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Evaluation of the efficiency of foliar spraying with salicylic acid and licorice extracts on the production of the peach tree and the quality of its fruits

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Abstract:

The research was conducted in Rankous areaat Damascus countryside during 2020 in order to study the effect of foliar application of salicylic acid and licorice extract on production and fruit quality of peach. Different concentrations of SA (control, 50 and 100 ppm) and licorice extract (control and 3 g/L)were sprayed on trees at three stages: buds swell, fruit set and one month before harvesting.

Results showed that SA application increased significantly peach production by 12.5 and 63.5% at 50 and 100 ppm, respectively as compared to control treatment where production was 46.80 kg/tree. Moreover, fruit firmness was enhanced in response to SA application which was 5.34 and 5.86 kg/cm^2 at 50 and 100 ppm concentration, respectively while the value was 5.03 kg/cm^2 in control. However, the highest vitamin C content was recorded by SA treatment at 100 ppm concentration (36.55 mg/100 g) which exceeded significantly the control treatment (25.66 mg/100g).

On the other hand, foliar application of licorice extract improved all studied parameters.

Fruitset percentage increased significantly from 37.45% in control treatment to54.16% in licorice treatment at 3g/L. Additionally, spraying tress with licorice extract increased total soluble solids percentage of fruits with a value of 11.36% which exceeded significantly the control treatment (8.47%).

Key Words: Prunus Persica, Organic Acids, Natural Extracts, Fruit Quality.

تقييم كفاءة الرش الورقي بحمض الساليسيليك ومستخلص عرق السوس في إنتاج شجرة الدراق وجودة ثمارها

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الملخص:

تم تنفيذ البحث في ناحية رنكوس في محافظة دمشق خلال العام 2020 بهدف دراسة تأثير الرش بحمض السالسيليك ومستخلص العرقسوس في إنتاج شجرة الدراق ونوعية الثمار. تم تطبيق الرش الورقي بتراكيز مختلفة من حمض السالسيليك (شاهد، 50، 100ppm)، أطوار: انتفاخ البراعم، عقد الثمار، شهر قبل الحصاد.

أظهرت النتائج أن الرش الورقي بحمض الساليسيليك قد زاد الإنتاج معنوياً بنسبة 12.5 و 63.5% مقارنة مع معاملة الشاهد حيث كان الإنتاج 46.80 كغ/شجرة. علاوة على ذلك، فقد تحسنت صلابة الثمار بالاستجابة للرش ب SA والتي بلغت 5.34 و 5.86 كغ/سم^2، على التوالي في التراكيز 50 و100 ppm مقارنة ب 5.03 كغ/سم^2 في معاملة الشاهد. كذلك تفوقت معاملة الرش بحمض السالسيليك بتركيز 100ppm معنوياً على معاملة الشاهد فيما يتعلق بمحتوى الثمار من فيتامين C والتي بلغت 36.55 و25.66مغ/100غ، على التوالي.

بالمقابل فقد أدت معاملة الرش بمستخلص العرقسوس إلى تحسين المؤشرات المدروسة. حيث ازدادت نسبة العقد من 37.45% في معاملة الشاهد بدون رش إلى 54.16% في معاملة الرش بمستخلص العرقسوس بتركيز 3 غ/ل. كذلك تفوقت هذه المعاملة على الشاهد فيما يتعلق بنسبة المواد الصلبة الذائبة في الثمار والتي بلغت 11.36% عند الرش بمستخلص العرقسوس مقارنة ب 8.47% في الشاهد.

الكلمات المفتاحية: Prunus persica، أحماض عضوية، مستخلصات طبيعية، جودة الثمار.

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Introduction:

The peach, PrunusPersica, which belongs to the Rosaceae family, is a fruit of temperate regions. It is believed that its original homeland is China and still grows there in a wild condition until now, as one of the most important peach growing areas in the world is Italy, Spain, America and West East Asia (Backman et al., 2006) Europe is the most producing region in the world in peach production, with an estimated production rate of about 49%, followed by the United States and then Asia, which comes after apples in second place in terms of production (patrolresaearches institute, 2003)

The peach occupies the first place globally among the stone fruit trees in terms of importance due to the nature of its heavy load in addition to the high nutritional value of its fruits. It contains sugars, organic acids and prctin substances in addition to containing a good amount of vitamins (A, B.C) and mineral elements such as phosphorous potassium and calcium (Bal, 2005).

For the purpose of improving and continuing the growth of plants, researchers have tended to find modern technical methods and methods for the purpose of adopting them in providing plants with the necessary nutrientsThis is done by reducing or limiting the obstacles faced by the nutrients in the soil, which reduce its readiness for plants. The world is now moving away from the use of chemicals because of their negative effects on the environment and plants, and resorting to natural plant extracts, which are usually non-polluting to the environment and somewhat low in costs (Hammadi and Abbas, 2012).

Therefore, he used several alternatives for this purpose, including spraying plants with natural plant extracts, including licorice root extract, as the licorice plant is one of the plants of the legume family. Its extract is used in many applied studies because it is a natural plant extract as an alternative to manufactured growth regulators and contributes to improving plant growth and productivity because it contains a substance Glycerin, which is about 50 times sweeter than cane sugar (Anita, 2005).

Where the results of the chemical analysis showed that it contains carbohydrates, fibers and protein by 42.59, 13.08, 4% in addition to moisture, fats and ash, and it also contains major mineral elements represented by potassium, magnesium, calcium and nitrogen (Ayoub, 2018).

The importance of the licorice plant is also due to the fact that it contains many chemical compounds such as glycerin and its acid, as they have an activity similar to that of steroid hormones, as it is one of the plant hormones that leads to an increase in the formation of proteins, thus increasing growth rates (Al-Mohammadi and Fadam, 2010)

Salicylic acid, which is a phenolic compound, is a plant hormone found in plants that regulates many physiological processes and has a role in plant growth and development, photosynthesis, regulation of ion uptake, hormonal balance and transport, and is a defense against pathogens and plays a role in stimulating the production of proteins (Hayat and Ahmad, 2007)

Salicylic acid (hydroxybenzoic acid) is a naturally occurring phenolic product produced by some plants. This acid is abundantly present in the bark and leaves, and it is a crystalline powder that melts at 157-159 °C. It is moderately soluble in water but highly soluble in organic solvents (Hamsas, 2013).

In a study done by Hussein (2019) where salicylic acid was sprayed on the apricot plant with three treatments (0, 100, 200 mg/L), the treatment 100 mg/L outperformed the rest of the treatments, and the best results were obtained for leaf area and leaf content of chlorophyll, as well as the increase in the number of fruits , in the weight of the fruit and thus productivity.

And in a study on the pepper plant using licorice, it led to an increase in the weight of the fruits and their content of vitamin C.

It was also elucidate by Hanshal and Sadiq (2011) when using licorice extract as a spray at three rates (0, 400, 800 mg/L), which gave plants with a large leafy surface and high yield of fruits, thickness, peel and great hardness.

In his research Jumaa and Al-Dulaimi (2012) where three treatments of licorice extract were used as spraying on grapes (0, 2, 4 g/L) this led to an increase in productivity, sugars, cluster weight and grain size, and in return the acidity decreased.

Also, when spraying licorice extract on carnation flowers at concentrations (0, 10,20 mg/L) led to an increase in the rate of flower knots and early flowering and an increase in their number (Fadel et al., 2015).
On the fenugreek plant (Al-Rubaie, 2016) it was indicate that by using licorice extract at a rate of (0, 2, 4 g / liter), which gave plants with a high content of chlorophyll, large weight, early flowering and containing a large number of flowers.
It was clear up Al-Qaisi et al., (2014) when two concentrations of 50, 100% of licorice extract were used on sunflower plant, which led to an increase in plant height, number of leaves, large leaf surface and high dry weight.
When spraying licorice extract on strawberry at concentrations (0, 2.4 mg/L), the results showed a significant increase in the number of flowers, the number of fruits, fruit weight, productivity and TSS percentage (Qanbar et al., 2019).
The importance and objectives of the research:
In some areas of its cultivation in Syria, the peach tree suffers from a decrease in productivity and poor quality of fruits, which can be due to many reasons, most of which are low soil fertility, unbalanced nutrition, and the presence of some problems in the soil that hinder the absorption of elements. Therefore, the aim of the research is to study the efficiency of the use of materials Organic foliar nutrition in production standards and some fruit quality characteristics of peach tree.

The material and methods:

1-Plant material: The peach tree, dexyredvariety, was used in the study,the age of trees was 12, which is a deciduous tree with oblong lance-shaped leaves, serrated, and has a distinctive aroma. The flower buds are simple, and when they open, they give a single flower of pink color, and the fruits are a stalk and wild in texture.
2- The place of implementation of the research: The research was conducted in Rankousarea at Damascus countryside during 2020, the soil was light loamy, well aerated and drained, and the rate of rain varies between 350-650mm.
3-transactions:
The search included two treatments.
One is salisylic acid at three concentrations (0-50-100 ppm)
The second treatment is licorice extract at two concentrations (0-3 g/l)
Each treatment was repeated 3 times and each replicate contained 3 trees
The total amont of plant is salicylic acid 2 x licorice 3 x bis3 x 3 trees = 54 plants.
4- Spraying times:
The first spray when the buds swell 10/3/2020, the second when the fruit set is completed 11/4/2020, the third spray (a month before the harvest) 9/5/2020.

Parameters studied:

1-5 Fruitest percentage (%):
The knot ratio was calculated by counting the fruits number of each plant on the three studied replicates every two days once to find out the number of new fruits numberand their proportions to the number of flowers (Mami et al., 2008)
2-5- Fruit weight (g):
The weight of the fruits was calculated by taking the fruits of each fruits and weighing the fruits of each fruit separately in each of the three studied replicates using a sensitive electronic balance, and it was calculated on the basis of (g/fruit) (Zekki and Gosselin, 1996).
3-5 Plant production (kg/tree):
The weight of the fruits was calculated by taking the fruits of each plant and weighing the fruits of each fruit separately in each of the three studied replicates using a sensitive electronic balance, and the entire weights produced by each plant were collected and calculated on the basis of (kg/tree) (Alan and Padem, 1994).

4-5 Determination of the hardness of peach fruits (kg/cm2):
It was measured by a penetrometer measuring 0.5 mm in diameter after removing the outer peel of the fruit (Hanshal and sadiq, 2011).
5-5 Total dissolved solids TSS (%):
The fruits of two plants were taken from each replicate separately and after squeezing these fruits, 1 ml of juice was taken and placed on the designated eye within the device after calibrating it with distilled water, then the reading was taken based on the percentage by refractometer (TSS%) (Bisignano et al, 2002)
6-5- Titratable Acidity TA (%):
5 ml of filtrate of fruit juice was taken for each refiner separately and diluted to 100 ml using distilled water and then titrated with sodium water solution to pH 8.1, and the titrated pH was calculated by the following equation:
TA%= (NaOH consumed *0.067*100)/ volume of juice taken for calibration (Alan and Padem, 1994).
7-5 Vitamin C content of fruits (mg/100g fresh weight):
It was estimated titrated by the dye 2,6-dichlorophenol indophenol (A.O.A.C, 2000).
Experimental Design and Statistical Analysis:
The experiment was designed in a randomized complete block fashion. After obtaining the data, they were entered into the Excel program, and then analyzed statistically using the Xl-State program, where the averages of the coefficients were compared with the Fisher Test) at a variance level of 5%.

The Results and discussion:

1- Effect of licorice and salicylic acid on thefruitset percentage (%):
Table (1) shows the changes in the percentage fruits numberwith the change in the concentration of licorice extract and salicylic acid in the peach plant. Where it is noted that there are significant differences for licorice and salicylic, and the interaction.
The results of the statistical analysis show that the treatment of 100 ppm was superior to all treatments, followed by a significant difference of 50 ppm compared to the control with regard to the concentration of salicylic acid. As for licorice, treatment of 3 g/l was significantly superior to treatment without spraying.
As for the interaction of the treatments, the highest significant value was recorded when the treatment was 3 g/l licorice X 100 ppm salicylic acid, which reached (68.00%), and the lowest significant value was observed when the control treatment salicylic acid X without licorice spray was (31.00%).

Table (1): Effect of licorice and salicylic acid on the fruitset percentage (%):

Licorice Salicylic	Control	3g/l	Average
Control	31.00^{F}	40.50^{D}	35.75^{b}
50 ppm	35.20^{E}	54.00^{B}	43.10^{ab}
100 ppm	44.00^{C}	68.00^{A}	56.00^{a}
Average	37.45^{b}	54.16^{a}	
$LSD_{5\%}$	Licorice=9.87,salicylic=13.45,Interaction=0.20		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.
The reason is that licorice contains potassium, which has a key role in increasing the growth of the root group and reducing water loss. This element also plays a key role in stimulating flowering through the

transfer of nutrients manufactured in the photosynthesis process to the flowers, which leads to an increase in the rate of flower knots (Khayyat et al., 2007)
Salicylic acid also has a role in increasing the auxin, which plays an important role in increasing the photosynthesis process and thus increasing the nutrients in the plant, which leads to early flowering and an increase in the rate of knots (Al-Rubaie et al., 2012).

2- Effect of licorice and salicylic acid on the weight of peach fruits (g):
The results of the statistical analysis appear in Table (2) for the peach fruit weight index, the 100 ppm treatment was superior to all treatments (108.10 g), followed by a significant difference of 50 ppm (87.30 g) compared to the control 71.50 g) with regard to the concentration of salicylic acid. As for the licorice extract, the treatment of 3 g/l was significantly superior to that of the control.
The highest significant value of the interaction was recorded when the treatment was 3 g/l licorice X 100 ppm salicylic acid, which reached (131.70 g), and the lowest significant value was observed when the control treatment salicylic X without licorice spray was (62.00 g).

Table (2): Effect of licorice and salicylic acid on peach fruit weight (g):

Licorice Salicylic	**Control**	**3g/l**	**Average**
Control	62.00^{F}	81.00^{D}	71.50^{b}
50 ppm	70.00^{E}	104.60^{B}	87.30^{ab}
100 ppm	84.50^{C}	131.70^{A}	108.10^{a}
Average	73.43^{b}	105.76^{a}	
$LSD_{5\%}$	Licorice=18.37Salicylic=13.90,interaction=1.21		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.
As for the increase in the weight of the fruits due to the catalytic role of the components of licorice in increasing vegetative growth and then increasing the manufactured materials and moving them from the front of the factory to the storage sites in the fruits (Ghuloum et al., 2012).
Salicylic acid also plays as a growth regulator, as it participates in regulating the physiological process, increasing the rate of photosynthesis, and controlling the absorption of ions like calicum, potassium and iron, thus increasing the weight of fruits (Bhupinder, 2012).

3- Effect of licorice and salicylic acid on the yield of peach tree (kg/tree):
Table (3) shows the improvement of the peach tree productivity index, where the percentage of increase reached (12.5, 63.5%) for the treatments (control, 100 ppm), respectively, compared to the 50 ppm (46.80 kg/tree). Through the results of the statistical analysis, significant differences were noted for the concentration of licorice and salicylic acid, and the interaction.
The 100 ppm treatment recorded a significant superiority over all treatments, the 50 ppm treatment was superior to the control. As for licorice, the change in licorice concentration did not show any significant effect on the productivity of the peach tree. The highest significant value of the interaction was observed when the treatment was 3 g/l licorice X 100 ppm salicylic and reached (90.00 kg/tree) with regard to the

interaction, and the lowest significant value was observed when the control treatment salicylic X without licorice spray was recorded (40.00 g/plant).

Table (3): Effect of licorice extract and salicylic acid on the yield of peach tree (kg/tree):

Licorice Salicylic	Control	3g/l	Average
Control	40.00^{F}	61.00^{C}	50.50^{ab}
50 ppm	46.60^{E}	47.00^{D}	46.80^{b}
100 ppm	63.10^{B}	90.00^{A}	76.55^{a}
Average	51.13^{a}	66.00^{a}	
$LSD_{5\%}$	Licorice=16.09Salicylic=13.94,interaction=0.20		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.

The reason is due to the effect of licorice on the enzymes for converting complex compounds into simple ones that the plant benefits from in building protein materials, in addition to the sugars and salts it contains that increase the osmotic pressure and thus increase the rate of absorption of water and nutrients, which is reflected on the total yield and thus productivity Also, spraying with salicylic acid enhances the synthesis of natural hormones and plays a positive role in the growth and nutrition of trees as a result of the increase in carbohydrates, oils and amino acids, and thus the increase in productivity (Pons, 2003).

4- Effect of licorice and salicylic acid on the hardness of peach fruits (kg/cm2):

Table (4) shows the changes of fruit firmness with the change in the concentration of licorice extract and salicylic acid in the peach plant. Where it is noted that there are significant differences for licorice and salicylic, and the interaction.

The results of the statistical analysis show that the treatment of 100 ppm was superior to all treatments, followed by a significant difference of 50 ppm compared to the control with regard to the concentration of salicylic acid. As for licorice, treatment of 3 g/l was significantly superior to treatment without spraying.

As for the interaction of the treatments, the highest significant value was recorded when the treatment was 3 g/l licorice X 100 ppm salicylic, which reached (6.32 kg/cm2), and the lowest significant value was observed when the control treatment salicylic X without licorice spray was (4.67 kg/cm2).

Table (4): Effect of licorice and salicylic acid on the hardness of peach fruits (kg/cm^2):

Licorice Salicylic	Control	3g/l	Average
Control	4.67^{F}	5.28^{D}	5.03^{b}
50 ppm	4.84^{E}	5.84^{B}	5.34^{ab}
100 ppm	5.41^{C}	6.32^{A}	5.86^{a}
Average	5.01^{b}	5.81^{a}	
$LSD_{5\%}$	Licorice=0.41Salicylic=0.61,interaction=0.02,		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.

The increase in hardness is attributed to the effect of licorice because it contains some mineral elements that activate enzymes that contribute to activating some processes of lignin and pectin formation, which mainly contribute to raising the rigidity of cell walls, and this corresponds to (Hanshal and sadiq, 2011). Salicylic acid also plays a key role in increasing the process of photosynthesis, and this is positively reflected on the growth rate, the quantity of production and the increase in the number and hardness of fruits (Javaheri et al., 2012).

5- Effect of licorice and salicylic acid on the TSS ratio of peach fruits (%):

The results of the statistical analysis appear in Table (5) for the percentage of dissolved solids index, the 100 ppm treatment exceeded over all treatments (11.60%), followed by a significant difference of 50 ppm (9.7%) compared to the control (8.46)%) with regard to the concentration of salicylic acid. As for the licorice extract, the treatment of 3 g/l was significantly superior to that of the control. The highest significant value of the interaction was recorded when the treatment was 3 g/l licorice X 100 ppm salicylic acid, which reached (13.20%), and the lowest significant value was observed when the control treatment salicylic acid X without licorice spray was (7.20%).

Table (5): Effect of licorice and salicylic acid on the TSS ratio of peach fruits (%):

Licorice Salicylic	**Control**	**3g/l**	**Average**
Control	7.20^{D}	9.30^{C}	8.46^{b}
50 ppm	7.80^{D}	11.60^{B}	9.70^{ab}
100 ppm	10^{C}	13.20^{A}	11.60^{a}
Average	8.47^{b}	11.36^{a}	
$LSD_{5\%}$	Licorice=1.62Salicylic=2.31,interaction=0.87		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.

The reason is that licorice contains potassium, which has a key role in increasing the growth of the root group, reducing water loss, its effect on cell division, its entry into the starch decomposition process, and increasing the effectiveness of the Starch synthetase enzyme, in addition to the positive correlation between potassium and the photosynthesis process, which leads to an increase in the weight and content of the fruits.of total dissolved solids TSS (Al Atrushy and Abdul qader, 2016).

6- Effect of licorice and salicylic acid on the content of vitamin C in peach fruits (mg/100g):

Table (6) shows the improvement in the vitamin C index of the peach fruit, as the percentage increase was (16.3, 42.4%) for the treatments (50, 100 ppm), respectively, compared to the control (25.66 mg/100 g). Through the results of the statistical analysis, significant differences were noted for the concentration of licorice and salicylic acid, and the interaction. The 100 ppm treatment recorded a significant superiority over all treatments, and in turn, the 50 ppm treatment was superior to the control. As for licorice, the treatment of 3 g/l was significantly superior to that of the control. The highest significant value of the interaction was observed when the treatment was 3 g/l licorice X 100 ppm salicylic, which reached (43.50 mg/100g) with

regard to the interaction, and the lowest significant value was observed when the treatment control salicylic X without licorice spray was (22.30 mg/100g).

Table (6): Effect of licorice and salicylic acid on the content of vitamin C in peach fruits (mg/100g):

Licorice Salicylic	**Control**	**3g/l**	**Average**
Control	22.30^{F}	27.90^{D}	25.66^{b}
50 ppm	24.20^{E}	35.50^{B}	29.85^{ab}
100 ppm	29.60^{C}	43.50^{A}	36.55^{a}
Average	25.75^{b}	35.63^{a}	
$LSD_{5\%}$	Licorice=5.61Salicylic=7.9,interaction=0.20		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.

The increase in the content of vitamin C in fruits is due to the fact that this vitamin is an enzymatic antioxidant whose concentration in fruits increases when spraying with licorice extract due to licorice containing potassium, which stimulates oxidative enzymes and thus increases vitamin C in fruits (Hussein et al., 2019). Also, during the breathing process and when spraying with salicylic acid, the activity of the fruit decreases, which leads to an increase in its content of soluble solids and vitamin C due to the acid breaking down of sugars and a decrease in the total level of phenol (Ghasemnezhad et al., 2010).

7- Effect of licorice and salicylic acid on the titratable acidity percentage (%):

Table (7) shows the changes in acidity with the change in the concentration of licorice extract and salicylic acid in the peach plant. Where it is noted that there are significant differences for licorice and salicylic, and the interaction. The results of the statistical analysis show that the control treatment was superior to all treatments, followed by a significant difference of 50 ppm compared to the 100 ppm treatment with regard to the concentration of salicylic acid. As for licorice, the treatment without spraying was significantly superior to that of 3 g/l. As for the interaction of the treatments, the highest significant value was observed in the control treatment, salicylic X without licorice spray, and it scored (0.44%), and the lowest significant value when the treatment was 3 g/l licorice X 100 ppm salicylic, which reached (0.11%).

Table (7): Effect of licorice and salicylic acid on the acidity of peach fruits (%):

Licorice Salicylic	Control	3g/l	Average
Control	0.44^{A}	0.32^{C}	0.36^{a}
50 ppm	0.39^{B}	0.21^{D}	0.30^{ab}
100 ppm	0.31^{C}	0.11^{E}	0.21^{b}
Average	0.37^{a}	0.21^{b}	
$LSD_{5\%}$	Licorice=0.08Salicylic=0.12,interaction=0.02		

The difference of lowercase letters indicates the presence of significant differences between the treatments, while the difference of uppercase letters indicates that there are significant differences for the interaction at the 95% confidence level.

The low acidity produced when spraying licorice extract may be attributed to the positive effect on improving growth, increasing the efficiency of the vegetative system, manufacturing carbohydrates, and increasing the percentage of sugars and their transfer to fruits, which led to early ripening and thus reduced acidity, and this is consistent with (Jumaa and Al-Dulaimi, 2012)Also, when spraying with salicylic acid, this leads to an increase in growth and nutrition of trees as a result of an increase in carbohydrates and oils, an increase in productivity and a decrease in acidity (Pons, 2003).

Conclusions:

1- Salicylic acid increased in the productivity of the peach trees and improved the quality of its fruits the best concentration was 100 ppm

2- Foliar spraying with licorice extract improves the production of the peach tree for its important role in the growth process and works to raise the quality standards of the fruits.

Suggestions:

1- Using a concentration of 100 ppm of salicylic acid as a foliar spray on peach trees to improve production.

2- A study of several concentrations of licorice extract and its effect on the growth and production of the peach tree.

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