızları (ml CO_2 kg^{-1} h^{-1}) her bir uygulama için incelenmiştir. Tüm CC uygulamaları meyve büyüklüğünü ve ağırlığını arttırmıştır. Şeftali meyvelerinde önemli kalite parametrelerinden olan renklenme üzerine tüm CC uygulamalarının kırmızı rengin gelişimi üzerine olumlu etkisinin olduğu belirlenmiştir. CC uygulamalarının meyvelerde toplam şeker içeriğini de artırdığı saptanmıştır.

1. Introduction

Peach fruit (*Prunus persica* L.) is native from China. Peaches (*Prunus persica* L.) are grown widely in mild temperate regions throughout the world for use as a high quality dessert fruit. Acreage for peach growing is increasing in Isparta (Turkey). Turkey has 545.902 tonnes of peach production (Anonim, 2011). Fragile storability due to rapid softening and price fluctuation from short harvest span is a problem. Reports on effects of plant bioregulators on growth and fruit quality are numerous (Kim et al., 2004).

Plant bioregulators affect the leaf mineral and chlorophyll content (Monge et al., 1994; Aguirre and Blanco, 1994), and delay the maturity by hindering the chlorophyll decrease (Mohammad and Khalil, 1997). Plant bioregulators are also reported to be effective for keeping freshness (Kim et al., 1999). CC increases fruit growth and coloration in peaches and cherries (Sato, 1994), and enhances rooting of mungbean (Lee et al., 1992) and tomato cuttings (Park et al., 1992). Wahdan et al., (2011) reported that, the foliar application of CC with different concentration on peach trees increased fruit weight and SSC contents. Moreover, in fruit Mangoes CC prouced oblong fruits with SSC, SSC/TA ratio and total sugars (Wahdan, 2011). CC and its analogs, allylcholine bromide and benzylcholine bromide, stimulate the photosynthetic O_2 evolution in wheat protoplast. Furthermore, choline analogs stimulate rooting and root growth of sweet potata, and they

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also increase growth rate of some plants (Che et al., 1990). Furushima et al. (1987) reported that maturity hastening and sugar content were increased by combined application of CC and gibberellins (GA). It is of considerable interest that choline chloride and its analogs have pleiotropic biological effects, both in vitro and in vivo, which range from their activities as accelerator of photosynthesis to participation in the control of plant growth (Hyeon et al., 1987; Che et al., 1990). However, the biochemical mechanisms responsible for the biological activity of choline chloride and its analogs have so far remained obscure (Che et al., 1990).In this study, the effects of pre-harvest application of CC on fruit size, fruit quality, ethylene production, respiration rate, sugars and some leave properties of 'Monroe' peach were examined.

2. Material and Method

Experiments were conducted at the commercial peach orchard located in Isparta, altitude is 963m-971m asl. The uniform trees, 14-years-old cv. 'Monroe' peach on *P. persica* rootstock, spaced at 6x5 m were used. Trees were trained to a vase system and pruned in late winter and standard cultural practices including, thinning, and pesticide sprays were provided to the trees for several years. Experimental design was a randomized block, with 12 treatments and 5 replicates using single tree for per treatment. CC was (Merck.) sprayed at 0 (water+surfactant), 1000, 2000, 3000 ppm plus 1% (v/v) Tween 20 as a surfactant onto fruits and leaves around the fruits until runoff. The spraying was performed with a hand pump sprayer at 7, 21 and 30 days before DBH in 2007 and 2008. Fruits were harvested at commercial stage of maturity, with a change in ground color from green to yellow-red at intervals of 3-4 days, for yield and fruit assessment. CC-treated fruits and untreated fruits were harvested separately and picked into specially designated bins. After each harvest pick, fruit was transported 30 km to the Postharvest Physiology Laboratory of Horticulture Department where the fruits were placed into cool storage (1°C) during the analyses. All treatments were harvested 3 times and from 28 August to 8 September (in 2007) and 26 August to 3 September (in 2008). However, the data was used by second harvest in this manuscript. The fruit weight, fruit colour [colour and colour difference meter in CIE L*, a*, b* values (Model CR-300, Minolta)], fruit firmness [a universal testing machine (Lloyd LF Plus Universal Test Machine)], SSC [digital refractometer (Palette PR–32 Atago)] were measured. TA was defined using a digital buret (Digitrate Isolab 50 ml) by titration with 0.1 N NaOH up to pH 8.1, using 10 ml of diluted juice, and the TA was converted to malic acid. Ethylene production and respiration rate were determined peaches of close to the jar after 1 day. Measurement of respiratory rate was done with gas analizator. Ethylene production was defined by using gas chromatography with a flame ionization detector (Gunes et al., 2001; Watkins and Hotchkiss, 2001). Sugar contents (%) were determined by dinitrophenol method. This method is a modified colorimetric method of Ross (1959). Reducing sugars were extracted by water and reacted with dinitrophenol solution. The color produced was measured at the absorption at 600 nm for determination of reducing sugar content. Moreover, some leaf analyses were made for determine the effect of CC treatments. Twenty leaves showing average growth from upper, middle, and lower parts of outer canopy were selected. Leaf area index (LAI) was measured by leaf area meter (AM 300 Area Meter, ADC, BioScientific Ltd.) (Ünlü 2000; Kim et al., 2004). Chlorophyll was extracted with 80% acetone, and measured by spectrophotometer (UV-1601, Shimadzu, Japan) at 645 and 663 nm. The experiment was arranged as a completely randomized design with five replications, each plot having 20 peaches. Statistical analyses were performed with General Linear Model using SPSS (V.16; Statistical software, SPSS. Inc., USA). The differences among means were analyzed by Duncan's multiple range test at $P<0.05$ of significance.

3. Result

Fruit Quality

In the first year of experiment, the fruits that only belonged to the applications which took place on the 7 DBH; were heavier in weight, in comparison to the fruits from the controlled groups. The lowest weight of fruits are supplied through 21 DBH-2000 ppm applications. In the second year, the effects of the applications on fruit weight were found to carry importance only through the dosages ($P<0.05$). The highest rate of fruit weight with 289.14 g was indentifyed to have 3000 ppm dosage (Table 1). In both of the experiment years, it was determined that, the general firmness of the inner fruits were increased in accordance with controlling results. In the first year, except the 30 DBH-1000 ppm dosage application; none of the other dosages seemed to have any effect on the increase fruit frimness.

Table 1. Fruit weight and firmness in 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	Fruit weight (g) First Year	Fruit weight (g) Second Year	Fruit firmness (N) First Year	Fruit firmness (N) Second Year
30 d	0	284.29	188.04	36.72	15.64
	1000	250.59	228.88	35.80	23.91
	2000	253.02	262.43	41.44	35.54
	3000	274.20	310.37	46.51	30.99
21 d	0	268.79	177.36	23.27	13.47
	1000	252.82	243.83	37.69	22.92
	2000	195.16	234.99	32.49	27.77
	3000	229.46	288.65	45.12	25.78
7 d	0	253.12	171.45	38.82	12.40
	1000	270.51	250.20	56.01	23.59
	2000	297.46	190.96	45.56	42.25
	3000	280.65	285.20	39.23	36.52
Main effects (Means)					
Time					
30		265.53	247.43	40.12	26.52
21		236.56	236.21	34.64	22.48
7		275.44	224.45	44.91	28.69
CC Conc.					
0		268.73	178.95 C	32.94	13.84 C
1000		257.97	240.97 B	43.17	23.47 AB
2000		248.55	229.46 B	39.83	35.18 A
3000		261.44	294.74 A	43.62	31.10 B

[1] days before harvest (DBH)

Lower-cases were used for indicating the difference between the concentrations. Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

The firmest group of fruits was supplied through 30 DBH-1000 ppm (56.01 N) dosage. In the second year, it was decided that the most ideal dosage to be applied was 35.18 N with 2000 ppm; and it was also determined that the fruits which had the lowest rate of fruit firmness, were the ones that belonged to the controlled groups (Table 1). In the first experiment year, the L* values which represented radiancy, were not found to carry any importance, both application wise and statistically. In the second year, the L* values were decreased in accordance to controlling, and the highest L* value (51.98) was decieded to have belonged to the controlled groups. Statistically, the average level differences between the dosages carry high importance (P<0.05). The lowest L* value was supplied through 3000 ppm dosage (Table 2). In the first experiment year, the effects of the applications on the a* values were determined to have no difference statistically. In the second year, it was assinged that the lowest a* values belonged to the controlled group, and it was found that statistically, the only importance was the variation between the doses (P<0.05); however, the doses were found to have belonged to the same group (Table 2). In the first experiment year, the highest b* values (32.63) were found to have decreased to the group of fruits from the 21 DBH. And the lowest ones belonged to the 21 DBH, with 2000 ppm dosage application. In the second year, the b* values were decreased in accordance with the controlling. The b* values remained to have the same effect in any dosage application, and statistically, the only importance was noted to be the variation in doses (P<0.05) (Table 2). In the first experiment year, it was determined that the application which had the highest SSC content was 30 DBH-1000 ppm dosage (10.68%); and the lowest SSC content was the 30 DBH-3000 ppm dosage (9.06 %), and statistically there were not any differences reported (Table 3). The highest average TA was defined to have belonged to the 30 DBH control group (0.67%), and the lowest to the 30 DBH-1000 ppm dosage (0.61%) application (Table 3). In the second experiment year, statistically the effects of SSC were reported to be only important over the variation of doses (P<0.05), and the highest SSC amount was determined to be 1000 ppm (14.31%) dosage (Table 3). The highest TA amount of all times was assinged to be on the applications which belonged to the 21 DBH (0.73%) with 2000 ppm (0.81%) dosage. Statistically, it was noted that both the variation of times and dosages carried high importance (P<0.05) (Table 3).

Ethylene production and respiration rates

In the first experiment year, statistically, the effects of the applications over the ethylene production were reported to have carried importance only on the variation of dosages and the lowest ethylene production was supplied through spraying of 0.46 µL/kg.h with 1000 ppm dosage on the 30 DBH. In the second year, the effects of the applications appeared only through the variation of doses and was supplied through 0.39 µL/kg.h with 3000 ppm dosage, at all times (Table 4). In the first experiment year, in terms of the respiration rates of the applications, statistically, only the variations of timing carried high importance (P<0.05). The lowest respiration rates were found at the fruits which were applied on the 30 DBH (7.00 mL.CO_2/kg.h). In the second experiment year, statistically, only the variation of doses carried high importance (P<0.05). The respiration rates of the applications have dropped in accordance with controlling, and the lowest respiration rate of all times was reported to be 3000 ppm dosage with 7.67 mL.CO_2/kg.h. (Table 4).

Table 2. Fruit colour (L*, a*, b*) in 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	*L**		*a**		*b**	
		First Year	Second Year	First Year	Second Year	First Year	Second Year
30 d	0	45.21	49.54	27.36	23.41	25.82	30.07
	1000	44.87	40.33	30.13	28.52	26.61	23.40
	2000	46.99	40.93	28.91	26.87	28.22	24.26
	3000	47.70	40.85	28.06	28.48	28.99	24.69
21 d	0	51.16	61.66	26.21	12.78	32.63	42.16
	1000	46.18	41.57	30.15	28.64	29.38	26.05
	2000	44.50	43.61	27.67	26.85	23.32	26.75
	3000	44.45	40.60	29.10	27.44	26.50	24.68
7 d	0	49.21	44.75	27.95	24.54	30.95	28.89
	1000	47.81	40.06	29.33	30.37	29.62	24.30
	2000	47.47	42.78	26.39	26.80	28.16	25.55
	3000	50.03	39.20	29.12	28.34	32.53	23.54
Main effects (Means)							
Time							
30		46.19	42.91	28.62	26.82	27.41	25.60
21		46.57	46.86	28.28	23.93	27.96	29.91
7		48.63	41.70	28.20	27.51	30.37	25.57
CC Conc.							
0		48.53	51.98 A	27.17	20.24 B	29.80	33.71 A
1000		46.29	40.65 B	29.87	29.17 A	28.54	24.59 B
2000		46.32	42.44 B	27.66	26.84 A	26.57	25.52 B
3000		47.39	40.22 B	28.76	28.09 A	29.41	24.30 B

[1] days before harvest (DBH)

Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

Total sugar, invert sugar, and sucrose

In both of the experiment years, the effects of the applications to the total sugar contents statistically were found to carry P<0.05 level of importance on the timing versus dosage interaction. In the first experiment year, the application which had the highest total sugar content was reported to have belonged to the 7 DBH with 3000 ppm dosage (6.10%); and the lowest the 30 DBH (5.14%) control group. In the second experiment year, the application which had the highest total sugar content was reported to have belonged to the 7 DBH with 1000 ppm dosage (11.34%); and the lowest the 21 DBH (5.21%) control group (Table 5). Analysing the invert sugar levels of the first year applications, statistically, it was reported that the variations of doses carry high importance (P<0.05). It was determined that the highest invert sugar amounts of all times through 1000 ppm dosage was 2.59%; and the lowest was around 2.54%. In the second year of applications, statistically, it was reported that timing versus dosage interaction carried high importance (P<0.05). It was determined that the CC application which had the highest invert sugar amount belonged to the 21 DBH with 3000 ppm dosage; and the lowest belonged to the 7 DBH with 3000 ppm dosage (Table 5). In the first and second years of application, in terms of the sucrose amounts, statistically it was reported that timing versus dosage interaction carried the highest impotence (P<0.05). In the first year the applications increased the sucrose amounts in accordance with the controlling. The highest amount of sucrose was supplied through the application of the 7 DBH with 3000 ppm dosage (3.46%), and the lowest through 30 DBH (2.49%) control group. It was recorded that in the second year, the application with the highest sucrose amount was the 30 DBH with 2000 ppm dosage (7.39%), and the lowest belonged to the 21 DBH (2.39%) control group (Table 5).

Leaf Area Index (LAI) and total chlorophyll, chlorophyll a, chlorophyll b in leaf

Analysing the LAI of the applications (Table 6), it was reported that statistically, in the first year, timing versus dosage interaction and in the second year, only the dosage variation carried the highest importance (P<0.05). In the first year, the highest LAI was supplied through the application of the 30 DBH with 3000 ppm dosage (2.451); and the lowest through 30 DBH with 1000 ppm dosage (0.979). In the second year, the highest LAI was supplied through the application of the 21 DBH with 2000 ppm dosage (1.97), and the lowest through the 7 DBH control group fruits (1.20).

The effect of the applications on the total chlorophyll features was statistically reported to have carried no importance. The lowest amount of chlorophyll was supplied through 30 DBH control group (1.07 mg/g) and the highest through 7 DBH with 1000 ppm dosage application (1.59 mg/g). In the second year the chlorophyll amounts have dropped. The lowest amount of chlorophyll was supplied through 21 DBH

Table 3. Total soluble solids (SSC) and Titratable acidity (TA) in 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	Total soluble solids (%)		Titratable acidity (%)	
		First Year	Second Year	First Year	Second Year
30 d	0	9.96	12.04	0.67	0.52
	1000	10.68	14.23	0.61	0.61
	2000	8.86	14.26	0.65	0.78
	3000	9.12	13.15	0.65	0.77
21 d	0	9.78	11.98	0.62	0.50
	1000	9.94	14.54	0.63	0.70
	2000	9.20	13.77	0.65	0.83
	3000	9.06	12.94	0.65	0.89
7 d	0	9.26	11.95	0.63	0.57
	1000	9.88	14.15	0.64	0.74
	2000	10.38	13.39	0.65	0.80
	3000	10.36	13.71	0.66	0.72
Main effects (Means)					
	Time				
	30	9.66	13.42	0.65	0.67
	21	9.50	13.31	0.64	0.73
	7	9.97	13.30	0.65	0.71
	CC Conc.				
	0	9.67	11.99 B	0.64	0.53 C
	1000	10.17	14.31 A	0.63	0.68 B
	2000	9.48	13.81 A	0.65	0.81 A
	3000	9.51	13.27 A	0.65	0.79 A

[1] days before harvest (DBH)

Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

with 1000 ppm dosage application (1.12 mg/g), and the highest through 7 DBH control group (2.24 mg/g). And statistically only the dosage variations were reported to carry importance (P<0.05) (Table 7). In the first experiment year, analysing the effects of the applications on the chlorophyll amounts, it was determined that the highest chlorophyll a amounts (1.17mg/g) were supplied through 7 DBH with 1000 ppm dosage application; and the lowest through 30 DBH control fruits. Statistically no difference was reported. In the second year, the only statistical importance noted, was the average variation of the dosage levels (P<0.05). The highest amount of chlorophyll was supplied only through the control fruit group (Table 7). In the first year, analysing the applications for chlorophyll b, statistically no importance was reported; and in the second year, the importance was reported to be on the variation of dosages (P<0.05). In the first year, the highest chlorophyll b amounts were detected by the 7 DBH control group (0.52 mg/g), and the lowest by the 21 DBH with 3000 ppm dosage application. In the second year, the applications lowered the chlorophyll amounts and the lowest amount (0.31mg/g) to be reported was applied at 1000 ppm dosage (Table 7).

Table 4. Ethylene production rate and Respiration rate in 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	Ethylene production (μL kg^{-1} h^{-1}) First Year	Ethylene production (μL kg^{-1} h^{-1}) Second Year	Respiration rate (mL.CO_2 kg^{-1} h^{-1}) First Year	Respiration rate (mL.CO_2 kg^{-1} h^{-1}) Second Year
30 d	0	0.76	1.09	5.06	13.62
	1000	0.45	0.66	7.76	11.09
	2000	0.51	0.36	7.89	6.34
	3000	0.58	0.30	7.27	6.81
21 d	0	0.79	0.64	8.12	15.47
	1000	0.47	0.26	9.98	8.56
	2000	0.50	1.47	8.01	17.81
	3000	0.63	0.52	8.96	8.28
7 d	0	0.59	0.87	8.10	20.50
	1000	0.48	0.58	7.50	8.29
	2000	0.48	0.30	7.14	8.94
	3000	0.54	0.35	7.86	7.91
Main effects (Means)					
Time					
30		0.58	0.60	7.00b	9.47
21		0.60	0.72	8.77a	12.53
7		0.52	0.53	7.65ab	11.41
CC Conc.					
0		0.71 A	0.87 A	7.09	16.53 A
1000		0.46 C	0.50 B	8.41	9.31 B
2000		0.50 C	0.71 AB	7.68	11.03 B
3000		0.59 B	0.39 B	8.03	7.67 B

[1] days before harvest (DBH)
Lower-cases were used for indicating the difference between the concentrations. Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

Table 5. Total sugar, reducing sugar and sucrose in 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	Total sugar (%) First Year	Total sugar (%) Second Year	Reducing sugar (%) First Year	Reducing sugar (%) Second Year	Sucrose (%) First Year	Sucrose (%) Second Year
30 d	0	5.14bB	6.31aB	2.57	3.30 abB	2.49bB	2.92abC
	1000	6.01aA	9.09bA	2.57	5.25aA	3.34aA	3.73bBC
	2000	6.01aA	10.75A	2.54	3.14bB	3.37aA	7.39aA
	3000	5.99aA	10.07abA	2.57	5.06aA	3.33aA	4.86bB
21 d	0	5.18bC	5.21bC	2.53	2.76bC	2.58bC	2.39bB
	1000	5.63bB	10.55abA	2.62	4.94aAB	2.91bB	5.44abA
	2000	5.87aAB	8.82bB	2.55	4.25aB	3.21aA	4.43bA
	3000	6.01aA	11.24aA	2.53	5.83aA	3.37aA	5.25abA
7 d	0	5.44aC	7.36aC	2.53	4.07aB	2.82aC	3.20aB
	1000	6.02aAB	11.34aA	2.57	4.94aA	3.35aB	6.20aB
	2000	5.97aB	5.27cD	2.54	2.26cC	3.33aB	2.92cC
	3000	6.10aA	9.13bB	2.53	1.75bC	3.46aA	7.16aA
Main effects (Means)							
Time							
30		5.80	9.06	2.56	4.19	3.13	4.72
21		5.69	8.96	2.56	4.45	3.02	4.38
7		5.77	8.28	2.54	3.26	3.24	4.87
CC Conc.							
0		5.10	6.30	2.54B	3.38	2.63	2.83
1000		5.85	10.33	2.59A	5.04	3.20	5.12
2000		6.01	8.28	2.54B	3.22	3.30	4.91
3000		6.04	10.15	2.54B	4.22	3.39	5.75

[1] days before harvest (DBH).
Lower-cases were used for indicating the difference between the concentrations. Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

4. Discussion

The effects of the application on the fruit weight (except 30 and 21 DBH applications on the first year) were proven to have increased in both years. In both years, the most effective dosage was determined to be 3000 ppm. In the studies of Kim et al., (2004), it was reported that, the 1000 ppm dosage of CC application of the 'Mibaek' peaches after 70 days of blossom (4 weeks before harvesting) was increased the fruit weight and height; and 3000 ppm dosage had no effect. It was found that in both years, the fruit firmness were highly effected by the CC application, and the applied fruits were firmer than those that belonged to the control group. It was also reported

that CC applications have increased the firmness of the peaches; which proves our studies to have parallel content with this research (Kim et al., 2004). Wahdan et al., (2011) reported that, CC applications (500, 1000, 1500, 2000 ppm) on 'Earligrande' peach increased fruit frimness. In the first experiment year, the CC applications have dropped the L* levels of the fruit colours in accordance with controlling. Additionally, it has increased the red colour progress (a* levels), and lowered the green base colour (b* values). The best results on reddening the outer colour of the fruits, were achieved by 1000 ppm dosage of application. In the second year, the L* values which represent the radiance and darkness levels, and b*values which represent the yellowness levels, were proven to have dropped in accordance with controlling; which led the fruits to develop a darker colour content and avoid any yellowing. It was recorded that, same as the first year, the applications have highly effected the a* values, and the best results at all times achieved through 3000 ppm dosage application. Our studies of CC applications' colour increasing feature, were supported by Sato's studies (1994). In both of the years, in accordance with the controlling, the SSC amounts have increased; and in the first experiment year, the amounts varied between 8.86-10.68%, and in the second experiment year, between 11.95-14.54%. The applications in both years, examined in respect to TA effects, have had periods of increase and decrease; which were recorded as, first experiment year being in between 0.62-0.67%, and in the second experiment year 0.52-0.89%. Our studies have proven that CC applications do not carry a consistent effect on the SSC and TA amounts. Our studies also support the inconsistent behavior of the applications on the SSC and TA amounts. Moreover, Kim et al., (2004) stated that CC applications, in accordance with controlling, had dropped the SSC amounts on 'Mibaek' peaches and the TA levels was increased.

Table 6. Leaf Area Index (LAI) in leaf of 'Monroe' peaches at harvest as affected by treatment date and CC concentration

Application time, d [1]	CC concentrations ppm	Leaf Area Index (LAI) First Year	Second Year
30 d	0	1.62aB	1.57
	1000	0.97bD	1.43
	2000	1.06bC	1.47
	3000	2.45aA	1.44
21 d	0	1.12cB	1.41
	1000	1.45aA	1.41
	2000	1.33aAB	1.97
	3000	1.27bAB	1.57
7 d	0	1.25bC	1.20
	1000	1.45aBC	1.47
	2000	1.55aB	1.71
	3000	2.26aA	1.78
Main effects (Means)			
Time			
30		1.53	1.48
21		1.29	1.59
7		1.63	1.54
CC Conc.			
0		1.33	1.39B
1000		1.29	1.44B
2000		1.3	1.71A
3000		1.99	1.59A

[1] days before harvest (DBH)

Lower cases were used for indicating the difference between the concentrations. Upper-cases letters were used for indicating the difference between times. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

Table 7. Total chlorophyll, Chlorophyll a and Chlorophyll b in leaf of 'Monroe' peaches at harvest as affected by treatment date and AVG concentration

Application time, d [1]	CC concentrations mg L^{-1}	Total chlorophyll (mg g^{-1})		Chlorophyll a (mg g^{-1})		Chlorophyll b (mg g^{-1})	
		First Year	Second Year	First Year	Second Year	First Year	Second Year
30 d	0	1.07	1.83	0.79	1.26	0.28	0.57
	1000	1.25	1.17	0.90	0.91	0.36	0.26
	2000	1.36	1.19	1.00	0.76	0.37	0.43
	3000	1.27	1.47	0.93	1.06	0.33	0.41
21 d	0	1.47	1.74	1.04	1.27	0.42	0.46
	1000	1.35	1.12	0.99	0.80	0.36	0.33
	2000	1.49	1.27	1.06	0.88	0.43	0.39
	3000	1.15	1.58	0.87	1.15	0.28	0.43
7 d	0	1.51	2.24	0.99	1.48	0.52	0.77
	1000	1.59	1.32	1.17	0.97	0.41	0.35
	2000	1.21	1.26	0.89	0.91	0.32	0.34
	3000	1.44	1.35	1.08	1.00	0.36	0.35
Main effects (Means)							
	Time						
	30	1.24	1.41	0.91	1.00	0.34	0.42
	21	1.37	1.43	0.99	1.03	0.37	0.40
	7	1.44	1.54	1.03	1.09	0.40	0.45
	CC Conc.						
	0	1.35	1.94A	0.94	1.34A	0.41	0.60A
	1000	1.40	1.20B	1.02	0.89C	0.38	0.31B
	2000	1.35	1.24B	0.98	0.85C	0.37	0.39B
	3000	1.29	1.46B	0.96	1.07B	0.32	0.40B

[1] days before harvest (DBH)

Big cases were used for indicating the difference between the concentrations. Means in columns followed by the same letters are not significantly different according to the Duncan's multiple range test at P<0.05.

The decrease of ethylene production in CC applications was importantly reported to have dropped in accordance with controlling. In the second year, both ethylene production and the respiration rates have decreased with the applications. The effects of the CC applications on ethylene amounts and respiration rates have not been examined prior to our studies; but the inconsistent nature of the effects, have proven our examination to be irrelevant. The CC application was proven to be more effective on the acceleration of the photosynthesis process and plant growth (Che et al., 1990). In the studies of Colaric, Stampar and Hudina (2004), it was reported that the total sugar levels of the peaches and nectarines varied in between 6.15-9.37%, and the sucrose levels 4.61-7.01%. In our studies, it was reported that the total sugar levels varied in between 5.14-11.34%, the invert sugar amounts %1.75-%5.83, and the sucrose amounts 2.49-7.39%. Chapman and Hovat (1990) stated in his studies that the sucrose content of the 'Monroe' peaches, before harvest was between 7-8%. In similar grounds, Holland et al., (1992) recorded that the total sugar content of the peach was 7.6%, and the sucrose content 5.2%. It was also recorded that in the first year, the leaf area index of the applications was best achieved at the 30 DBH with 3000 ppm dosage application; and in the second experiment year, the best results of all times for the highest leaf area index were achieved by 2000 ppm and 3000 ppm dosage application. In parallel to our studies on CC applications, it was reported that CC applications have increased the leaf area indexes of the 'Mibaek' peaches aswell (Kim et al., 2004). On CC applications, the effects of the leaves on chlorophylls were decreased in comparison with controlling. The high results achieved by 1000 ppm and 2000 ppm dosages of applications. Similar to our studies, Kim et al. (2004) reported that CC applications of 1000 ppm dosage, decreased the chlorophyll content of the leaves; and 3000 ppm dosage proved to have similar results with the control group.

As a result, the application of CC significantly increased SSC, fruit color (a* value), total sugars for 'Monroe' peach varieties can be recommended. These findings could bring great benefits for the marketing of sweet cherries.

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