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Calcium lactate and salicylic acid foliar application influence eggplant growth and postharvest quality parameters

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Abstract: Eggplant is one of the most popular and vital vegetable crops in the world. Various plant bio-regulators have been used in different crops to increase uptake of nutrients thereby leading to improvement in growth, flowering, fruit quality, storability and yield. The scope of this study was to evaluate the effects of calcium lactate and salicylic acid foliar application on growth parameters, physiological characteristics and shelf-life of eggplant fruit. Obtained results showed that the highest applied concentrations of calcium lactate (4 mM or 0.8 g l^{-1}) and salicylic acid (1.5 mM or 0.2 g l^{-1}) foliar application led to the highest values of measured growth parameters and yield. Applying of calcium lactate and salicylic acid foliar treatments could increase tissue firmness and ascorbic acid content of fruits. Foliar application of calcium lactate 4 mM (0.8 g l^{-1}) and salicylic acid 1 mM (0.13 g l^{-1}) was the best treatment to decrease percentage of fruit decay. In conclusion, our results showed that foliar application of calcium lactate and salicylic acid can be useful and inexpensive treatment to improve growth parameters, physiological characteristics and post-harvest properties of eggplant fruit.

Key words*:* eggplant; calcium sources; chlorophyll content; foliar spraying; post-harvest fruit characteristics; salicylic acid.

Foliarno dodajanje kalcijevega laktata in salicilne kisline vpliva na rast jajčevca in na obstojnost plodov pri shranjevanju

Izvleček: Jajčevec je v svetovnem merilu ena izmed najbolj popularnih plodovk. Pri pridelavi različnih kulturnih rastlin so bili uporabljeni razni bioregulatorji privzema hranil, kar bi vodilo k izboljšanju rasti, cvetenja, kakovosti plodov, povečanju pridelka in trajnosti pri shranjevanju. Namen te raziskave je bil ovrednostiti učinke foliarnega dodajanja kalcijevega laktata in salicilne kisline na rastne parametre, fiziološke lastnosti in trajanje plodov pri shranjevanju. Dobljeni izsledki so pokazali, da sta imeli največji foliarni dodajanji kalcijevega laktata (4 mM ali 0,8 g l^{-1}) in salicilne kisline (1,5 mM ali 0,2 g l^{-1}) največji učinek na vrednosti merjenih rastnih parametrov in velikosti pridelka. Foliarano obravnavanje s kalcijevim laktatom in salicilno kislino bi lahko povečalo čvrstost tkiv in vsebnost askorbinske kisline v plodovih. Foliarno dodajanje kalcijeva laktata 4 mM (0,8 g l^{-1}) in salicilne kisline 1 mM (0,13 g l^{-1}) je bilo najboljše obravnavanje za zmanjševanje odstotka propadlih plodov. Zaključimo lahko, da so ti izsledki pokazali, da bi lahko bilo foliarno dodajanje kalcijeva laktata in salicilne kisline uporaben in poceni postopek za izboljšanje rastnih parametrov, fiziološki lastnosti in lastnosti plodov jajčevca pri shranjevanju.

Ključne besede: jajčevec; vir kalcija; vsebnost klorofila; foliarno gnojenje; lastnosti plodov pri shranjevanju; salicilna kislina

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1 INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the most popular and vital vegetable crops in the world (Kaushik, 2019). Various plant bio-regulators have been used in different crops to increase uptake of nutrients thereby leading to improvement in growth, flowering, fruit quality, storability and yield (Ranjbar et al., 2017; Mustafavi et al., 2018; Ghahremani et al., 2020). However, recently new plant growth regulators like salicylic acid (SA) and calcium lactate (CL) have been found beneficial in maintaining balance between vegetative and reproductive growth andincreasing the uptake of nutrients thereby resulting in high yield of superior quality crops with prolonged storability and consistent bearing (Shaarawi et al., 2016). Calcium (Ca^{2+}) has been extensively studied both as an essential element and for its potential role in maintaining postharvest quality of fruit and vegetable crops by contributing to the linkage between pectic substances within the cell wall. CL treatment reduced the respiration rate and improved the firmness of persimmon slices (Youssef et al., 2017). SA is one of the groups of common phenolic compounds that are produced naturally by plants, which can act as endogenous plant growth regulator. Its application might be safe and more useful for plant growth improving. SA stimulates the growth and development of roots of the treated plants (by increasing of H^+-ATPase activity and root ATP content) thereby improving nutrient uptake (Ghassemi-Golezani and Farhangi-Abriz, 2018). Enhancement of chlorophyll and carotenoid pigments levels, photosynthetic rate and modifying the activity of some of the important enzymes are other roles assigned to SA. It induces specific changes in leaf anatomy and chloroplast structure (Uzunova and Popova, 2000). The effect of postharvest calcium chloride (CC) and SA applications on shelf-life and quality attributes of kiwifruits were evaluated by Kazemi et al. (2011). Results of this experiment showed that post-harvest SA and CC treatments prevented fruit softening and decreased mass loss of fruits. Also in the other experiment, the effect of pre-harvest CC application on post-harvest life and quality of peach fruits was studied. 0.5 %, 1.0 % and 1.5 % of CC solutions were sprayed on peach plants and CC 1.5 % resulted in maximum fruit firmness, sensory quality score and calcium content during the storage period.

The scope of the present research was to investigate the effects of CL and SA foliar application on growth parameters, several fruit quality attributes such as tissue firmness, ascorbic acid content and total soluble solids of fruits and some of the most important post-harvest properties of eggplant fruit such as titratable acidity, fruit mass loss, fruit decay and browning of pulp tissue.

2 MATERIALS AND METHODS

The experiment was conducted in University of Zanjan, Zanjan, Iran in 2018-2019. Soil samples of experimental farm were collected from a depth of 0 to 60 cm andthen analyzed. Table 1 shows the measured characteristics of experimental farm soil. Also, Table 2 shows quality and chemical properties of applied irrigation water.

Table 1: Physical and chemical properties of experimental farm soil

Clay (%)	Silt (%)	Sand (%)	Soil texture	Organic matter (%)	K (g kg^{-1})
37	38	25	Clay loam	0.94	0.2

Na (g kg^{-1})	Ca (g kg^{-1})	N (%)	EC (dS m^{-1})	pH
0.13	0.12	0.07	1.49	7.4

Table 2: Quality and chemical properties of applied irrigation water

SO_4^{2} (mg l^{-1})	HCO_3^- (mg l^{-1})	CO_3^{2-} (mg l^{-1})	Cl (mg l^{-1})	Mg (mg l^{-1})
550.5	159	0.0	435.3	241.6

Ca (mg l^{-1})	K (mg l^{-1})	Na (mg l^{-1})	EC (dS m^{-1})	pH
400	2.74	152	2.7	7.2

2.1 PLANT MATERIAL

Eggplant seeds (IR3121 cultivar) were sawn in peat moss at controlled condition (23 ± 2 °C temperature and 60 to 70 % relative humidity). Seedlings were transplanted to the field in 4-5 leaf stage (in May) at a distance of 60 cm between rows and 50 cm between plants. Seedlings were immediately irrigated after planting and then were watered by using of drip irrigation every 3 days. Weeds were controlled by hand weeding. Eggplant fruits were harvested at full ripening stage. Harvested fruits were stored at cold storage (10 °C temperature and 85 ± 5 % relative humidity) for 30 days. Post-harvest characteristics evaluation was performed during storage at 10-day intervals.

2.2 METHODS

2.2.1 Growth parameters and yield

Number of fruit per plant, diameter of fruit, height of plant, average mass of fruit, length of fruit, leaf area and yield were measured as growth parameters in harvest stage. Average mass of fruit was recorded by using digital scale (EK3000I). Leaf area was measured by using digital scanner (E84-10017) and imageJ software (V3).

2.2.2 Physiological characteristics

Total chlorophyll and carotenoid content, titratable acidity, tissue firmness, ascorbic acid and total soluble solids of fruits were measured as physiological characteristics. Total chlorophyll and carotenoid content of leaves was determined by measuring absorption with a spectrophotometer at 645 and 663 nm for chlorophyll content and 480 and 510 nm for carotenoid content (*spectrophotometer*-SAFAS UVmc2) as described by Arnon (1967). For evaluating of titratable acidity, tissue of eggplant fruit (10 g) was homogenized in 40 ml distilled water and filtered to extract the juice. 2 to 5 drops of phenolphthalein were added in this juice. A 10 ml aliquot was taken in a titration flask and titrated against 0.1N NaOH till permanent light pink color appeared. Three consecutive readings were taken from each replication of a treatment and percent acidity as malic acid was calculated by using the following formula:

% TA=[E×N×S×F/C]×100 (Raja et al. 2105). (E: Equivalent wt. of malic acid) (N: Normality of NaOH) (S: ml NaOH used) (F: vol. of aliquot taken) (C: wt. of sample).

Fruit firmness was measured with penetrometer (FT-327-48011-Alfonsine-Italy) and expressed pressure necessary to force a plunger of 11 mm size into the fruit (Arvanitoyannis et al., 2005). Ascorbic acid content of fruit was determined by applying of iodometric titration method according to Vanderslice et al. (1990). Total soluble solids was evaluated by using refractometer (ATAGO Brixo-32) and expressed as degrees brix (Paull and Chen, 1989).

2.2.3 Post-harvest characteristics

Following properties were analyzed to evaluate post-harvest characteristics of eggplant fruits (during storage): titratable acidity, tissue firmness, ascorbic acid, soluble solids content, fruit mass loss, fruit decay and browning of pulp tissue.

Fruit mass loss: Mass loss was determined by the following formula: Mass loss (%)=[(A-B)/A] × 100

Where A indicates the fruit mass at the time of harvest and B indicates the fruit mass after storage intervals (Huang et al., 2000).

Fruit decay: Fruit decay percent was estimated by visual scoring method, as described by Kader et al. (2010) on 1-4 scale, with reference points of: 4 = severe; 3 = moderate; 2 = slight; 1 = none. The score attribution depends on morphological effects such as color change, microorganism effects and smell.

Browning of pulp tissue: The color parameter L* indicates the lightness of color (0 = black and 100 = white). A Minolta Colorimeter model CR-300 was used to determine L*, and the readings were taken soon after slicing the central section of each fruit (thickness = 0.5 cm). All measurements were done on three fruits from each condition and by duplicate. The results were expressed as L_0, values higher than 86 denotes whitish pulp and values between 81 and 82 show only seed browning. Lightness near to 78 indicates an incipient browning of seed and pulp, while values below 73 denote considerable browning of seed and pulp (Ahmad et al., 2013).

2.3 STUDY DESIGN

Factorial experiment was laid out based on randomized complete blocks design (to evaluate growth parameters and physiological characteristics in harvest stage) and completely randomized design (to evaluate postharvest characteristics during storage) with three replications. The factors are foliar application of CL and SA in different concentrations including three levels for CL solution: 0 mM (control), 2 mM (0.4 g L^{-1}) and 4 mM (0.8 g L^{-1}) and three levels for SA solution: 0 mM (control), 1 mM (0.13 g L^{-1}) and 1.5 mM (0.2 g L^{-1}) and also during of storage in three levels including: 10, 20 and 30 days. CL and SA foliar application was carried out at 6-leaf stage for the first time and continued at 10-day intervals until harvest stage.

2.4 STATISTICAL ANALYSIS

Data were analyzed by analysis of variance (ANOVA) using the SAS software (V9). Mean comparisons were performed by Duncan's multiple range test at confidence level of 95 %.

3 RESULTS AND DISCUSSION

3.1 GROWTH PARAMETERS AND YIELD

According to ANOVA analysis, significant influence of CL and SA foliar application and interaction between them on all of measured growth parameters was found. Table 3 shows, the highest applied concentrations of CL (4 mM) and SA (1.5 mM) foliar application led to the highest values in all of measured growth parameters. Also, the highest value of yield (127.21 t ha^{-1}) was recorded in plants sprayed by CL 4 mM and SA 1.5 mM. Yield increased by 13.46 % at sprayed plants by CL 4 mM and SA 1 mM compared to CL 2 mM and SA 1 mM treated plants. Similar stimulatory effects of SA and different types of calcium sources (calcium oxide, calcium chloride, calcium chelate and calcium lactate) on different growth parameters were reported in tomato (Rab & Haq, 2012), strawberry (Kazemi, 2013a), cucumber (Kazemi, 2013b), cowpea (Mohamed & Basalah, 2015) and lettuce (Almeida et al., 2016; Khani et al., 2020). SA stimulates the growth and development of roots of the treated plants by increasing of H^+-ATPase enzyme activity and root ATP content (Ghassemi-Golezani and Farhangi-Abriz, 2018) thereby improving nutrient uptake. So, increasing of nutrient uptake rate can be as important reason for increasing of growth parameters and yield in SA treated plants. According to Hepler (1994), the effects of different calcium sources on growth parameters of different crops can be related to the fact that calcium ions (Ca^{2+}) appeared to participate in the regulation of different aspects of cell division. Calcium is one of the most important ions in formation of the mitotic spindle which directly affects cell division.

3.2 PHYSIOLOGICAL CHARACTERISTICS

All of the measured physiological characteristics were significantly affected by CL and SA foliar application and interaction between them. The highest chlorophyll content (1.32 mg g FM^{-1}) was related to sprayed plants by CL 4 mM and SA 1 mM and the lowest carotenoid content (0.36 mg g FM^{-1}) was obtained in control (sprayed plants by CL 0 mM and SA 0 mM) (Table 4). Foliar application of SA was found to increase the chlorophyll content in cowpea (Chandra & Bhatt, 1998), tomato (Kalarani et al., 2002), cucumber (Yildirim et al., 2008) and strawberry (Karlidag et al., 2009a, 2009b). Martin-Diana et al. (2005), reported that carotenoid levels were higher in CL-treated carrots than that in control samples at the end of 10 days storage. Results showed that, the highest and lowest values of total soluble solids were related to control fruits (harvested from sprayed plants by CL 0 mM and SA 0 mM) and harvested fruits from CL 4 mM and SA 0 mM sprayed plants, respectively. Foliar application of CL and SA led to a significant reduction in total soluble solids of fruits. Different results were reported about effect of calcium sources on total soluble solids of fruits, for instance, according to Akhtar et al. (2010), CC treatment could significantly increase total soluble solids in Loquat fruit but in contrast, Dong et al. (2004) reported that, total soluble solids of tomato reduced by employing of calcium treatment. Calcium sources and SA treatments lead to a decrease in respiration rate, ethylene biosynthesis and ripening of fruits, which in turn decrease the polysaccharide degradation in cell wall and cell membrane. So, decreasing of polysaccharide degradation can lead to a reduction of total soluble solids of fruits.

Titratable acidity increased by 2.86 % at harvested fruits from CL 4 mM and SA 1.5 mM sprayed plants compared to fruits of treated plants by CL 4 mM and SA 0 mM. Applying of CL and SA foliar treatment could increase tissue firmness and ascorbic acid content of fruits and CL 4 mM and SA 1.5 mM foliar spraying was the best treatment to increase tissue firmness and ascorbic acid content of eggplant fruits. Fruit softening results from cell wall degradation by cell wall hydrolases such as polygalactosidases, pectin methylesterases, b-galactosidase and xylanase along with cell membrane deterioration. As an ethylene inhibitor, SA delays fruit ripening and prevents fruit softening by reducing the activity of cell wall-degrading enzymes. Srivastava and Dwivedi (2000) reported that SA reduced polygalactosidases, xylanase, and cellulase enzyme activity in harvested banana fruits. Wang et al. (2006) reported that SA treatment can increase ascorbic acid content in fruit and vegetable crops by increasing of ascorbate peroxidase enzyme activity. Our finding with respect to the effect of CL and SA foliar application on ascorbic acid content is in line with those reported by Elvwan and Hamahyomy (2009). They observed an increase in ascorbic acid content of greenhouse pepper by employing of low concentration of SA foliar application.

Table 3: Effect of CL and SA foliar application on growth parameters and yield at harvest

SA concentration (mM)	CL concentration (mM)	Leaf area (mm)	Average mass of fruits (g)	Number of fruit per plant	Diameter of fruit (cm)	Length of fruit (cm)	Height of plant (cm)	Yield (t ha^{-1})
	0	185.4f	255.66f	11.23g	3.54f	19.35f	63.11h	95.57g
0	2	192.32d	262.66e	11.41f	3.65e	19.73ef	64.21g	99.72f
	4	196.12c	275.66c	12.03c	3.83d	20.12e	66.59e	110.06c
	0	191.59d	269.33d	11.64e	3.84d	21.47d	65.42f	104.16e
1	2	195.29c	273.66c	11.05h	3.94c	22.57bc	67.39e	100.31f
	4	199.19b	280b	12.43b	4.25b	23.28b	72.59c	115.89b
	0	188.64e	274c	11.82d	3.82d	21.60d	70.03d	107.48d
1.5	2	200.89b	282.66b	12.38b	3.91c	22.40c	74.18b	115.42b
	4	207.45a	297.33a	12.84a	4.42a	24.08a	81.77a	127.21a

Values in columns for same variable followed by the same letter are not significantly different according to Duncan's multiple range test ($p \leq 0.05$)

Table 4: Effect of CL and SA foliar application on the content of metabolites and firmness at harvest

SA concentration (mM)	CL concentration (mM)	Chlorophyll content (mg g $FM^{-1)}$	Carotenoid content (mg g $FM^{-1)}$	Total soluble solids (0B)	Titratable acidity (%)	Tissue firmness (N)	Ascorbic acid content (mg 100 g Juice)
	0	0.80h	0.36h	5.07a	5.45e	3.23f	1.75e
0	2	0.93f	0.39g	4.87b	5.47de	2.76ef	1.70e
	4	1.25c	0.45d	4.18g	5.44e	2.64c	1.83d
	0	1.01e	0.42f	4.78c	5.49cd	3.00d	1.82d
1	2	1.05d	0.44e	4.67d	5.50bcd	3.37b	1.90c
	4	1.32a	0.51c	4.46e	5.52b	3.41ab	1.94bc
	0	0.87g	0.39g	4.82bc	5.52bc	2.92de	1.90c
1.5	2	0.94f	0.62a	4.53e	5.53b	3.29bc	1.99b
	4	1.29b	0.59b	4.34f	5.60a	3.54a	2.07a

Values in columns for same variable followed by the same letter are not significantly different according to Duncan's multiple range test ($p \leq 0.05$)

3.3 POST-HARVEST CHARACTERISTICS

According to ANOVA analysis, all of the measured post-harvest characteristics except fruit decay were affected by interaction between CL and SA foliar application and duration of storage.

Figure 1 shows the effect of interaction between CL and SA treatment and duration of storage on total soluble solids, titratable acidity, tissue firmness and ascorbic acid content of fruits. Total soluble solids of fruits raised by increasing the time of storage from 10 to 20 days but a reverse trend (reduction) was detected in total soluble solids of fruits from 20 to 30 days of storage. In our opinion, change in ratio of respiration rate (consumption of sugars) to conversion of starch to sugar (production of sugars) would be a main reason on increasing of total soluble solids in first days of storage with a peak on 20 days of storage and then decreasing until 30 days after storage. The rate and speed of conversion of starch to sugar (production of sugars) is higher than respiration rate (consumption of sugars) in first days of storage and it can lead to a significant increase in total soluble solids of fruits

but the ratio of respiration rate to conversion of starch to sugar increased after 20 days of storage, so a significant decrease was detected in total soluble solids of fruits in the last days of storage. (Figure 1a). The highest value of titratable acidity (5.53 %) was obtained in harvested fruits from sprayed plants by CL 4 mM and SA 1.5 mM after 10 days of storage (Figure 1b). During storage, there is conversion of starch to sugar and the oxidation of organic acids to sugar which rapidly reduce the titratable acidity and increase total soluble solids of fruits (Campestre et al., 2002). Tissue firmness reduced by increasing the time of storage but harvested fruits from treated plants showed higher value of tissue firmness than that in control (Figure 1C). According to Mahajan et al. (2017), the reduction of fruit firmness during post-harvest stage is mainly caused due to the dissolution of the middle lamella, decreasing of cell-to-cell adhesion and the weakening of parenchyma cell walls as a result of the action of cell wall modifying enzymes leading to shriveling and softening. We guess the inhibitory effect of CL and SA on degrading enzymes activity can be as main reason for positive effect of foliar treatment on fruit tissue firmness

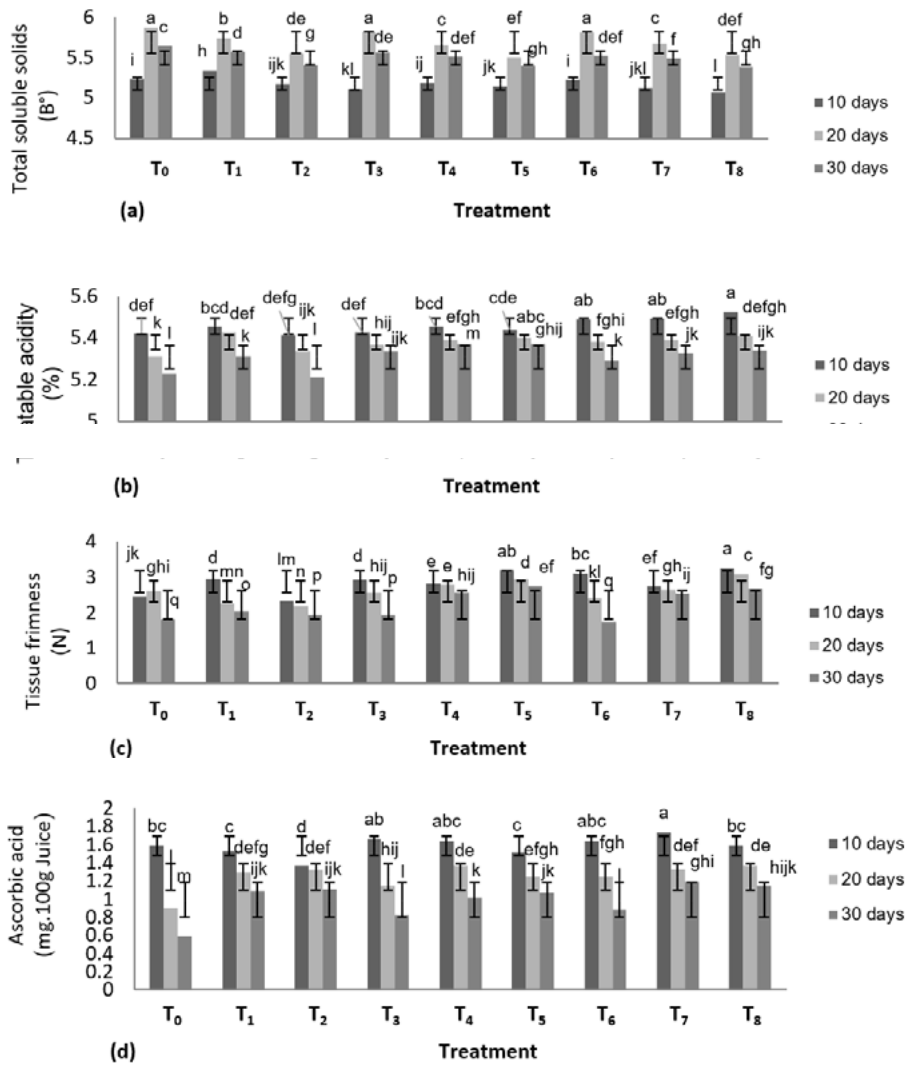

Figure 1: Effect of CL and SA foliar application and during of storage on: a total soluble solids, b titratable acidity, c tissue firmness and d ascorbic acid content
Values in columns for same variable followed by the same letter are not significantly different according to Duncan's multiple range test ($p \leq 0.05$)

in this study. The highest and lowest values of ascorbic acid content were related to harvested fruits from CL 2 mM and SA 1.5 mM sprayed plants after 10 days of storage and control fruits after 30 days of storage (1.78 and 0.58 mg.100g juice, respectively) (Figure 1d). Our results showed that ascorbic acid content of fruits reduced by increasing of duration of storage but foliar treatment led to a reduction in ascorbic acid decreasing rate. According to Umebese and Bankole (2013), SA foliar application can increase nitrate reductase enzyme activity and this enhancement corresponds with the reduction of ascorbic acid decreasing rate.

Figure 2 shows the effect of CL and SA treatment and duration of storage on pulp tissue browning and fruit mass loss. The highest and lowest values of pulp tissue browning were related to control fruits after 30 days of storage and harvested fruits from CL 4 mM and SA 1.5 mM sprayed plants after 10 days of storage (89.27 and 67.16 % respectively) (Figure 2a).

The best treatment to minimize fruit mass loss was CL 4 mM and SA 1 mM foliar spraying after 10 days of storage (6.75 %) (Figure 2b). Our findings with respect to the effect of CL and SA treatment and duration of storage on fruit mass loss showed that control fruits recorded maximum fruit mass loss after 30 days of storage (19.54 %). In this study, increasing of duration of storage led to a raise in fruit mass loss. Fruit mass loss is basically related to water loss and this essentially due to transpiration, which accounts for 90 % of total mass loss and initially comes from the peel. Water loss adversely affects the quality and limits the economic post-harvest life of crops (Ennab et al., 2020). Our findings showed that foliar treatment led to a reduction in fruit mass loss. The result of this study is similar to the findings reported by Gupta et al. (2011). They reported that reduction in physiological mass loss in calcium sources treated fruits might be due to the maintenance of fruit firmness and tissue rigidity by decreasing the enzyme activity responsible for disintegration of cellular structure, which decreases the gaseous exchange.

According to ANOVA analysis, percent of fruit decay was conditioned by interaction between CL and SA foliar application and also main effect of duration of storage. Obtained results showed that the best treatment to decrease fruit decay was CL 4 mM and SA 1 mM foliar application (1.9 %) and 10 days storage led to the lowest

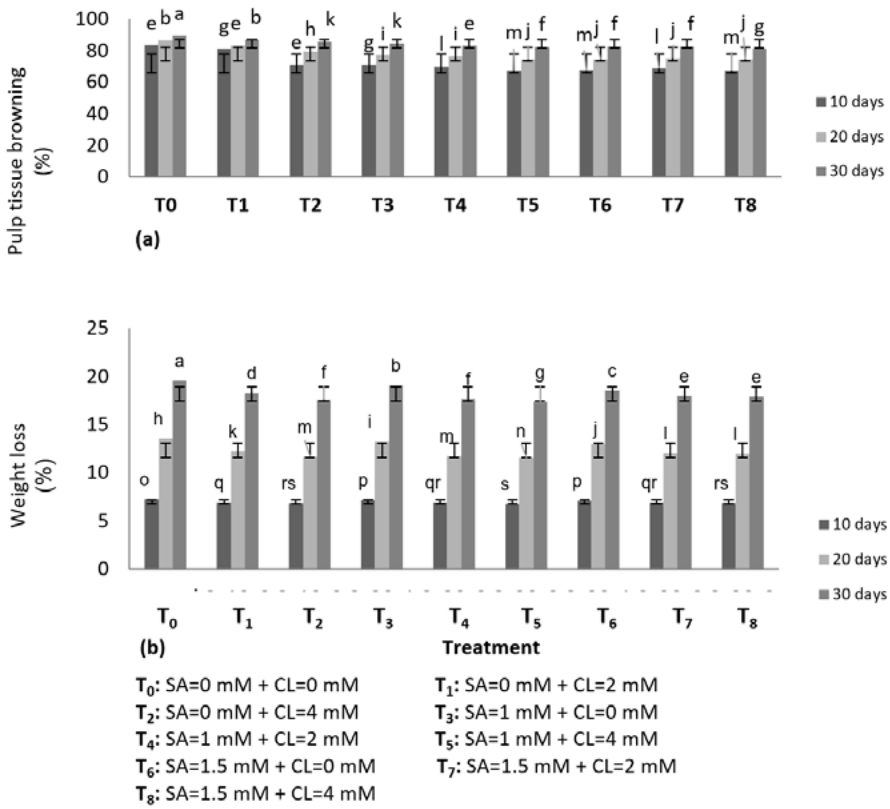

Figure 2: Effect of CL and SA foliar application and during of storage on: a browning percent and b mass loss
Values in columns for same variable followed by the same letter are not significantly different according to Duncan's multiple range test ($p \leq 0.05$)

fruit decay percent (1.28 %) (Table 6). SA and calcium sources significantly reduced fruit decay of stored mandarins and sweet oranges due to enhancing the activity of antioxidant enzymes and improving resistance to fungal attack, the accumulation of H_2O_2 and defense-related metabolites like ornithine, threonine and polymethoxylated flavones (Zhu et al., 2016), and the anti-senescent effect that maintains fruit firmness, which eventually reduced microbial attack (Ahmed et al., 2013). Pre-harvest treatment of SA reduced post-harvest fruit decay and fungal diseases in melon (Huang et al., 2000), mango (Zainuri et al., 2001) and apple (Krishna et al., 2012).

Table 5: Effect of CL and SA foliar application and duration of storage on fruit decay after harvest

SA concentration (mM)	CL concentration (mM)	Fruit decay (%)	Duration of storage (day)	Fruit decay (%)
	0	2.58a	10	1.28c
0	2	2.15cd	20	2.20b
	4	2.03de	30	3.10a
	0	2.36b		
1	2	2.12cd		
	4	1.93e		
	0	2.18cd		
1.5	2	2.17cd		
	4	2.22bc		

Values in columns for same variable followed by the same letter are not significantly different according to Duncan's multiple range test ($p \leq 0.05$)

4 CONCLUSION

Our results showed that foliar application of CL and SA can be useful and inexpensive treatment to improve growth parameters, physiological characteristics and post-harvest properties of eggplant fruit. The highest applied concentrations of CL and SA (4 mM and 1.5 mM) foliar application led to the highest values in all of measured growth parameters such as leaf area, mass, number, diameter and length of fruit, height of plant and yield. Foliar spray of eggplants by CL at 4 mM and 2 mM and also SA at 1 mM and 1.5 mM led to a significant increase in photosynthetic pigments. The highest tissue firmness and ascorbic acid content of eggplant fruit was obtained by highest concentration foliar application of CL and SA. Also, negative effects of increasing of storage time on post-harvest properties decreased by employing of CL and SA foliar application. Using of higher concentrations of SA and CL as well as applying of other plant bio-regulator in eggplant cultivation is recommended for future researches.

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