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Research Article

Effects of Rhizobacteria on Plant Growth and Fruit Quality of Blackberry in Alkaline Soil

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ABSTRACT

This study was conducted at Selçuk University, Faculty of Agriculture, Department of Horticulture, Research and Application Orchard. In the study, the effects of different bacterial strains on yield, fruit quality, plant growth, and nutrition issues in Jumbo and Chester blackberry varieties in calcareous soil conditions were determined. As a result of the measurements and analyzes, it was determined that bacterial applications are effective on plant growth, yield, and fruit quality criteria. Shoot length values were found longer in the Chester variety, while the Jumbo variety had higher values in the number of shoots per plant. There was no statistically significant difference in terms of yield per decare of varieties. When the efficiency is examined in terms of applications, 637Ca application in Chester variety and 637Ca + SY 55 application in Jumbo variety have the highest efficiency values. With the data obtained, it was determined that bacterial applications made positive contributions to blackberry plants grown in calcareous soil conditions.

1. Introduction

Blackberries are widespread perennial shrubs native to the temperate Northern hemisphere. Blackberry (*Rubus fruticosus* L.) is a popular berry species that is widely found in nature and widely cultivated throughout the world. In addition to the rapid increase in blackberry consumption in recent years, it is also processed into various foods, such as fresh, frozen, or commercially, and products such as jam, wine, tea, ink, food coloring, ice cream, and cake. Blackberry berries have a pleasant taste, high nutritional value, and important health benefits (Wu et al., 2007). Although blackberries do well in most soils, deep, well-drained soils are ideal. Blackberries perform best at a soil pH between 5.5 and 6.5. Blackberry roots are located close to the surface, and excess fertilizer can burn leaves or even kill plants. Lime soils cover more than 30% of the world's land. These soils are mostly characterized as soils with low availability of nutrients due to poor solubility of microelements such as Fe, Mn, Zn, Cu, and B at high pH and also because P forms complex compounds with Ca (Marschner, 2011). Except for the Black Sea Region in Turkey, all of the other regions show high calcareous soil characteristics. Significant yield losses occur due to chlorosis caused by high lime content, and the producer increases input costs by using excess fertilizer to solve the problem. Nowadays, there is a global challenge to find alternatives to reduce the massive use of chemical fertilizers and agrochemical products. In this sense, PGPR is an eco-friendly alternative that may be used to replace or reduce the use of these chemical products. Some of the beneficial bacteria bind the free nitrogen in the air asymbiotically to the soil and make it available to the plants. In addition, some beneficial bacteria can promote phosphorus nutrition of plants by increasing the solubility of organic and inorganic phosphorus that plants cannot benefit from in the soil. In addition, it lowers the soil pH through the organic acids they secrete and can increase the availability of microelements such as Fe, Zn, Mn, Cu, and B in particular. Some bacteria can help plants uptake Fe by producing siderophores. PGPR is widely used to promote growth and development in different plant species (Glick et al., 2001). In addition, especially in recent years, intensive studies have been conducted to determine the effects of these bacteria to promote plant growth under abiotic stress conditions.

2. Materials and Methods

A two-year field study was conducted on the three-year-old plants of blackberry cultivars ‘Jumbo and Chester’ (*Rubus fruticosus* L.) propagated by *invitro* micropropagation technique of nodal segment. The soil has a high lime content (29.6%) with a 7.49 pH.

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Alcaligenes feacalis 637Ca, *Microbacterium esteraromaticum* SY48, *Rhizobium radiobacter* SY55, and *Kocuria rhizophila* SY63 bacterial strains were used in the experiment. The 637Ca can dissolve $CaCO_3$, SY55 N-fixing, SY63 convert phosphorus, and SY48 convert potassium into forms that can be used by the plant.

Experiment, both as a single treatment such as;

1-Control,

2-637Ca,

3-SY55,

4-SY63,

5-SY48 and in a combination such as;

6-637Ca+SY55,

7-637Ca+SY63,

8-637Ca+SY48,

9-637Ca+SY55+SY63,

10-637Ca+SY55+SY48,

11-637Ca+SY63+ SY48,

12-637Ca+SY55+SY63+SY48 was performed.

The bacterial treatments with 637Ca, SY48, SY55, SY63 and their combinations (10^9 CFU·ml^{-1}) were given to the plant root via dipping 30 minutes before planting. The plants of the control were immersed in water. All bacteria used in the research were applied with irrigation in June, July, August, and September after planting. In the second year of the experiment, bacteria were applied with irrigation in May, June, July, August, and September. To determine the effect of the bacterial treatments on plant development, the number of the primocane shoot (shoot per plant), average primocane shoot length (cm), leaf area (cm^2), plant fresh and dried weight (g), root length (cm), and root fresh and dried weight (g) were measured and observed. Fruit number per plant, average fruit weight, yield per blackberry plant (g), and yield per decare (kg) were measured for the effect of bacterial treatments on yield. Also, the fruit quality was measured with total soluble solids (TSS) (%), pH of fruit juice, total acidity content (TAC) of fruit juice (%), and fruit color (L, C H.

All data were analyzed using one-way analysis of variance (ANOVA) and significant differences among the means were compared by Duncan's multiple range test at P = 0.05 level using SPSS 23.0 (SAS Inc., Cary, NC, USA).

3. Results and Discussion

Positive results of bacterial applications on plant growth, fruit quality characteristics, and yield have been reported in many fruit species such as apple, banana, cherry, peach, pear, quince, raspberry, sour cherry, and strawberry (Arıkan et al., 2013; Arikan and Pirlak, 2016; Aslantaş et al., 2007; Garcia-Seco et al., 2015; Ipek et al., 2014; Karakurt and Aslantas, 2010a; Karakurt et al., 2011; Karlidag et al., 2010; Kavino et al., 2010; Mia et al., 2005; Orhan et al., 2006; Pii et al., 2017; Seema et al., 2018). When all of the research data are considered, the results obtained are similar to the results of previous studies. In blackberry, the number of primocane shoots is an important criterion for yield. Primocane shoots become productive in their second year and take the name floricane. Some blackberry cultivars can have the floricane shoots that occurred from primocane shoots in the same year. Floricane shoots die within the same season after being harvested.

In this research, the primocane shoot number was counted in both years. A statistical difference was found between the effectiveness of the treatments and cultivars on the number of primocane shoots. In 2019, While the maximum number of primocane shoots were counted in the 637Ca, SY 48, SK 63, and 637Ca+SY 48+SY 55+SK 63 treatments in the Chester cultivar, SY 55, and 637Ca+SY 55 were found the maximum number of primocane shoots in the Jumbo cultivar. In 2020, the primocane shoot numbers decreased in both cultivars Chester and Jumbo because of the water deficiency and hot temperature in the Konya region. The maximum primocane shoot number was counted in all bacterial treatments in the Chester cultivar while the maximum primocane shoot number of Jumbo was counted in all treatments except for Control, 637Ca, and 637Ca+SY 48 treatments in 2020 (Table 1). Comparable results about shoot numbers of blackberry (García-Seco et al., 2013; Garcia-Seco et al., 2015; Robledo-Buriticá et al., 2018), apple (Aslantaş et al., 2007; Karakurt and Aslantas, 2010a), and raspberry (Orhan et al., 2006) have been reported.

Table 1
Primocane shoot number per blackberry plant

Treatments	2019		2020	
	Chester	Jumbo	Chester	Jumbo
Control	5.80 b	5.00 d	1.33 b	2.50 c
637Ca	6.00 ab	6.20 c	2.17 ab	2.50 c
SY 48	6.00 ab	6.80 bc	2.17 ab	2.83 ab
SY 55	4.60 c	8.20 a	1.83 ab	3.33 a
SK 63	5.40 ab	6.40 bc	1.67 ab	3.00 ab
637Ca+SY 48	5.00 c	7.00 b	2.17 ab	2.67 bc
637Ca+SY 55	4.00 d	8.20 a	2.00 ab	3.17 ab
637Ca+SK 63	4.40 c	6.80 bc	2.17 ab	3.33 a
637Ca+SY 48+SY 55	4.80 c	6.20 c	1.83 ab	2.83 ab
637Ca+SY 48+SK 63	3.80 d	7.00 b	1.83 ab	3.00 ab
637Ca+SY 55+SK 63	4.80 c	6.60 bc	2.00 ab	3.17 ab
637Ca+SY 48+SY55+SK 63	6.40 a	6.40 bc	2.33 a	3.33 a
Cultivars	5.80 b	6.73 a	1.95 b	2.97 a

The shoot length was measured longer in 2020 than in the 2019 year. While the water deficiency and hot temperature decreased the number of shoots in 2020, the other hand, it increased shoot length in the same year. According to the shoot length data in 2019, the longest shoot length had the highest value in all the remaining applications except Control, SK 63, 637Ca+SY 55, and 637Ca+SY 48+SY55+SK 63 in the Chester, while 637Ca+ SK 63 was the longest shoot length in the Jumbo cultivar. In 2020, while the number of shoots decreased, the length of shoots increased. The longest shoot length was measured in 637Ca+SY 48+SY 55, SK 63, 637Ca+SY 48+SK 63, 637Ca+SY 55, 637Ca+SY 48+SY 55+SK 63, and 637Ca treatments in the Chester, while the longest shoot length was obtained from 637Ca, 637Ca+SY 55, 637Ca+SY 48+SY 55, and 637Ca+SK

63 in Jumbo. In both years, Chester cultivars had a longer shoot length than the Jumbo cultivar (Table 2). In the previous studies about PGPR, shoot length have been increased by the PGPR treatments in some fruit species (Arikan and Pirlak, 2016; Aslantaş et al., 2007; Esitken et al., 2005; Esitken et al., 2006; Pérez Moncada et al., 2015; Robledo-Buriticá et al., 2018).

Table 2
Average primocane shoot length (cm) per blackberry plant

Treatments	2019		2020	
	Chester	Jumbo	Chester	Jumbo
Control	74 b	60 b	203 cd	175 b
637Ca	89 a	55 bc	316 ab	193 a
SY 48	83 a	50 c	178 d	141 c
SY 55	79 ab	52 bc	227 cd	145 c
SK 63	69 b	50 c	354 a	145 c
637Ca+SY 48	81 a	62 b	259 bcd	157 c
637Ca+SY 55	61 c	61 b	344 a	190 a
637Ca+SK 63	79 ab	70 a	280 bc	186 a
637Ca+SY 48+SY 55	77 ab	60 b	355 a	190 a
637Ca+SY 48+SK 63	76 ab	51 c	350 a	153 c
637Ca+SY 55+SK 63	85 a	59 b	198 cd	177 b
637Ca+SY 48+SY55+SK 63	72 b	55 bc	326 ab	170 b
Cultivars	77 a	57 b	283 a	168 b

The largest leaf area was measured in 637Ca+ SY 55 treatment in Chester while 637Ca, and 637Ca+ SY 55 treatments in the Jumbo cultivar in the 2019 year. The same result of the leaf area was obtained in both cultivars. The largest leaf area in 637Ca+ SY 55 treatment in Chester while 637Ca, and 637Ca+ SY 55 treatments in the Jumbo cultivar in the 2020 year (Table 3). The efficiency of the PGPR on leaf growing have been determined and reported by some researchers (Erturk et al., 2012; Karakurt and Aslantas, 2010b; Karakurt et al., 2011; Orhan et al., 2006; Pérez Moncada et al., 2015; Seema et al., 2018).

Table 3
Average leaf area (cm^2) per blackberry plant

Treatments	2019		2020	
	Chester	Jumbo	Chester	Jumbo
Control	52 d	58 e	56 d	59 d
637Ca	72 b	86 a	73 b	88 a
SY 48	74 b	60 e	74 b	60 d
SY 55	70 b	70 c	71 b	71 c
SK 63	62 cd	79 b	63 c	79 b
637Ca+SY 48	47 e	75 b	47 e	76 b
637Ca+SY 55	80 a	84 a	82 a	85 a
637Ca+SK 63	66 c	77 b	67 c	78 b
637Ca+SY 48+SY 55	55 d	76 b	56 d	77 b
637Ca+SY 48+SK 63	64 c	78 b	67 c	79 b
637Ca+SY 55+SK 63	73 b	73 bc	72 b	74 b
637Ca+SY 48+SY55+SK 63	63 c	65 d	66 c	66 c
Cultivars	65 b	74 a	66 b	74 a

In 2020, plant fresh and dry weight, root length, and root fresh, and dry weight were measured after uprooting the blackberry plants. The root length of the blackberry plants showed differences between cultivars and treatments. In the root length, plant fresh and dry weight, and root fresh and dry weight, the Chester highest value than the Jumbo cultivar. The longest root was measured in the cultivar of Chester. The treatments of 637Ca+SY 48+SY 55, 637Ca, 637Ca+SK 63, 637Ca+SY 48, SY 48, SK 63, and 637Ca+SY 48+SY 55+SK 63 had the longest root in Chester while the 637Ca+SY 48+SY 55, 637Ca, 637Ca+SY 55, 637Ca+SK 63, 637Ca+SY 55+SK 63, SK 63, and 637Ca+SY 48+SY 55+SK 63 treatments had the longest root length in Jumbo (Table 4). The fresh biomass weight of the Chester was found higher in SY 48, SK 63, 637Ca+SK 63, and 637Ca+SY 48+SY 55 than in other treatments. The fresh plant weight of the Jumbo cultivar was measured higher in the 637Ca, SK 63, 637Ca+SY 55, 637Ca+SK 63, 637Ca+SY 48+SY 55, 637Ca+SY 55+SK 63, and 637Ca+SY 48+SY55+SK 63 than the other treatments. All treatments except the Control, SY 55, 637Ca+SY 48, 637Ca+SY 55, 637Ca+SY 48+SK 63, and 637Ca+SY 55+SK 63 were found the highest plant dry weight in Chester. The highest plant dry weight of the Jumbo cultivar was measured in the 637Ca, 637Ca+SY 55, 637Ca+SK 63, and 637Ca+SY 48+SY 55 treatments (Table 4). The highest fresh root weight was measured in 637Ca, SY 48, SK 63, 637Ca+SK 63, 637Ca+SY 48+SY 55, and 637Ca+SY 48+SY 55+SK 63 in Chester while all remaining treatments except for Control, SY 48, SY 55 had the highest fresh root weight in Jumbo. Cultivar. In the Chester cultivar, the highest dry root weight was obtained from SK 63, 637Ca+SK 63, 637Ca+SY 48+SY 55, and 637Ca+SY 48+SY 55+SK 63 treatments. The 637Ca, SK 63, 637Ca+SY 55, 637Ca+SK 63, 637Ca+SY 48+SY 55, 637Ca+SY 55+SK 63, and 637Ca+SY 48+SY 55+SK 63 treatments was the highest in dry root weight in Jumbo (Table 4). In the plant root length and biomass measurements, PGPR treatments had increases in these plant features, and reports of some fruit species supported (Arıkan et al., 2013; Arikan and Pirlak, 2016; Erturk et al., 2012; Ipek et al., 2014; Karakurt and Aslantas, 2010b; Karakurt et al., 2011; Orhan et al., 2006; Pérez Moncada et al., 2015; Pırlak and Köse, 2009; Seema et al., 2018) the study results.

Table 4
Plant and Root Measurements

Treatments	Root Length (cm)		Fresh Plant Weight (g)		Dry Plant Weight (g)		Fresh Root Weight (g)		Dry Root Weight (g)	
	Chester	Jumbo	Chester	Jumbo	Chester	Jumbo	Chester	Jumbo	Chester	Jumbo
Control	88 d	88 c	346 e	313 c	277 d	271 b	158 d	145 c	85 c	77 b
637Ca	135 a	112 a	528 b	351 a	321 ab	279 a	191 a	160 a	84 c	86 a
SY 48	130 a	93 b	447 a	310 c	331 a	258 c	199 a	144 c	89 c	76 b
SY 55	100 c	97 c	363 d	313 c	287 c	259 c	165 c	145 c	89 c	77 b
SK 63	128 a	102 a	455 a	336 a	335 a	259 c	202 a	154 a	111 a	82 a
637Ca+SY 48	130 a	85 c	387 d	322 b	299 bc	264 c	174 b	149 ab	94 b	79 b
637Ca+SY 55	110 b	110 a	402 c	348 ab	307 b	278 a	180 b	159 a	98 b	85 a
637Ca+SK 63	131 a	105 a	452 a	345 a	333 a	276 a	200 a	158 a	110 a	84 a
637Ca+SY 48+SY 55	136 a	115 a	456 a	348 a	336 a	278 a	202 a	159 a	111 a	85 a
637Ca+SY 48+SK 63	89 d	90 b	328 e	319 b	268 e	262 c	151 d	147 ab	80 c	78 b
637Ca+SY 55+SK 63	92 d	103 a	343 e	338 ab	276 d	272 b	157 d	155 a	84 c	83 a
637Ca+SY 48+SY55+SK 63	128 a	100 a	435 b	333 ab	324 ab	270 b	194 a	153 a	106 a	81 a
Cultivars	116 a	100 b	411 a	331 b	307 a	269 b	181 a	152 b	95 a	81 b

The fruit quality criteria and yield value were observed in the 2020 year. In the first year of the study, the plant growth parameters were observed in blackberry plants. The Chester cultivar had a higher fruit number than the Jumbo cultivar. The highest fruit number per plant was counted in 637Ca in the Chester cultivar while the highest fruit number was found in the 637Ca+SY 55 treatment in the Jumbo cultivar (Table 5). The increase in the fruit number is supported by some reports (Kumar et al., 2020; Orhan et al., 2006; Seema et al., 2018).

Table 5
Average fruit number per blackberry plant

Treatments	Chester	Jumbo
Control	115 f	126 d
637Ca	323 a	168 c
SY 48	296 b	83 e
SY 55	209 c	125 d
SK 63	136 e	155 c
637Ca+SY 48	87 g	265 b
637Ca+SY 55	133 e	397 a
637Ca+SK 63	167 d	232 b
637Ca+SY 48+SY 55	157 d	120 d
637Ca+SY 48+SK 63	167 d	155 c
637Ca+SY 55+SK 63	141 e	78 e
637Ca+SY 48+SY55+SK 63	199 c	87 e
Cultivars	177 a	166 b

There was no statistical difference between the average fruit weight of the cultivars. While the 637Ca and SK 63 were found to have the highest average fruit weight in the Chester cultivar, the 637Ca+SY 55 was measured as the highest average fruit weight in the Jumbo cultivar (Table 6). Related results have been reported by other researchers in different fruit species (Arikan and Pirlak, 2016; Ipek et al., 2014; Orhan et al., 2006).

Table 6
Average fruit weight (g)

Treatments	Chester	Jumbo
Control	2.43 b	2.36 d
637Ca	3.05 a	2.62 bc
SY 48	2.49 b	2.40 d
SY 55	2.20 c	2.24 d
SK 63	3.04 a	2.62 bc
637Ca+SY 48	2.27 c	2.64 bc
637Ca+SY 55	2.49 b	3.21 a
637Ca+SK 63	2.52 b	2.80 b
637Ca+SY 48+SY 55	2.52 b	2.82 b
637Ca+SY 48+SK 63	2.43 b	2.75 b
637Ca+SY 55+SK 63	2.57 b	2.31 d
637Ca+SY 48+SY55+SK 63	2.45 b	2.51 c
Cultivars	2.54^{NS}	2.61^{NS}

It has been found no statistical difference between the yields per plant of the cultivars. In the Chester cultivar, 637Ca had the highest yield per plant while the 637Ca+SY 55 was found the highest yield per plant in the Jumbo cultivar (Table 7). In some fruit species, it has been reported that PGPR applications increased fruit weight (Esitken et al., 2005; García-Seco et al., 2013; Karlidag et al., 2010; Karlidag et al., 2007; Pirlak et al., 2007).

Table 7
Yield per blackberry plant (g)

Treatments	Chester	Jumbo
Control	280 g	297 e
637Ca	984 a	442 c
SY 48	737 b	199 g
SY 55	461 c	280 f
SK 63	416 d	408 c
637Ca+SY 48	197 h	699 b
637Ca+SY 55	331 f	1275 a
637Ca+SK 63	422 d	648 b
637Ca+SY 48+SY 55	395 e	339 d
637Ca+SY 48+SK 63	406 d	427 c
637Ca+SY 55+SK 63	364 e	181 g
637Ca+SY 48+SY55+SK 63	486 c	219 g
Cultivars	457^{NS}	452^{NS}

Although, it has been determined to be no statistical difference between the yields per decare of the cultivars, the highest yield per decare was harvested in the 637Ca treatment in the Chester cultivar and the 637Ca+SY 55 in the Jumbo (Table 8). It has been found that PGPR application increased the yield in some fruit species (Esitken et al., 2006; Karlidag et al., 2010; Karlidag et al., 2007).

Table 8
Yield per decare (kg)

Treatments	Chester	Jumbo
Control	93 f	99 d
637Ca	327 a	147 c
SY 48	245 b	66 e
SY 55	153 c	93 d
SK 63	138 d	135 c
637Ca+SY 48	65 g	233 b
637Ca+SY 55	110 e	424 a
637Ca+SK 63	140 d	215 b
637Ca+SY 48+SY 55	131 d	112 d
637Ca+SY 48+SK 63	135 d	142 c
637Ca+SY 55+SK 63	121 e	60 e
637Ca+SY 48+SY55+SK 63	162 c	73 e
Cultivars	152^{NS}	150^{NS}

While it was determined that there was no statistical difference between the cultivars on the TSS, the treatments showed differences in TSS value in each cultivar. The TSS value ranged from 9.3% to13.3% in Chester. The Jumbo TSS value showed to range from 9.7% to 13.9% (Table 9). The TTS value had been obtained previously in studies consistent with our results (Arikan and Pirlak, 2016; Erturk et al., 2012; Kumar et al., 2020; Seema et al., 2018)

Table 9
Total Soluble Solid (%)

Treatments	Chester	Jumbo
Control	11.6 b	11.9 c
637Ca	9.3 d	10.2 d
SY 48	12.6 a	12.9 b
SY 55	13.3 a	13.9 a
SK 63	10.0 c	11.3 c
637Ca+SY 48	13.0 a	12.7 b
637Ca+SY 55	13.1 a	11.5 c
637Ca+SK 63	10.2 c	10.6 d
637Ca+SY 48+SY 55	10.7 b	9.7 d
637Ca+SY 48+SK 63	10.3 c	11.6 c
637Ca+SY 55+SK 63	11.0 b	13.2 a
637Ca+SY 48+SY55+SK 63	12.7 a	12.6 b
Cultivars	11.4^{NS}	11.8^{NS}

The pH of the fruit juice value was not shown differences in both cultivars and treatments of the cultivars. The pH value ranged from 2.99 to 3.43 in treatments of both cultivars. Different studies have

shown consistent results for our study (Arikan and Pirlak, 2016; Kumar et al., 2020; Mia et al., 2005; Seema et al., 2018).

The TAC was not showed a difference between cultivars but there were statistical differences in TAC between treatments (Table 10). The total acidity content ranged from 0.55% to 0.80% and some reports showed equivalent results (Arikan and Pirlak, 2016; Kumar et al., 2020; Mia et al., 2005; Seema et al., 2018).

Table 10
Total Acidity Content (%)

Treatments	Chester	Jumbo
Control	0.76 a	0.64 ab
637Ca	0.72 a	0.63 ab
SY 48	0.65 ab	0.68 ab
SY 55	0.64 ab	0.58 b
SK 63	0.69 ab	0.65 ab
637Ca+SY 48	0.64 ab	0.67 ab
637Ca+SY 55	0.56 b	0.55 b
637Ca+SK 63	0.74 a	0.71 ab
637Ca+SY 48+SY 55	0.63 ab	0.77 a
637Ca+SY 48+SK 63	0.69 ab	0.67 ab
637Ca+SY 55+SK 63	0.80 a	0.69 ab
637Ca+SY 48+SY55+SK 63	0.73 a	0.62 ab
Cultivars	11.4^{NS}	11.8 ^{NS}

The L, C, and H color values of the fruit harvested in treatments of the Chester and Jumbo cultivar were shown in table11 and table 12.

Table 11
Fruit color of the Chester cultivar

Treatments	L	C	H
Control	19.9 a	1.5 ab	45.1 b
637Ca	19.8 a	1.3 b	54.0 a
SY 48	18.9 ab	1.6 ab	43.8 b
SY 55	19.4 ab	1.9 a	39.7 c
SK 63	19.8 a	1.8 a	45.0 b
637Ca+SY 48	20.0 a	1.7 ab	44.3 b
637Ca+SY 55	19.9 a	1.3 b	43.6 b
637Ca+SK 63	20.0 a	1.3 b	48.5 ab
637Ca+SY 48+SY 55	20.5 a	1.8 a	38.5 c
637Ca+SY 48+SK 63	19.3 ab	1.7 ab	47.1 ab
637Ca+SY 55+SK 63	18.1 b	1.4 b	45.5 b
637Ca+SY 48+SY55+SK 63	19.5 ab	1.8 a	55.5 a

Table12
Fruit color of the Jumbo cultivar

Treatments	L	C	H
Control	19.6 a	2.0 ab	35.5 c
637Ca	18.2 ab	1.6 b	47.6 a
SY 48	19.7 a	2.3 ab	41.0 b
SY 55	19.6 a	1.3 c	45.5 ab
SK 63	20.2 a	1.3 c	45.2 ab
637Ca+SY 48	18.3 ab	1.6 b	47.9 a
637Ca+SY 55	17.8 b	1.7 b	48.1 a
637Ca+SK 63	19.9 a	2.9 a	47.9 a
637Ca+SY 48+SY 55	19.8 a	1.3 c	42.0 b
637Ca+SY 48+SK 63	19.8 a	1.9 ab	44.3 ab
637Ca+SY 55+SK 63	20.1 a	3.1 a	39.9 b
637Ca+SY 48+SY55+SK 63	20.9 a	1.5 b	47.9 a

The L, C, and H values of the fruits of the cultivars showed no differences in L and H values, while there was a statistical difference in the C value of the cultivars (Table 13).

Table 13
Fruit color of the cultivars

Cultivars	L	C	H
Chester	19.63	1.62 b	45.93
Jumbo	19.52	1.92 a	44.45

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