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(Original Article)

Effect of Spraying with Some Natural and Chemical Compounds on Growth and Fruiting of 'Florida' Strawberry Cultivar

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Abstract

The effects of boron, salicylic acid and chitosan on growth, yield components and fruit quality of a strawberry variety (Florida) were examined in the 2022 and 2023 seasons. A randomized complete block design was used.

The results showed that the application of boron, salicylic acid and chitosan increased plant height, number of leaves/plants, number of extensions, leaf area, total chlorophyll, number of fruits per plant and yield per plant compared to water spraying (control) increased significantly.

The results also showed that the physical properties of the fruits, i.e., Fruit weight, fruit height, fruit diameter and fruit hardness increased significantly when using boron, salicylic acid or chitosan compared to sprayed water (control).

The results also showed that boron, salicylic acid and chitosan spraying significantly improved the chemical composition of the fruits by increasing the percentage of total soluble solids, sugar content, vitamin C content and decreasing acidity compared to the control treatment.

It has been suggested that foliar application of chitosan or boron can significantly improve plant growth, yield and fruit quality.

***Keywords**: Boron, Chitosan, Florida cv, Foliar application, Salicylic acid, Strawberry.*

Introduction

Strawberries (*Fragaria x ananassa* Duch.) are one of the most important fruit crops grown in Egypt for fresh consumption, export and processing due to their high nutritional and medicinal value. It is a small fruit plant from the Rosecea family. The strawberry cultivation area in Egypt has increased to approximately 45,714 hectares. (1 fodder = 4200 m2), with a total production of 687,653 tons. According to statistics from M.A.L.R. (2022), the total amount of exportable fruits was 54,000 tons of fresh fruit and about 140,000 tons of frozen strawberries. Recently, the UN World Trade Center reported that Egypt is the world's largest exporter of frozen strawberries. Exports reached 140,000 tons, accounting for 20% of global exports and worth US$165 million or 14.3% of total global exports in 2020 (FAO, 2020).

Strawberries are important for human health because they are a rich source of vitamin C, in addition to potassium, iron and comprehensive antioxidants (Halvorsen *et*

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al., 2002). It also contains large amounts of fiber, secondary metabolites and sugar. The high content of these compounds has a positive effect on health as they can inhibit blood clotting and reduce cardiovascular diseases (Mohamed *et al*., 2021). However, the quality and quantity of these compounds are influenced by genetic, environmental and agricultural factors (Kallio *et al*., 2000).

Florida is an important strawberry variety that has been widely cultivated in Egypt in recent years. The fruit is a short-day variety and usually has a conical shape. The outside of the ripe fruit is dark red and shiny, while the inside is bright red. It has a firm, crunchy consistency and an excellent taste. Increasing yield while maintaining fruit quality is an important goal that can be achieved through foliar application of nutrients, which are commonly used in many crops to promote growth and fruit set.

This strawberry variety has high yields early in the season and good fruit size during the peak production period in Florida and southwest Spain. The taste is acceptable and good under ideal growing conditions. The Radiance fruit is firm yet juicy and features an attractive calyx. The fruits are shiny light to dark red, easy to harvest and have a smooth appearance.

Foliar application of micronutrients is clearly an ideal method to avoid problems with nutrient availability. Boron has effects on cell wall structure, cell elongation and root elongation. It is also thought to be a nutrient that increases carbohydrate translocation in the phloem, which can increase soluble solids content in fruits (Marschner, 2012). Boron applications have increased yield and fruit quality (Wojcik and Lewandowski, 2003).

In addition, boron is an important micronutrient essential for the stabilization of certain components such as cell wall structure and function, cell membrane activity, improved cell division, tissue differentiation, and increased net photosynthetic rates as leaf chlorophyll content increases (Rafeii and Pakkish, 2014). and Mohamed *et al*., 2018).

Salicylic acid (SA), a naturally occurring phytohormone, acts as an important signaling molecule and increases the resistance of treated plants to abiotic stresses (Khan *et al*. 2012). Salicylic acid also plays an important role in plant growth, ion absorption and nutrient transport in the plant body. The phenolic compound salicylic acid is found in many plants and is also involved in local and systemic resistance to fungal pathogens (Meena *et al*., 2001).

Exogenous application of salicylic acid improved the growth and productivity of the strawberry cultivar Fern, with one, two, three, or four foliar applications of 1.0 mM salicylic acid resulting in the highest values for leaf chlorophyll, leaf elements, initial yield, and total yield. (Karlidag *et al*., 2009 and Kazemi, 2013).

Chitosan is a linear polysaccharide with a random distribution of β-(1-4)-linked D-glucosamines (deacetylated units) and N-acetyl-D-glucosamines (acetylated units); it is a polysaccharide called 2-amino-2-deoxyβ-D-glucosamine; it is also known as chitosan, a highly aminated polysaccharide. Chitosan can be obtained from marine crustaceans such as shrimps, mussels and needlefish or from the exoskeletons of most

insects, called chitin, which can be converted into chitosan by isolation and amination of acetyl groups (Sugiyama *et al*., 2001).

Chitosan is a chemical biopolymer derived from crustaceans and is soluble in organic acids. Chitosan is considered environmentally friendly for use in agriculture because it breaks down easily in the environment and is non-toxic to humans. Chitosan and its derivatives have been reported to induce a natural defense response in plants and are used as natural compounds to combat pathogenic diseases before and after harvest. Antimicrobial activity of chitosan against various plant pathogens has been reported (Rahman *et al*., 2014).

The aim of this study is to investigate the effect of foliar application of boron, salicylic acid and chitosan on the growth and fruiting of Florida strawberry plants.

Materials and Methods

The experiment was conducted for two consecutive seasons in 20223 and 2024 at the farm of Agricultural Research Institute in Arab Al-Awamir, Abnub district Assiut governorate. Florida transplants were obtained as cold storage (frigo) plants from a local nursery.

The soil was sandy and prepared by plowing, sowing and fertilizing. A drip irrigation system was used in the experiment.

The area of each experimental plot was 12.80 m2 and included a bed 8.0 m long and 1.6 m wide. Each bed consisted of four rows and the plants were spaced 0.25 m apart rows and transplanted 0.15 m within a row. Transplanting took place on September 20 (60 days after sowing) when the plants reached 3-4 true leaves. The four treatments were administered in a completely randomized block design with four replicates, with each experimental plot consisting of five 2 m rows. All other cultural practices required for strawberry cultivation were carried out in accordance with the recommendations of the Egyptian Ministry of Agriculture.

The experimental treatments were control treatments (water spray), boron as boric acid (17% B) at 5 mg/L, salicylic acid at 5 mm/L, and chitosan at 5 mg/L.

For treatment with boric acid and salicylic acid, the powders were dissolved in hot water, allowed to cool, and then applied to the plant material.

A stock solution (2% w/v) of chitosan was prepared by dissolving chitosan in 0.5% (v/v) glacial acetic acid with constant stirring and the pH was adjusted to 5.6 with 1 N NaOH. The stock solution was sterilized at 121 °C for 20 minutes and then lower concentrations, i.e., h. (5 mg/L), prepared by appropriate dilution with distilled water (Du *et al*., 1997).

Three spray applications of each treatment were applied at one-monthly intervals. The first application was 6 weeks after transplantation. Triton B was added as a wetting agent in an amount of 0.05% to the entire spray solution before use. Foliar applications were carried out with a manual pump sprayer until dripping.

1. Characteristics of Vegetative growth:

Ten flowering plants were randomly selected from each plot; the average of ten plants was taken as one replicate. The following characteristics were recorded for each plant:

-Plant height (cm).

-Number of leaves per plant.

-Number of elongations per plant.

-Leaf area (cm^2)

-Total chlorophyll count (SAPD)

2. Yield components

Number of fruits per plant.

Total yield weight (g): Total yield per plant was calculated by measuring the weight of fruits harvested at full ripeness (full red color) during the growing season.

3. Physical characteristics

20 fruits from each replicate were randomly collected at harvest time and the following traits were measured

Average fruit weight (g): calculated by dividing the total harvest weight (g) by the number of fruits on the plant.

Fruit length (L) (cm) and Fruit diameter (D) (cm): They were estimated by using Vernier caliper

Fruit firmness (kg/cm^2): It was estimated by using penetrometer.

4. Chemical characteristics of fruits: The same samples used for physical characterization were used to measure the following attributes:

Total soluble solids % (TSS): Measured with a hand refractometer

Total sugars % and reducing sugars%: Determined according to the Lane and Eynon method described in (A.O.A.C (1990).

Total titratable acidity%: Determined by titration of pure fruit juice with 0.1 N NaOH with phenolphthalein as indicator (A.O.A.C, 1990). The acid content was calculated as g citric acid/100 ml of juice.

The content of vitamin C: Analysis was performed according to the standard method described in A.O.A.C (1990) and expressed as mg/100 g.

Statistical analysis

All data obtained were analyzed statistically. Analysis of variance (ANOVA) was performed according to the method of Snedecor and Cochran (1991).

Results

Plant growth parameters

The data in Tables (1) and (2) show the effect of boron, salicylic acid and chitosan on the plant growth parameters of Florida strawberry plants in the 2022 and 2023 seasons. It is clear from the data that similar trends were observed during the two seasons Staggering in studies.

The results showed that the application of boron, salicylic acid and chitosan significantly increased plant height, number of leaves/plants, number of extensions, leaf area and total chlorophyll compared to water spraying (control). In this regard, the application of boron, salicylic acid and chitosan resulted in the highest plant height (22.45, 21.8 and 22.9 cm, respectively) and number of leaves per plant (18.45, 18.7 and 21.15, respectively, averaged over two seasons). Plants sprayed with water had the lowest significant values, recording average values of 18.85 and 16.15 cm for the two seasons. No significant differences were observed when using boron and salicylic acid. It can be concluded that from an economic point of view the use of salicylic acid or chitosan was preferred.

Regarding leaf area and total chlorophyll; Boron, salicylic acid and chitosan had a positive influence on these growth parameters compared to the control. Boron and chitosan had the highest leaf area (216.75 and 226.1 cm^2) and total chlorophyll, followed by boron (51.95 and 53.5 SAPD averaged over two seasons). In contrast, the control had the lowest leaf area (194.9 cm^2) and total chlorophyll (45.35 SAPD). For the control, boron salicylate and chitosan, leaf areas of 194.9, 216.75, 213.35 and 226.1 cm^2 were recorded. The percentage increase in leaf area as a result of the treatments compared to the control was 10.54, 8.86 and 15.87%, respectively.

Table 1. Effect of boron, salicylic acid, and chitosan spraying on growth traits of Florida strawberry plants during 2022 and 2023 seasons.

Char.	Plant height (cm)			leaves number/plant			Number of elongations		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Control	18.70	19.00	18.85	15.30	17.00	16.15	3.70	3.30	3.5
Boron	22.30	22.60	22.45	17.50	19.40	18.45	4.10	4.80	4.45
Salicylic Acid	21.70	21.90	21.8	17.80	19.60	18.7	4.10	4.90	4.5
Chitosan	22.70	23.10	22.9	20.10	22.20	21.15	4.20	5.20	4.7
LSD 5%	**0.88**	**0.64**	**0.54**	**0.96**	**1.13**	**0.75**	**0.16**	**0.21**	**0.13**

Table 2. Effect of boron, salicylic acid, and chitosan spraying on leaf area and total chlorophyll of Florida strawberry plants during 2022 and 2023 seasons.

Char.	Leaf area (cm^2)			Total chlorophyll (SPAD)		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean
Control	201.3	188.5	194.9	46.5	44.2	45.35
Boron	225.1	208.4	216.75	51.8	49.6	50.7
Salicylic Acid	223.2	203.5	213.35	53.1	50.8	51.95
Chitosan	235.6	216.6	226.1	54.9	52.1	53.5
LSD 5%	**11.24**	**10.83**	**6.52**	**2.45**	**2.11**	**1.65**

Yield components

The results in Table (3) showed that the application of boron, salicylic acid and chitosan significantly increased the number of fruits per plant and yield per plant compared to water spraying (control). The highest yield component was obtained with the use of boron, which proved to be the best agent.

The recorded number of fruits per plant was (16.8, 21.15, 19.14 and 19.8 fruits respectively) and the yield per plant (average values for the two seasons studied were (605.3, 804.4, 705.6 and 730.8) due to spraying water (control), boron, salicylic acid and chitosan, respectively.

The yield per plant increased by the corresponding percentages compared to the control due to the treatments achieved (the average values for the two seasons studied were 39.70, 30.73 and 36.83%, respectively). No significant differences were found by spraying Chitosan and salicylic acid.

Table 3. Effect of boron, salicylic acid and chitosan spraying on yield components of Florida strawberry plants during 2022 and 2023 seasons.

Char.	Fruit number / plant			Yield weight / plant (g)		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean
Control	16.7	16.9	16.8	589.0	621.5	605.3
Boron	20.9	21.4	21.15	812.8	796.0	804.4
Salicylic Acid	18.98	19.3	19.14	753.8	657.3	705.6
Chitosan	19.7	19.9	19.8	765.7	695.8	730.8
LSD 5%	**1.05**	**0.98**	**0.78**	**28.25**	**22.31**	**18.29**

Fruit quality

A. Fruit physical characteristics

The data in Table (4) shows the effects of boron, salicylic acid and chitosan on the physical properties of Florida strawberry fruits in the 2022 and 2023 seasons. From the data it is clear that the results showed a similar trend during the two seasons studied.

The results showed that the physical properties of the fruits, i.e., Fruit weight, length, diameter and firmness were significantly improved by the application of boron, salicylic acid or chitosan compared to the water-sprayed fruits (control). The highest values were achieved when using chitosan. The recorded fruit weights were (29.8, 34.0, 33.1 and 34.7 g) and fruit lengths were (5.18, 5.51, 5.48 and 5.83 cm as average values for the two study seasons). Chitosan showed the highest fruit diameter (3.93 cm) on average over the two seasons, followed by boron (3.87 cm) and salicylic acid at 3.85 cm compared to the control (3.67). On the other hand, the control had the lowest fruit firmness (average 1.20 kg/cm^2 over the two seasons).

Regarding fruit firmness, boron, salicylic acid and chitosan all had a positive influence on fruit firmness compared to the control. Chitosan showed the highest fruit firmness (1.70 kg/cm^2), followed by boron (1.44 kg/cm^2) averaged over the two seasons. On the other hand, the control had the lowest fruit firmness (average 1.20 kg/cm^2 over the two seasons). Fruit firmness was 1.20, 1.44, 1.33 and 1.70 kg/cm^2 for control, boron, salicylic acid and chitosan, respectively. The percentage increase in fruit firmness was (20.0, 10.0 and 37.14%) for the treatments compared to the control. Statistically

significant differences resulted from the use of boron, or chitosan. Therefore, it was concluded that from a general economic point of view it is desirable to use boron or chitosan.

Table 4. Effect of boron, salicylic acid and chitosan spraying on fruit traits of Florida strawberry during 2022 and 2023 seasons

Char.	Fruit weight (g)			Fruit length (cm)			Fruit diameter (cm)			Fruit firmness (kg/ cm^2)		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Control	29.9	29.7	29.8	5.12	5.23	5.18	3.62	3.71	3.67	1.20	1.20	1.20
Boron	34.1	33.8	34.0	5.46	5.56	5.51	3.82	3.92	3.87	1.43	1.44	1.44
Salicylic Acid	33.2	32.9	33.1	5.43	5.53	5.48	3.80	3.89	3.85	1.32	1.33	1.33
Chitosan	34.8	34.5	34.7	5.58	6.08	5.83	3.88	3.97	3.93	1.69	1.71	1.70
LSD 5%	**0.84**	**0.91**	**0.63**	**0.19**	**0.16**	**0.13**	**0.12**	**0.08**	**0.06**	**0.08**	**0.06**	**0.05**

B. Fruit chemical characteristics

The results in Tables (5) and (6) show that the application of boron, salicylic acid and chitosan improves the chemical composition of fruits in terms of increasing T.S.S. significantly improved. %, sugar and vitamin C (V.C) content and decrease in acidity compared to the control treatment.

Table (5) shows that foliar application of chitosan and boron in this order gives better results in terms of TSS (7.21 and 6.82%), total sugars (5.50 and 5.34%) and reducing sugars (4.20 and 4.05%) delivered. In contrast, the control plants were lowest in this regard for the three traits measured (6.12, 4.67 and 3.55%, respectively).

The TSS was (6.12, 6.82, 6.62 and 7.21) and the total sugar content was (4.67, 5.34, 5.04 and 5.50% (average of two seasons)). The percentage increase in total sugar content was (12.48, 9.40 and 17.78%) as boron, salicylic acid and chitosan were compared with the control, respectively.

When sprayed with water (control), boron, salicylic acid and chitosan, V.C. The content was 208.30, 229.25, 223.80 and 233.20 mg/100 g (averaged over two seasons), respectively. The percentage increase in V.C. content (6.93, 7.38 and 12.02%) with the application of boron, salicylic acid and chitosan, respectively, compared to the control.

Table 5. Effect of boron, salicylic acid and chitosan spraying on TSS and sugar contents of Florida strawberry fruits during 2022 and 2023 seasons.

Char.	TSS %			Total sugar %			Reducing sugar %		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Control	6.02	6.22	6.12	4.71	4.62	4.67	3.6	3.5	3.55
Boron	6.71	6.92	6.82	5.55	5.13	5.34	4.2	3.9	4.05
Salicylic Acid	6.52	6.71	6.62	5.10	4.98	5.04	3.9	3.8	3.85
chitosan	7.10	7.32	7.21	5.55	5.44	5.50	4.2	4.2	4.20
LSD 5%	**0.32**	**0.29**	**0.18**	**0.19**	**0.16**	**0.11**	**0.12**	**0.11**	**0.07**

As for the percent acidity, all treatments reduced this parameter compared to the control, obtaining lower values for chitosan and boron (0.78% and 0.81%, respectively, averaged over the two seasons). On the other hand, the control treatment showed the highest value in this regard (0.91% on average over two seasons).

In general, the chemical composition of fruits had the lowest percentage except acidity in the control. However, fruits sprayed with chitosan or boron had the highest values in this regard.

Table 6. Effect of boron, salicylic acid and chitosan spraying on acidity and V.C of Florida strawberry fruits during 2022 and 2023 seasons.

Char.	Acidity %			V.C (mg / 100g)		
Seasons / Treat.	2022	2023	Mean	2022	2023	Mean
Control	0.92	0.89	0.91	201.4	215.2	208.30
Boron	0.82	0.80	0.81	221.8	236.7	229.25
Salicylic Acid	0.89	0.87	0.88	216.3	231.3	223.80
Chitosan	0.79	0.77	0.78	226.5	239.9	233.20
LSD 5%	**0.023**	**0.031**	**0.016**	**6.34**	**7.11**	**4.10**

Discussion

From this study, foliar application of boron significantly increased growth characteristics. This may be due to the physiological role of boron and its involvement in protein metabolism, pectin synthesis, maintenance of proper water balance in the plant, adenosine triphosphate (ATP) resynthesis and sugar translocation during flowering and fruiting (Meena *et.al*., 2001).

The application of boron was very beneficial in the photosynthesis process as it promoted carbohydrate accumulation and ultimately improved fruit quality (Singh *et al*., 2012 and Mohamed *et al*., 2021).

Salicylic acid is a phenolic endogenous growth regulator, normally produced in very small amounts in plants, that regulates a range of physiological and biochemical processes in plants, including seed germination, plant growth, flowering induction, nutrient uptake and transport, water-plant relationships, membrane permeability, stomatal conductance, photosynthesis and enzyme activity (Arfan *et al*. (2007); Hayat *et al*. (2010); Youssef *et al*. (2017) and Mohamed *et al*. (2018)).

Chitosan is widely used in agriculture, mainly to promote plant defense (Naeem *et al*., 2010). Chitosan also promotes plant growth, development and productivity and improves the yield components of various crops (El-Tantawy (2009); El-Tanahy *et al*. (2012) and El-Miniawy *et al*. (2013)).

In the current study, chitosan, boron or salicylic acid played an important role in regulating a number of vital processes, including plant growth, and increased vegetative growth traits. Then these were attributed to an increase in yield and an improvement in fruit quality.

The results of this study are consistent with those of other researchers such as Martin-Mex *et al*., 2005; Arfan *et al*., 2007; Hayat *et al*., 2010; Singh *et al*., 2012; El-Miniawy *et al*., 2013; Youssef *et al*., 2017; Mohamed et al., 2018, Mohamed *et al*., 2021 and Masoud *et al*., 2024.

Conclusion

The results of this study showed the effects of boron, salicylic acid and chitosan on plant growth, yield and fruit quality. It is believed that foliar application of chitosan or boron could significantly improve plant growth, yield, and fruit quality of Florida strawberries.

References

A.O.A.C. (1990). Association of Official Agriculture Chemists, 2 vols. 15th Ed. Washington, D.C. U.S.A.

Arfan, M., Athar, H. R., and Ashraf, M. (2007). Does exogenous application of salicylic acid through the rooting medium modulate growth and photosynthetic capacity in two differently adapted spring wheat cultivars under salt stress? J. Plan. Physiol. 6(4): 685-694.

Du, J., Gemma, H., and Wahori, S. (1997). Effects of chitosan coating on the storage of Peach Japanese Pear and Kiwi fruit. J. Jpn. Soc. Hortic. Sci. 66(1):15- 22.

El-Miniawy, S. M., Ragab, M. E., Youssef, S. M., and Metwally, A. A. (2013). Response of strawberry plants to foliar spraying of chitosan. Research J. of Agric. and Bio. Sci. 9(6): 366-372.

El-Tanahy, A. M. M., Mahmoud, A. R., Abdel-Mouty, M. M., and Ali, A. H. (2012). Effect of chitosan doses and nitrogen sources on the growth, yield and seed quality of cowpea. Aust. J. Basic and Appl. Sci. 6(4): 115-121.

El-Tantawy, E. M. (2009). Behavior of tomato plants as affected by spraying with chitosan and aminofort as natural stimulator substances under application of soil organic amendments. Pak. J. Biol. Sci. 12: 1164-1173.

FAO (2020). Food and Agriculture organizations of the United Nations. (FAO): Roma, Italy (54): 177.

Halvorsen, B. L., Holte, K., Myhestad, M. C. W., Bayikmo, J., Hvatium, E. Remberg, S. F., Wold, A. B., Haffner, K., Buugered, H., Andersen, L. F., Moskauy, J. G., Jacobs, D. R., and Biomhoff, R. (2002). A systematic screening of total antioxidants in dietary plants. J. Nutr. 132: 461-471.

Hayat, S., Hasan, S.A., Hayat, Q., Irfan, M., and Ahmad, A. (2010). Effect of salicylic acid on net photosynthetic rate, chlorophyll fluorescence, and antioxidant enzymes in Vigna radiata plants exposed to temperature and salinity stresses. Plant Stress. 4: 62-71.

Kallio, H. M., Hakela, A., Pelkkikangas, M., and Lapveleianen, A. (2000). Sugars and acids of strawberry varieties. Europ. Food Res. Tech. 212: 81-85.

Karlidag, H., Yildirim, E., and Turan, M. (2009). Exogenous application of salicylic acid affects quality and yield of strawberry grown under antifrost heated greenhouse condition. J. Plant Nutr. Soil Sci. 172: 270-276.

Kazemi, M. (2013). Foliar application of salicylic acid and calcium on yield component and chemical properties strawberry. Bull. Env. Pharmacol. Life Sci. 2(11):19.23

Khan, N. A., Nazar, R., Iqbal, N., and Anjum, N. A. (2012). Phytohormones and Abiotic Stress Tolerance in Plants. Springer, Berlin, Heidelberg.

M.A.L.R. (2022). Ministry of Agriculture and Land Reclamation Publishes. Economic Affairs Sector.

Marschner, H. (2012). Mineral Nutrition of Higher Plants, 3rd Ed; Academic press London, UK

Martin-Mex R., Villanueva-Couoh, E., Herrera-Campos, T., and Larque-Saaverda, A. (2005). Positive effect of salicylates on the flowering of cucumber. Aus. J. Bas. Appl. Sci. 2(11):879-883.

Masoud A. A. B., Haridy A. G. H., ElAkad M. M., Mahmoud Y. A., and Sleem A. F. M. (2024): Effect of Foliar Application of Boron, Salicylic Acid, and Chitosan on Growth and Fruiting of "Festival" Strawberry. *Assiut* Journal of Agricultural Sciences 55 (4): 50-163.

Meena, B., Marimuthu, T., and Velazhan, R. (2001). Salicylic acid induces systemic resistant in groundnut against late leaf spot caused by *Cercosporidium personatum.* J. Mycol. Plant Pathol. 31:139-145.

Mohamed, H. M, Petropoulos, S. A., and Ali, Maha M. (2021). The application of nitrogen fertilization and foliar spraying with calcium and boron affects growth aspects, chemical composition, productivity and fruit quality of strawberry plants. Horticulture. 7(257): 1-20.

Mohamed, R. A., Al-Kharpotly, A., and Abd-Elkader, D. Y. (2018). Salicylic acid effects on growth, yield and fruit quality of strawberry cultivar. J. of Medicinally active plants. 2(6):1-11.

Naeem, M, Hassan, A., Ahmed, M., and EL-Sayed, A. (2010). Radiation-induced degradation of chitosan for possible use as a growth promoter in agricultural purposes. Carbohydrates Polymers. 79: 555-562.

Rafeii, S., and Pakkish, Z. (2014). Improvement of vegetative and reproductive growth of 'Camarosa' strawberry: Role of humic acid, Zn and B. Agric. Conspec. Sci. 79: 239-244.

Rahman, M. H., Shovan, L.R., Hjeljord, L. G., Aam, B. B., and Eijsink, V. G. (2014). Inhibition of fungal plant pathogens by synergistic action of chito-oligosaccharides and commercially available fungicides. PLOS One. 9(4): e93192.

Singh, P. C., Gangwar, R. S., and Singh, V. K. (2012). Response of Boron, Zinc and Copper on quality of Anola fruits cv Banarasi. Hort. Flora Research Spectrum. (1): 89-90.

Snedecor, G. W., and Cochran, W. G. (1991). Statistical Methods. 8th edition. Iowa State University Press, Ames, Iowa. 593 p.

Sugiyama, H., Hisamichi, K., Sakai, K., Usui, T. Ishiyama, J. I., Kudo, H., Ito, H. and Senda, Y. (2001). The conformational study of chitin and chitosan oligomers in solution. Bioorganic and Medicinal Chemistry, 9: 211-216.

Wojcik, P., and Lewandowski, M. (2003). Effect of calcium and boron sprays on yield and quality of "Elsanta" strawberry. J. plant Nutr. 26: 671-682.

Youssef, S. M. S, Abu El-Azm, Nashwa A.I., and Abd Elhady, S.A. (2017). Frequent foliar sprayings of salicylic acid with elevated concentrations enhance growth, yield and fruit quality of strawberry (Fragaria x ananassa Duch. cv. Florida) plants. Egypt. J. Hort. (44): 61-74.

تأثير الرش ببعض المركبات الطبيعية والكيميائية على نمو وإثمار الفراولة صنف فلوريدا

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الملخص

تم دراسة تأثير الرش الورقي للبورون وحمض الساليسيليك والشيتوزان على النمو ومكونات المحصول وخصائص الثمار نباتات الفراولة (فلوريدا) خلال موسمي 2022، 2023.

حيث تم الرش الورقي بالبورون بتركيز 5ملجم / لتر وحمض الساليسيليك بتركيز5مليمول / لتر والشيتوزان. بتركيز5 ملجم / لتر وقد تم تصميم التجربة بنظام القطاعات كامله العشوائية.

وقد أظهرت النتائج أن رش البورون وحمض الساليسيليك والشيتوزان أدى إلى زيادة معنوية في طول النبات وعدد الأوراق / النباتات وعدد االمدادات ومساحة الورقة والكلوروفيل الكلي مقارنة بالكنترول المعامل بالماء.

كما أظهرت النتائج أن رش البورون وحمض الساليسيليك والشيتوزان أدى إلى زيادة معنوية في عدد الثمار لكل نبات وكمية المحصول لكل نبات مقارنة بالكنترول.

كما أظهرت النتائج أن الخصائص الطبيعية للثمار، من وزن الثمار وارتفاع الثمار وقطر الثمار وصلابة الثمار، زادت معنويا عند رش البورون أو حمض الساليسيليك أو الشيتوزان مقارنة بالكنترول.

كما أظهرت النتائج أن إضافة البورون وحمض الساليسيليك والشيتوزان أدى إلى تحسين التركيب الكيميائي للثمار بشكل ملحوظ من حيث زيادة نسبة المواد الصلبة الذائبة الكلية ومحتوى السكر وفيتامين ج وخفض الحموضة مقارنة بمعاملة الكنترول .

ومن ناحية أخرى أظهرت الثمار المرشوشة بالشيتوزان أو المعاملة بالبورون أعلى القيم في هذا الصدد.

وعليه يمكن التوصية بأهمية الرش الورقي بالشيتوزان أو البورون وذلك لتحسين النمو الخضري للنباتات مع زيادة الإنتاجية وجودة الثمار.

الكلمات المفتاحية: *البورون، الشيتوزان، الرش الورقي، حمض الساليسيليك، فراولة فلوريدا.*