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Effect of Sodium Selenate and Potassium Silicate on Growth, Productivity, Storability and Economical Evaluation of "Florida Prince" Peach and "Le-Conte" Pear: A. "Florida Prince" Peach

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Abstract: Sodium selenate (SS) at 2, 4, 8 ppm and potassium silicate (PS) at 250, 500, 1000 ppm were sprayed 3 times on "Florida Prince" peach grafted on "Nemaguard" rootstock during 2020 and 2021 seasons (bud dormant, fruit set and 2 weeks after fruit set). All obtained data were statistically analyzed using a randomized complete block design. The present results showed that, all concentrations of SS or PS markedly increased fruit yield, relatively increase of fruit yield, yield efficiency, number of fruits / tree, fruit weight and size, fruit shape index, TSS, N, P, K, S, Se and Si in leaves, grower net income and investment rate compared with control. On the other hand, the conducted treatments decreased fruit drop percentage, fruit firmness and juice acidity. The differences were mostly significant. Deal with storability, the present treatments supported peach fruits during cold storage at 0 ± 1°C and 90 ± 5 RH for 2 months where they increased TSS and total sugars, fruit weight loss and decreased firmness and acidity to the suitable rate. It is noticeable that, increasing the dosage of SS or PS clearly increased the positive effect on peach fruits. So we can recommend peach owners to spray their trees with 8 ppm sodium selenite or 1000 ppm potassium silicate 3 times at bud dormant, fruit set and 2 weeks after fruit set to gain many profits of yield, fruit quality, storability, net income (for about 19950 or 25357 LE compared to 14100 LE \ fed .for control).

Key words: Peach · Selenium · Silicon · Fruit quality · Economical evaluation · Storability

INTRODUCTION

In Egypt, peach crop presents on important economic value and exporting potential. According to FAO [1] the area cultivated with peach in Egypt is 60884 Fed. In which produced 328390 tons / year mainly in the newly reclaimed areas. Peaches are extremely perishable fruits as rapid increase in ethylene production with rapid ripening which limits the shelf life of fruits and storability [2, 3]. Therefore there is a need to ascertain pre and post-harvest application for maintaining fruit quality for long periods.

Silicon (Si) is one of the superabundant elements since it reached about 29% of the Earth's crust and 3-17% in soil solution [4, 5]. It is considered a quasi-essential element because of its benefits for enhancing plant growth, yield, fruit, quality, mitigate biotic and abiotic stresses, photosynthetic activity, improving K / Na ratio, stimulate some enzymes activity, increasing the soluble substances of xylem and encourage antioxidant defense mechanism [6-8]. In this respect, Zhang and Ervin [9] reported that, silicon applications retarded fruit softening through suppression effect on some enzymes as xylanase and cellulose.

Little attention has been paid to the role of selenium (Se) on the growth and yield of fruit trees. However, its advantageous role has been noted in naturally occurring Se-accumulating plants require Se for their normal growth and act against oxidative stress [10]. Selenium appears to be effective in delaying plant senescence and fruit ripening during a decrease in ethylene biosynthesis, thus decreasing postharvest losses due to its antioxidant properties and as a component of different enzymes such as glutathione peroxidase, superoxide dismutase and

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thioredoxin reductase [11-13]. Also, spraying peach and pear trees with sodium selenite affected the shelf-life of fruits, retarded flesh firmness reduction and fruit ripening Pezzarassa *et al.* [14] may be as a result of improving photosynthesis and protecting photosystem in pear, grape and peach [15].

The aim of this study was to investigate the possibility of augmenting Se and Si content in peach trees by foliar application with sodium selenite and potassium silicate and evaluate the effects on fruit yield, quality and ripening during cold storage during cold storage for two months at 0°C ± 1 and 90 ± 5 relative humidity (RH).

MATERIAL AND METHODS

This study was conducted on 10 years old "Florida prince" peach trees grafted on "Nemaguard" rootstock and grown on sandy soil at 4 x 5 m. apart (210 trees / fed.). The selected trees were nearly uniform in growth vigor and subjected to the same cultural practices in a private farm at km 86 of the Desert Road of Cairo Alex. During (2020 and 2021) seasons, 3 trees in each treatment were sprayed 3 times at: bud dormant (30 Jan.) , fruit set (8 March) and 2 weeks after fruit set (25 March) with:

- Sodium selenite ($Na_2 SeO_4$) at 2 ppm (20 ml / 10 liters)
- Sodium selenite ($Na_2 SeO_4$) at 4 ppm (40 ml / 10 litters)
- Sodium selenite ($Na_2 SeO_4$) at 8 ppm (80 ml / 10 litters)
- Potassium Silicate ($K_2 Si O_3$) at 250 ppm (12.5 ml / 10 litters)
- Potassium Silicate ($K_2 Si O_3$) at 500 ppm (25 ml / 10 litters)
- Potassium Silicate ($K_2 Si O_3$) at 1000 ppm (50 ml / 10 litters)
- Control treatment sprayed with tap water.

The obtained data were handled as follows:

Fruit Set: We could not calculate fruit set because the grower has thinned the fruits.

Fruit Drop (%): In both seasons of study, 4 flowering branches around the circumference of the tree were labeled and the fruits were counted and recorded periodically till harvest to calculate fruit drop percentage, as the following equation: Number of remained fruits × 100/ Number of fruit lets.

Number of Fruits /Tree: At harvest time (25 Apr.), number of fruits per each studied tree were counted and recorded.

Fruit Yield (Kg / Tree): At harvest time the number of fruits per tree were counted and multiplied by fruit weight to estimate yield as kg / tree.

Relatively Increase of Fruit Yield (%): Was estimated as the equation:

Relatively increase of fruit yield (%): = (The yield of treatment –The yield of control) x100/ the yield of control.

Yield Efficiency: Was assessed as the equation: The yield per tree (kg) / plant distance (m^2).

Fruit Physical Characteristics: At harvest, sixty fruits / treatment (3 replicates) were randomly sampled to determine the following fruit physical characteristics:

Fruit Shape Index: Fruit length / fruit diameter width.

Fruit Weight (g): Determined by weighing a sample of fruits from each replicate and the mean fruit weight was calculated.

Fruit size (cm^3): Using water displace meter method.

Firmness (Lb. / Iinch^2): It was determined from the two sides of fruits by using a pressure tester (Advance Force Gorge RH13, UK).

Fruit Chemical Characteristics

Total Soluble Solids (TSS%): Was determined in fruit juice by Abbe hand refractometer.

Total Acidity (TA%): Was determined in fruit juice as malic acid according to A.O.A.C. [16].

Total Sugars (%): Was determined according to Tasun *et al.* [17].

Leaf Mineral Content: In mid Aug. of both seasons, fifty mature mid shoot leaves / tree were sampled, washed with tap water then with distilled water and oven dried at 50°C to constant weight, ground, digested with sulphoric acid and hydrogen peroxide for the determination of N, P, K. Nitrogen percentage was estimated by microkjeldahl Gunning method A.O.A.C. [16]. Phosphorus percentage was determined colorimetically by hydroquinone method Foster and Cornelia [18]. Potassium percentage was estimated by flame photometer as Jackson [19]. Also, Silicon (mg/Kg), selenium (mg/Kg) and Sulfate (%) elements were analyzed at Soil and Water Research Institute as described by Soltanpour and Schwab [20].

Economical Evaluation of the Tested Treatments: The profitability of the present treatments which indicated the cost and the net income per feddan were calculated in table (6) with 3 sprays / season includes 4200 liters per fed. Chemicals, labors and constant costs were assessed for control and treatments. Constant costs include: electricity for irrigation, fertilizers, pesticides, pruning and labors.

Yield price / ton (5000 LE): Was estimated by multiple yield of treatments (ton / fed.) x farm gate price per ton (LE).

Total cost = Chemicals + Labors cost +Constant cost.

Net income / fed. (LE): Was assessed as yield price per ton (LE)- total cost per fed. (LE).

Storability Study

Fruit Weight Loss (%): Was assessed as the equation = (Fruit weight at harvest - Fruit weight after one or two months x 100) / Fruit weight after one or two months.

Fruit Weight Loss (%): Was assessed as the equation = (Fruit weight at harvest - Fruit weight after one or two months x 100) / Fruit weight at harvest.

- Fruit firmness (Lb/inch2).
- Juice TSS%.
- Juice acidity (%).
- Total sugars (%).

Statistical Analysis: The experiment was arranged as a randomized complete blocks design and the collected data were statistically analyzed (except economical evaluation) according to Snedecor and Cochran [21]. It is noticeable that, Tables (1-5) have one factor (treatments effect) while tables (7-11) have two factors: Factor A (Storage periods) and Factor B (Treatments effect). Means of treatments were compared using least significant difference (LSD) test at $P < 0.5$.

RESULTS

Effect of Sodium Selenate and Potassium Silicate on Fruiting

Fruit Drop (%): Table (1) showed that, control treatment significantly increased fruit drop percentage during the two studied seasons (30.2 and 26.2 %). On the other hand, all the studied treatments significantly decreased fruit drop percentages especially with 8 ppm sodium selenate (15.0 and 14.6 %) and 1000 ppm potassium silicate (18.3 and 17.9 %) during 2020 and 2021 seasons respectively.

Number of Fruits per Tree: Table (1) showed that, increasing the dose of sodium selenate (304.3 and 338.0) or potassium silicate (363.9 and 301.5) markedly increased number of fruits per tree compared to the rest of treatments and control (241.6 and 283.8) during 2020 and 2021 seasons respectively. However, increasing number of fruits per tree reflected on increasing fruit yield.

Fruit Yield (Kg / Tree): Fruit yield was on a real high with higher sodium selenate (39.6 and 43.7 kg/ tree) and higher potassium silicate concentration (41.2 and 39.8 kg/ tree) in comparison with lower concentration and control treatment (17.3 and 21.0 kg/ tree) in the 2 studied seasons respectively (Table 1 & Fig. 2).

Relativity Increase of Fruit Yield: It is noticed from Table (2) that, higher concentration of sodium selenate (133.7 and 113.7) as well as potassium silicate (219.9 and 100.9) gave relatively increase of fruit yield than lower concentrations or control during 2020 and 2021 seasons respectively.

Fruit Yield Efficiency (kg / m^2): Table (2) revealed that, fruit yield efficiency gradually increased with increasing the concentration of sodium selenate from 2 ppm (0.68 and 1.64) to 4 ppm (1.56 and 1.85) to 8 ppm (1.98 and 2.19 kg/m^2) as well as increasing the concentration of potassium silicate from 250 ppm (1.08 and 1.21) to 500 ppm (1.43 and 1.58) to 1000 ppm (2.06 and 1.99 kg/m^2) in comparison to control (0.87 and 1.05 kg/ m^2) in the two studied seasons respectively.

Table 1: Effect of sodium selenate and potassium silicate on fruit drop (%), number of fruits /tree and fruit yield (kg/tree)" of Florida prince" peach during 2020 and 2021 seasons

Treatments	Fruit drop (%) 2020	Fruit drop (%) 2021	No. of fruits / tree 2020	No. of fruits / tree 2021	Fruit yield (kg / tree) 2020	Fruit yield (kg / tree) 2021
Sodium selenate 2 ppm	19.3 bc	20.3 bc	136.8 d	316.0 a	23.6 c	32.8 abc
Sodium selenate 4 ppm	17.1 bcd	16.9 cd	279.8 ab	320.4 a	31.2 b	37.0 ab
Sodium selenate 8 ppm	15.0 d	14.6 d	304.3 a	338.0 a	39.6 a	43.7 a
Potassium silicate 250 ppm	22.4 b	21.7 b	232.9 abc	225.7 ab	21.6 c	24.1 d
Potassium silicate 500 ppm	20.1 b	19.2 bc	248.5 ab	273.0 a	28.6 b	31.6 abc
Potassium silicate 1000 ppm	18.3 bc	17.9 b-d	363.9 a	301.5 a	41.2 a	39.8 a
Control	30.2 a	26.2 a	241.6 abc	283.8 a	17.3 d	21.0 d

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test).

Table 2: Effect of sodium selenate and potassium silicate on relatively increase of fruit yield, yield efficiency (kg / m²) and fruit shape index on "Florida prince" peach during 2020 and 2021 seasons

Treatments	Relatively increase of fruit yield (%) 2020	Relatively increase of fruit yield (%) 2021	Yield efficiency (kg / m²) 2020	Yield efficiency (kg / m²) 2021	Fruit shape index (Length/Width) 2020	Fruit shape index (Length/Width) 2021
Sodium selenate 2 ppm	69.7 c	62.40 abc	0.68 cd	1.64 abc	0.94 bc	0.95 c
Sodium selenate 4 ppm	130.4 b	92.60 ab	1.56 b	1.85 ab	0.94 bc	0.99 b
Sodium selenate 8 ppm	133.7 b	113.7 a	1.98 a	2.19 a	0.98 b	1.08 a
Potassium silicate 250 ppm	60.80 c	54.30 abc	1.08 c	1.21 d	0.95 bc	0.96 bc
Potassium silicate 500 ppm	102.7 b	54.80 abc	1.43 b	1.58 abc	0.97 b	0.96 bc
Potassium silicate 1000 ppm	219.9 a	100.9 a	2.06 a	1.99 a	1.00 b	0.97 bc
Control	-	-	0.87 c	1.05 d	1.04 a	1.00 b

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

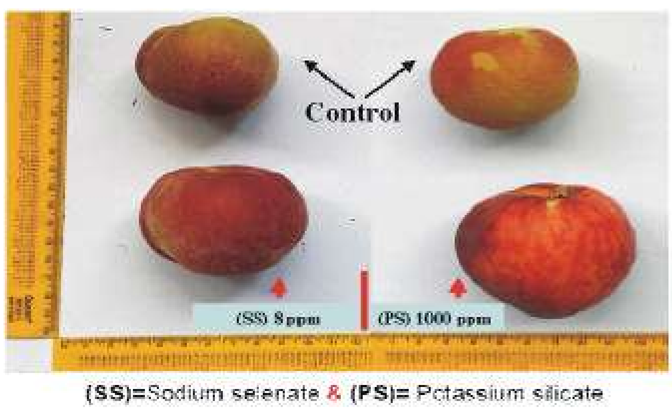


Fig. 1: Effect of Effect of Sodium Selenate and Potassium Silicate on fruit of "Florida prince" peach

Effect of Sodium Selenate and Potassium Silicate on Fruit Physical Characteristics:

Fruit Shape Index (Length / Width): The present results (Table 2) showed that, the shape index of "Florida Prince" peach fruit decreased with the present treatments (sodium selenate and potassium silicate) than control. So, we can use the shape index as a marker for the present treatments.

Fruit Weight (g) and Size (cm^3): Table (3) illustrate that the fruit weight and size took the same trend granted to the studied treatments of sodium selenate and potassium silicate where all concentrations increased fruit weight and size specially higher dosage of sodium selenite or potassium silicate (Fig. 1) in comparison to control (71.8 and 73.4 g) as well as (78.6 and 74.0 cm^3).

Fruit Firmness (lb / $inch^2$): All studied treatments decreased the fruit firmness than control (Table 3). Also, increasing the dose of sodium selenate or potassium silicate gradually decreased the fruit firmness to appropriate firm (19.37 and 19.89 lb / $inch^2$) compared to lower concentration and control (24.67 and 24.50 lb / $inch^2$).

Table 3: Effect of sodium selenate and potassium silicate on fruit weight (g), fruit size (cm^3) and fruit firmness ($lb/inch^2$) of "Florida prince" peach during 2020 and 2021 seasons

	Fruit weight (g)		Fruit size (cm^3)		Fruit firmness ($lb/inch^2$)	
Treatments	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	101.1 ab	110.3 abc	89.60 abc	77.20 e	24.36 a	24.39 a
Sodium selenate 4 ppm	116.0 a	119.8 abc	93.80 abc	88.70 abcd	21.33 d	23.50 b
Sodium selenate 8 ppm	124.0 a	135.1 a	119.3 a	108.8 a	21.60 d	19.80 d
Potassium silicate 250 ppm	92.90 bc	105.6 abcd	82.90 abcd	96.50 abc	23.37 ab	24.67 a
Potassium silicate 500 ppm	120.1 a	122.4 ab	106.5 ab	104.2 ab	22.67 abc	23.37 bc
Potassium silicate 1000 ppm	128.5 a	141.0 a	131.3 a	117.2 a	19.37 e	19.89 d
Control	71.80 d	73.40 e	78.60 abcd	74.00 e	24.67 a	24.50 a

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Table 4: Effect of sodium selenate and potassium silicate on TSS (%), acidity (%) and total sugars (%) of "Florida prince" peach juice during 2020 and 2021 seasons

	TSS (%)		Acidity (%)		Total sugars (%)	
Treatments	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	9.30 e	9.30 cd	0.95 a	0.98 a	10.29 d	11.01 c
Sodium selenate 4 ppm	9.80 d	9.80 c	0.93 ab	0.95 b	11.95 bc	12.55 b
Sodium selenate 8 ppm	10.3 c	10.8 b	0.88 c	0.86 c	12.63 b	13.68 a
Potassium silicate 250 ppm	9.30 e	9.60 c	0.98 a	1.00 a	10.26 d	11.16 c
Potassium silicate 500 ppm	10.8 b	10.5 b	0.88 c	0.92 b	11.71 c	12.38 b
Potassium silicate 1000 ppm	11.1 a	11.7 a	0.76 d	0.82 d	14.10 a	14.04 a
Control	9.20 e	9.20 cd	0.96 a	1.06 a	9.07 e	9.85 d

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Effect of Sodium Selenate and Potassium Silicate on Fruit Chemical Characteristics:

Fruit Juice TSS (%), Acidity (%) and Total Sugars: Table (4) revealed that, increasing the concentration of sodium selenate or potassium silicate clearly increased TSS than control (9.2 and 9.2 %) and total sugars (9.07 and 9.85 %) of the studied peach fruits. While the highest treatments decreased the acidity of juice (0.88 and 0.86%) and (0.76 and 0.82 %) than remained treatments and control (0.96 and 1.06 %) respectively. Increasing TSS and total sugars as well as decreasing acidity mean better taste of fruits.

Effect of Sodium Selenate and Potassium Silicate on Leaf Mineral Content: Concerning the mineral control of N, P, K the present data in (Table 5) showed that, foliar spray of sodium selenate (SS) or potassium silicate (PS) markedly increased peach leaf content of N, P, K than control (1.66, 0.154 & 2.28%) and the increment of SS or PS dose obviously increased the leaf content of these minerals (2.68 and 2.66 % N), (0.325 and 0.265 % P) and (2.38 and 2.44 % K) respectively than the rest of treatments may be as a result of promote Se for the absorption of N, P, K [22]. As for sulfate (s), selenium and silicon minerals content of peach leaves, the present data showed that, increasing the dose of sodium selenate from 2 to 4 and to 8 ppm clearly increased leaf content of sulfate from 0.ll to 0.12 and to 0.14 % compared to control (0.10%). On the other hand, the laboratory analysis sets could not get any differences on leaf content of selenium than control. Meanwhile, the present treatments of potassium silicate markedly increased leaf content of silicon than control (24.10 mg / kg) and increasing the dose of application from 250 to 500 and to 1000 ppm caused an obvious increment of leaf silicon content from 28.90 to 32.67 and to 35.60 mg/kg.

Effect of Sodium Selenate and Potassium Silicate Spray on Economical Evaluation: Table (6) showed an economical evaluation where spraying rate was 4200 liters for 3 applications per season and per Fed. labor cost per Fed. was 50 LE. while chemicals cost differed with the treatments. Constants cost includes: electricity for irrigation, fertilizers, pesticides, pruning and labors which estimated by 2500 LE / Fed. Fruit yield also differed with the treatments. Assess farm gate price with 5000 LE per ton get yield price hence get the net income which showed that, all treatments increased the net income than control (14100 LE per Fed.). However, increasing the dose of both sodium selenate (SS) and potassium silicate (PS) clearly increased the net income where 8 ppm of SS get net income 19950 LE while 1000 ppm of PS get 25357 LE (Fig. 2). Also, Zayan *et al*. [23] stated that, PS clearly increased crop value and net income of "Desert red" peach.

Table 5: Effect of sodium selenate and potassium silicate on leaf mineral content of "Florida prince" peach during 2021 season

Treatments	N (%)	P (%)	K (%)	S (%)	Se (mg/kg)	Si (mg/kg)
Sodium selenate 2 ppm	1.93 cd	0.243 b	2.35 b	0.11 ab	< 0.2 a	24.1 d
Sodium selenate 4 ppm	1.98 cd	0.277 ab	2.37 b	0.12 ab	< 0.2 a	24.1 d
Sodium selenate 8 ppm	2.68 a	0.325 a	2.38 b	0.14 a	< 0.2 a	24.1 d
Potassium silicate 250 ppm	2.16 abc	0.176 c	2.29 c	0.1 b	< 0.2 a	28.9 c
Potassium silicate 500 ppm	2.29 bcd	0.231 b	2.35 b	0.1 b	< 0.2 a	32.67 b
Potassium silicate 1000 ppm	2.66 ab	0.265 ab	2.44 a	0.1 b	< 0.2 a	35.6 a
Control	1.66 d	0.154 c	2.28 c	0.1 b	< 0.2 a	24.1 d

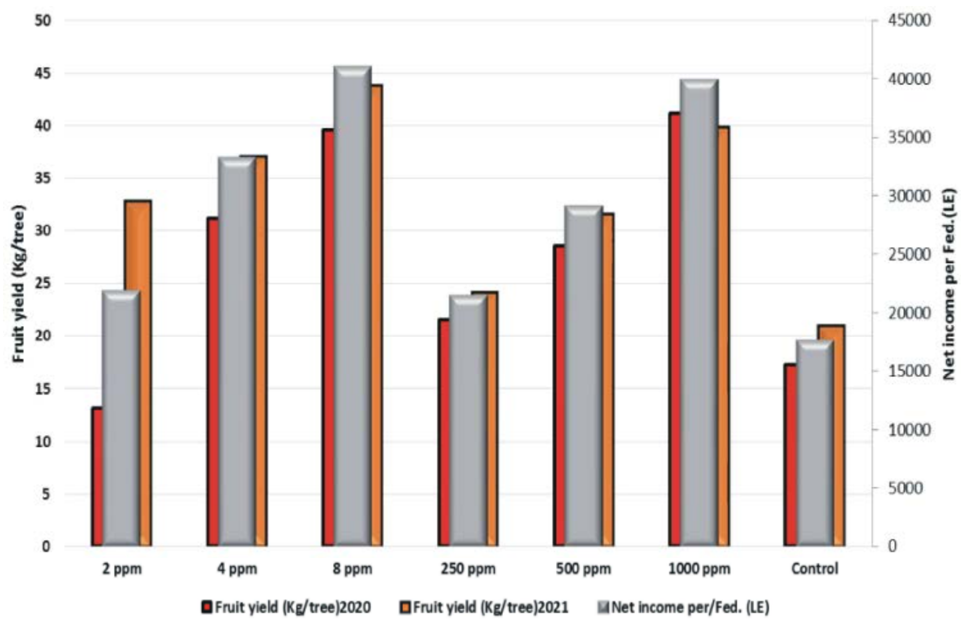
*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Table 6: Effect of sodium selenate and potassium silicate spray on economical evaluation of "Florida prince" peach during 2021 season

Treatments	Spraying rate / fed (L)	No. of application / fed	Chemicals cost / fed (LE)	Labor cost / fed (LE)	Chemicals + Labors cost / fed (LE)	Constant cost (LE / fed) 1	Total cost / fed (LE)	Fruit yield (ton / fed) 2	Farm gate pric / ton (LE)	Yield price / ton (LE)	Net income (LE)
Sodium selenate 2 ppm	4200	3	4200	3500	7700	2500	10200	4.88	5000	14200	21790
Sodium selenate 4 ppm	4200	3	8400	3500	11900	2500	14400	7.16	5000	21400	33130
Sodium selenate 8 ppm	4200	3	16800	3500	20300	2500	22800	8.75	5000	19950	40960
Potassium silicate 250 ppm	4200	3	2793	3500	6293	2500	8793	4.80	5000	15207	21410
Potassium silicate 500 ppm	4200	3	5607	3500	9107	2500	11607	6.33	5000	20043	29020
Potassium silicate 1000 ppm	4200	3	11193	3500	14693	2500	17193	8.51	5000	25357	39840
Control	4200	3	-	3500	3500	2500	6000	4.02	5000	14100	17600

* Constant cost includes: Electricity for irrigation, fertilizers, pesticides, pruning and labors

**Yield is the mean of the two studied seasons (ton/fed). There are 210 trees/fed



*2, 4, 8 Sodium selenite and 250, 500, 1000 Potassium silicate

Fig. 2: Effect of 2, 4, 8 ppm SS and 250, 500, 1000 ppm PS on "Florida prince" Peach fruit yield and net income per Fed

Effect of Sodium Selenate and Potassium Silicate on "Florida Prince" Peach During Cold Storage:

Fruit Weight Loss (%): Fig. (3) illustrated that, the present treatments markedly affected weight loss percentage of peach fruits where increasing the dosage of sodium selenite (SS) from 2 to 4 to 8 ppm clearly increased fruit weight loss (from 12.54 to 18.44 to 20.69 %). Also, increase the dosage of potassium silicate (PS) from 250 to 500 to 1000 ppm after two months of cold storage obviously increased weight loss percentage (from 9.68 to 12.06 to 12.76%) during the 1st season of study (2020) comparable with control (4.36%). In addition, 2021 season has the same trend of the 1st one. However, increasing weight loss percentages with the present treatments specially with higher concentration of SS and PS compared with control may be as a result of higher peach fruit weight, size, total soluble solids and lower fruit firmness (Tables 3, 4) led to higher fruit weigh loss percentage.

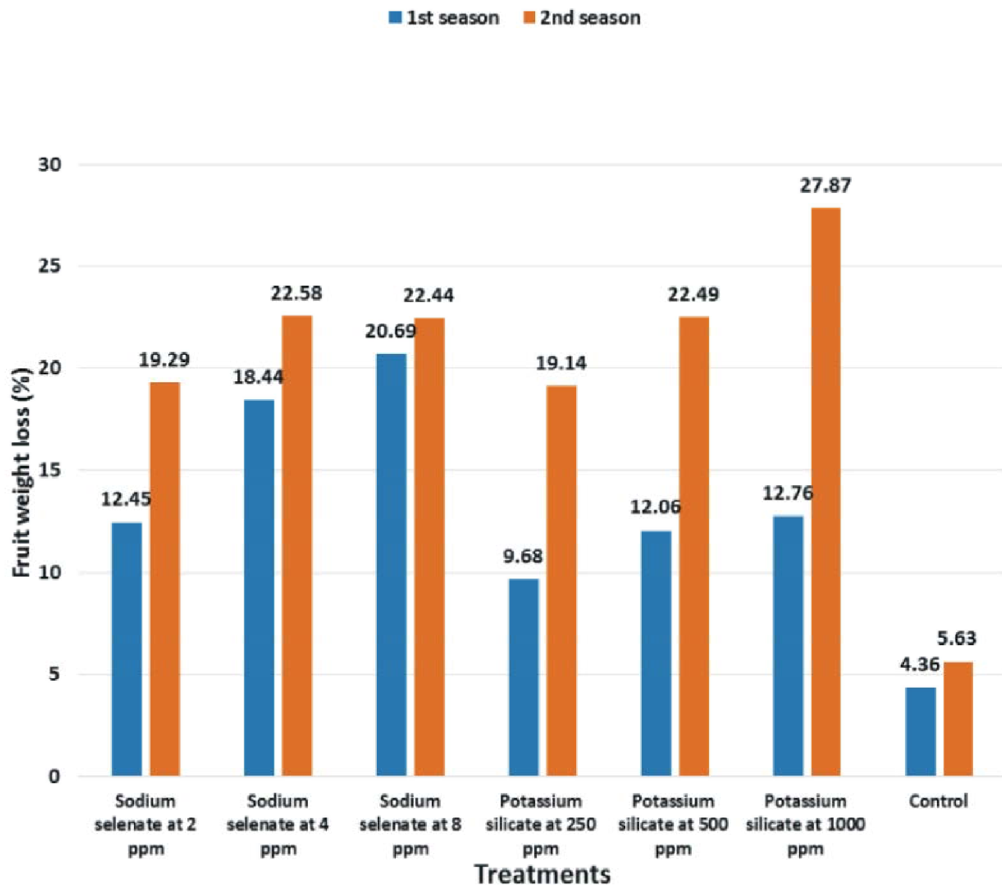


Fig. 3: Effect of 2, 4, 8 ppm SS and 250, 500, 1000 ppm PS on the average of fruit weight loss (%) of "Florida prince" peach during cold storage for two months in 2020 and 2021 seasons

Table 7: Effect of sodium selenate and potassium silicate on fruit firmness (Lb/inch2) of "Florida prince" peach during cold storage in 2020 and 2021 seasons.

	Storage period (Month)							
	0 Time (at harvest)		1 Month		2 Months		Mean (A)	
Treatments	2020	2021	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	20.36 a	20.39 ab	17.36 b-d	17.39 b-d	12.36 f	12.39 fg	16.69 A	16.72 A
Sodium selenate 4 ppm	18.00 a-d	19.50 a-c	16.00 c-e	17.50 b-d	12.00 fg	13.50 ef	15.33 AB	16.83 A
Sodium selenate 8 ppm	17.60 b-d	15.83 de	15.67 ef	13.83 gh	11.60 fg	9.83 gh	14.96 B	13.16 C
Potassium silicate 250 ppm	19.37 ab	20.67 a	17.03 b-d	17.67 a-d	12.03 fg	12.67 fg	16.14 AB	17.00 A
Potassium silicate 500 ppm	18.67 a-c	19.17 a-c	16.6 b-d	17.17 cd	12.67 f	13.17 ef	16.00 AB	16.50 A
Potassium silicate 1000 ppm	15.37 de	15.89 de	13.37 ef	13.89 ef	9.37 gh	9.89 gh	12.70 C	13.22 C
Control	20.67 a	20.50 ab	15.67 de	15.50 d-f	8.67 h	8.50 h	15.00 B	14.83 B
Mean (B)	18.58 A	18.85 A	15.97 B	16.14 B	11.24 C	11.42 C	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P = 0.05; LSD test) ** Factor A (Storage periods) and Factor B (Treatments effect)

Fruit Firmness (lb / inch^2): Table (7) showed that, increasing the dose of sodium selenate (SS) or potassium silicate (PS) significantly fixed peach fruits to the appropriate firmness (14.96 and 13.16 lb/ inch^2) with 8 ppm of SS as well as (12.7 and 13.22 lb/ inch^2) with 1000 ppm PS than lower concentrations during the two studied seasons respectively. It is also noticeable that, fruit firmness significantly decreased from (18.58 and 18.85 lb/ inch^2) at harvest time to (15.97 and 16.14 lb/ inch^2) after one month of cold storage and to (11.24 and 11.42 lb/ inch^2)

Table 8: Effect of sodium selenate and potassium silicate on TSS (%) of "Florida prince" peach juice during cold storage in 2020 and 2021 seasons

	Storage period (Month)							
	0 Time (at harvest)		1 Month		2 Months		Mean (A)	
Treatments	2020	2021	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	9.17 f	9.23 g	10.40 e	10.00 fg	11.00 c-e	11.33 c-e	10.19 B	10.19 CD
Sodium selenate 4 ppm	9.83 ef	9.83 fg	11.67 b-d	10.67 c-f	12.33 ab	11.33 c-e	11.28 AB	10.61 C
Sodium selenate 8 ppm	10.17 ef	10.75 c-f	12.00 a-c	11.50 b-e	12.67 ab	12.50 ab	11.61 A	11.58 B
Potassium silicate 250 ppm	9.17 f	9.58 fg	10.67 de	10.67 c-f	10.83 c-e	11.33 c-e	10.22 B	10.53 C
Potassium silicate 500 ppm	10.75 de	10.50 d-f	12.33 ab	11.33 c-e	12.67 ab	11.83 bc	11.92 A	11.22 B
Potassium silicate 1000 ppm	11.08 c-e	11.67 b-d	12.50 ab	13.33 a	13.00 a	13.50 a	12.19 A	12.83 A
Control	9.17 f	9.23 g	10.33 ef	10.00 fg	11.00 c-e	10.33 e-g	10.17 B	9.85 D
Mean (B)	9.91 B	10.11 C	11.41 A	11.07 B	11.93 A	11.74 A	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P = 0.05; LSD test). ** Factor A (Storage periods) and Factor B (Treatments effect)

Table 9: Effect of sodium selenate and potassium silicate on fruit juice acidity (%) of "Florida prince" peach during cold storage in 2020 and 2021 seasons

	Storage period (Month)							
	0 Time (at harvest)		1 Month		2 Months		Mean (A)	
Treatments	2020	2021	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	0.95 ab	0.98 a	0.82 cd	0.88 bc	0.75 de	0.74 ef	0.84 AB	0.87 A
Sodium selenate 4 ppm	0.93 ab	0.95 ab	0.74 ef	0.88 bc	0.67 f-h	0.64 g	0.78 BC	0.82 B
Sodium selenate 8 ppm	0.88 bc	0.86 b-d	0.65 gh	0.82 c-e	0.52 i	0.59 g	0.68 DE	0.76 C
Potassium silicate 250 ppm	0.98 a	1.00 a	0.79 de	0.89 bc	0.73 e-g	0.77 ef	0.83 AB	0.89 A
Potassium silicate 500 ppm	0.88 bc	0.92 ab	0.73 ef	0.78 d-f	0.65 gh	0.65 g	0.75 CD	0.78 BC
Potassium silicate 1000 ppm	0.76 de	0.82 c-e	0.63 h	0.73 f	0.52 i	0.51 h	0.64 E	0.69 D
Control	0.96 ab	1.00 a	0.88 bc	0.88 bc	0.80 de	0.81 c-f	0.88 A	0.90 A
Mean (B)	0.91 A	0.93 A	0.75 B	0.84 B	0.66 C	0.67 C	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P = 0.05; LSD test). ** Factor A (Storage periods) and Factor B (Treatments effect)

Table 10: Effect of sodium selenate and potassium silicate on total sugars (%) of "Florida prince" peach fruit during cold storage in 2020 and 2021 seasons

	Storage period (Month)							
	0 Time (at harvest)		1 Month		2 Months		Mean (A)	
Treatments	2020	2021	2020	2021	2020	2021	2020	2021
Sodium selenate 2 ppm	10.29 h-j	11.01 h	12.87 c-f	12.80 d-f	12.71 c-f	12.61 ef	11.96 D	12.14 D
Sodium selenate 4 ppm	11.95 e-g	12.55 ef	13.58 b-d	13.71ed	13.48 b-d	13.31 c-e	13.00 C	13.19 C
Sodium selenate 8 ppm	12.63 d-f	13.68 cd	14.42 b	14.96 b	14.45 b	14.78 b	13.83 B	14.47 B
Potassium silicate 250 ppm	10.26 ij	11.16 h	11.57 f-i	12.28 fg	11.48f-i	12.47 ef	11.10 E	11.97 D
Potassium silicate 500 ppm	11.71 f-h	12.38 e-g	13.47 b-c	14.08 bc	13.33b-e	14.09 bc	12.84 C	13.52 C
Potassium silicate 1000 ppm	14.10 bc	14.04 bc	16.00 a	16.07 a	16.09 a	16.05 a	15.40 A	15.39 A
Control	9.07 j	9.85 i	10.85 g-i	11.50 gh	10.50 hi	12.07 fg	10.14 F	11.14 E
Mean (B)	11.43 B	12.10 B	13.25 A	13.63 A	13.15 A	13.63 A	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P = 0.05; LSD test). **Factor A (Storage periods) and Factor B (Treatments effect)

after two months of cold storage at 0°C ± 1 and 90 ± 5 RH. The interaction effect cleared that, peach fruits softened more quickly with control treatment especially after two months of cold storage to 8.67 and 8.5 lb/ inch^2 during 2020 and 2021 seasons respectively.

Juice TSS (%): The present results (Table 8) cleared that, TSS of the juice of peach fruits markedly increased with both of prolonging storage period from at harvest (Zero time) (9.91 and 10.11 %) to one month (11.41 and 11.07) and to two months (11.93 and 11.74 %) as well as with increasing sodium selenate dose to 8 ppm (11.61 and 11.58 %) and potassium silicate to 1000 ppm (12.19 and 12.83 %) compared with lower concentration and control (10.17 and 9.85 %). As for interaction effect, potassium silicate at 1000 ppm after two months of cold storage recoded the highest TSS (13.00 and 13.50 %). However, the differences were mostly significant.

Juice Acidity (%): Table (9) showed that, acidity of peach juice significantly decreased with increasing period of storage from (0.91 and 0.93 %) at harvest (Zero time) to (0.75 and 0.84 %) after one month as well as to (0.66 and 0.67 %) after two months of cold storage. Also, increasing the dose of sodium selenate (SS) or potassium silicate (PS) clearly decreased juice acidity to the appropriate percentages (0.68 and 0.76 %) for SS as well as (0.64 and 0.69 %) for PS compared to the rest of treatments and control (0.88 and 0.90 %) during the two studied seasons respectively. Meanwhile, increasing fruit juice T.S.S and decreasing acidity means better fruit taste.

Total Sugars (%): Table (10) illustrated that, the present treatments significantly increased juice total sugars than control (10.14 and 11.14 %). Meanwhile, increasing sodium selenate (SS) or potassium silicate (PS) dose clearly increased the percentage of total sugar juice than lower concentrations where 8 ppm (SS) induced (13.83 and 14.47 %) as well as 1000 (PS) caused 15.4 and (15.39 %) during the two studied seasons respectively. It is also noticeable that, total sugars percentage of peach juice significantly increased from harvest time (11.43 and 12.1 %) to one month of cold storage (13.25 and 13.63 %) but were about the same after 2 months (13.15 and 13.63 %). As for the interaction, potassium silicate at 1000 recorded the highest total sugars percentages after one month (16.0 and 16.07 %) and two month (16.09 and 16.05 %).

DISCUSSION

Different concentrations of sodium selenate (2, 4 or 8 ppm) or potassium silicate (250, 500 or 1000 ppm) effectively increased fruit yield, number of fruits / tree, relatively increase of fruit yield, yield efficiency, fruit weight and size, juice TSS and sugars; while decreased fruit drop, fruit shape index and fruit firmness. Meanwhile, the economical evaluation showed much higher of net income and investment rate of all studied treatments than control. As for the effect of the present treatments on storability, the treatments increased juice TSS, total sugars and fruit weight loss and decreased firmness and juice acidity. It is also noticeable that "Florida prince" peach fruits clearly decreased in weight, firmness and acidity, whilst increased in juice TSS during cold storage at 0 ± 1°C and 90 ± 5 RH from harvest time to one month and two months. With regard to sugars of peach juice, they significantly increased from harvest time to one month but were about the same after 2months. However, higher concentration of sodium selenate or potassium silicate was more effective than lower ones.

However, previous review supported the present results, where Ma [8], Van-Bockhaven *et al.* [6], Meena *et al* [7], Okba *et al.* [24] and Pavanello *et al.* [25] showed that, silicon is considered a quasi-essential element, encourage antioxidant defense mechanism, enhanced plant growth, yield, fruit quality, mitigate biotic and abiotic stresses, photosynthetic activity, improve K\Na ratio, stimulate some enzymes activity, as well as increase the soluble substances of xylem. Also Zhang and Ervin [9] reported that, silicon applications retarded fruit softening during suppression effect on some enzymes as xylanase and cellulase. Terrey *et al.* [10], Babalar *et al.* [26], Puccinelli *et al.* [27] said that, many plants require selenium (Se) for their normal growth and act against oxidative stress. Selenium is effective in delaying fruit senescence and ripening during decrease ethylene biosynthesis subsequently decrease postharvest losses due to its antioxidant properties as a component of some enzymes such as: glutathione peroxidase, superoxide dismutase and thioredoxin reductase [14, 11, 12]. Also, spraying peach and pear trees with Sodium selenate affected the shelf-life of fruits, retarded the flesh firmness reduction and fruit ripening Pezzarossa *et al* [14] may be as a result of improving photosynthesis and protecting photosystem in pear, grape and peach [15].

Leaf analysis for mineral content showed that, sodium selenate (SS) foliar spray clearly increased leaf mineral control of N, P, K, S and Si than control, but the analysis sets could not measure Se concentrations in the samples of peach leaves. Increasing the dose of (SS) increased leaf content of these minerals. Also, foliar spray of potassium silicate (PS) obviously increased leaf mineral content of N, P, K and Si than control and the increment of (PS) dose reflected on much more leaf content of these minerals.

Furthermore, these results were provided with the same trend were Liu *et al.* [22] stated that, spraying sodium selenate increased pear leaves control of K, S and Se but decreased P where the effect of Se on mineral elements content varied depending on its dosage where low dose of Se promote the absorption of N, P, K but their absorption was inhibited under high doss possibly because high Se dose causes oxidative and toxic stress, thereby damaging the integrity of plant cell membranes and reducing its selective transmittance. However, Das *et al.* [28] showed that, exposure to selenate increased both reducing and non-reducing sugar contents in the rice seedlings accompanied with an increase in the activities of sugar metabolizing enzymes like sucrose synthase and sucrose phosphate synthase.

CONCLUSION

Therefor, foliar sprays of "Florida Prince" peach trees with sodium selenate at 8 ppm or potassium silicate at 1000 ppm at: bud dormant, fruit set and 2 weeks after fruit set is a preferable trial for enhancing fruiting aspects, fruit quality, storability and net income.

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