

Effect of Ascorbic and Salicylic Acids Foliar Spraying on Growth, Fruiting and Fruit Quality of Pecan Trees

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PECAN TREES cv. Cherokee were foliage sprayed with 150 ppm or 300 ppm ascorbic acid; 150 ppm salicylic acid and the combination of 150 ppm ascorbic and salicylic acids at the start of female inflorescences emerging and repeated after one month. All treatments increased vegetative growth *i.e.* leaf area, leaf dry weight and chlorophyll content and tree fruiting, *i.e.* fruit set, yield number and weight, reduced fruit shedding; improved fruit quality *i.e.* nut weight, kernel percentage and oil content. The treatment of 300ppm ascorbic acid was the most effective in this respect.

Keywords: Pecan- Ascorbic acid – Salicylic acid- Fruiting- Fruit quality- Vegetative growth- Oil content – Kernel percentage – Chlorophyll.

Pecan (*Carya illinoensis*) is a nut crop characterized by high nutritional and commercial values. Pecan fruits contain more than 70% oil and a considerable amount of carbohydrates, protein, vitamins and minerals. Pecan fruit is used either fresh or in food industries, also pecan wood is tough and elastic that makes it suitable for furniture industry.

Ascorbic acid (Vit."C") is an organic compound in higher plants which is required in trace amounts to maintain normal growth (Oertli, 1987). Ascorbic acid has an auxinic action and also a synergistic effect on flowering and fruiting of fruit trees. It is recently used instead of auxins and other chemicals for enhancing growth, yield and fruit quality (Mansour *et al.*, 2000 on Banaty grapevines, El-Sayed *et al.*, 2000 on grape and Ahmed *et al.*, 2003 on banana).

On the other hand, salicylic acid was reported to be new growth hormone (Raskin, 1992) and to induce many stimulating effects on growth and some physiological activities of different plants (Bardis, 2004 on garlic plant; Kumar and Reddy, 2007 on mango and Huang ren Hua *et al.*, 2008 on navel orange).

The aim of this work was to investigate the efficacy of ascorbic acid or salicylic acid on improving vegetative growth, fruiting and fruit quality of "Cherokee" pecan trees.

Material and Methods

This investigation was carried out during 2006 and 2007 seasons at El-Kanater El-Khayria experimental Orchard, Hort. Res. Inst., Ministry of Agriculture on healthy trees, nearly uniform in growth (30 years old) planted in a clay loam soil at 7 x 7m. apart subjected to surface irrigation system and received regularly the same recommended cultural practices. The purpose of this work is to study the effect of ascorbic and salicylic acids foliar spraying on vegetative growth, productivity and fruit quality.

The trees were sprayed twice, the first at the start of female inflorescences emerging and the second after one month.

The treatments were as follow:

1. Control (tap water).
2. 150ppm ascorbic acid.
3. 300ppm ascorbic acid.
4. 150ppm salicylic acid.
5. 150ppm ascorbic acid + 150ppm salicylic acid.

The treatments were arranged in complete randomized blocks design, treatment represented with three replicates and each replicate with one tree. The obtained data were evaluated as follows:

Vegetative growth parameters

1. Leaf area: Twenty leaves of the middle shoot were measured and their area was estimated using a planimeter.
2. Leaf dry weight: In late September, 20 leafs for each replicate were picked, washed, weighed and dried at 60° in an electric oven until a constant weight and leaf dry weight was estimated.
3. Leaf chlorophyll content: Chlorophyll content was calorimetrically determined in fresh leaf at 660, 644nm wave length for chlorophyll a and B respectively according to (Brougham, 1960).

Tree fruiting

Fruit set percentage

Random samples of 20 female inflorescences were labeled, the number of flowers was counted, Number of setting fruitlets for each inflorescence was also counted and recorded, fruit set percentage was calculated according to the following equations:

$$\text{Fruit set (\%)} = \frac{\text{No. of developing fruitlets}}{\text{No. of flowers}} \times 100$$

Fruit shedding

The previous 4 tagged inflorescences were used to calculate fruit shedding percentage as follows:

$$\text{Fruit shedding (\%)} = \frac{\text{No. of dropped fruits until harvest}}{\text{No. of setting fruits}} \times 100$$

Yield

On October 10th in both seasons, fruits were picked, weighed, separated from husks, then nuts were weighed again. Its number was counted; after that nut percentage was calculated as follows:

$$\text{Nut (\%)} = \frac{\text{Weight of husk nut (g)}}{\text{Weight of nut (g)}} \times 100$$

Fruit quality

Nut physical characteristics *i.e.* nut weight, nut length and diameter were measured and nut shape index was calculated.

Nuts were cured for one month at room temperature then, weighed and kernel characteristics were determined as follows:

$$\text{Kernel (\%)} = \frac{\text{Kernel weight (g)}}{\text{Nut weight (g)}} \times 100$$

Kernel was dried in an electric oven at 70° until constant weight and kernel moisture content was calculated.

Kernel oil content (%)

Kernel oil was determined as percentage by soxlet apparatus; petroleum ether of 40° boiling point was used as a solvent according to (A.O.A.C. 1980).

Statistical analysis

The obtained data were subjected to statistical analysis according to Snedecor and Corahan (1980). Means were separated using Duncan's multiple range test. (Duncan, 1955).

Results and Discussion

Vegetative growth parameters

Leaf area

Table 1 shows clearly that all treatments increased leaf area in comparison with the control during the two seasons of the study. The treatment of 300ppm ascorbic acid was superior compared to the other treatments followed in a descending order by 150ppm ascorbic acid in the first season and by the combination of 150ppm ascorbic acid + 150ppm salicylic acid in the second one, the other treatments came in between in this respect.

Leaf dry weight

The results revealed that, the treatment of 150ppm salicylic acid gave the highest values of leaf dry weight, followed by 300ppm ascorbic acid, whereas,

the lowest values came from the control, the other treatments came in between Table 1.

Chlorophyll a content

It is evident that (Table 1) all treatments increased leaf chlorophyll a content as compared with the control. The treatment of 150ppm salicylic acid surpassed the other treatments, followed descendingly by 300ppm ascorbic acid, and 150ppm ascorbic acid or the combination between 150ppm ascorbic acid+150ppm salicylic acid without significant differences between them. Such trend was valid for both seasons of the study .

Chlorophyll b content

Table 1 shows that 300ppm ascorbic acid exhibited the lowest values of chlorophyll b in both seasons. In the first season, the other treatments inducing control gave similar values without significant differences between them, while in the second season it was found that 150ppm salicylic acid gave the highest values, followed in a descending order by both 150ppm ascorbic acid and the combination between 150ppm ascorbic acid and 150ppm salicylic acid without significant differences between them and the control.

Chlorophyll a/b ratio

It is clear that (Table 1) in both seasons of the study, the treatment of 300ppm ascorbic acid significantly increased chlorophyll a/b compared to the other treatments. While the least values came from the control. The other treatments came in between.

TABLE 1. Effect of ascorbic acid and salicylic acids foliar sprays on some vegetative parameters of cherokee pecans cultivar (2006 and 2007) seasons.

Treatments	Leaf area (cm)		Leaf dry weight (g)		Chlorophyll a mg/gm		Chlorophyll b mg/gm		Chlorophyll a/b ratio	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	18.7c	19.0c	0.17d	0.18c	1.3d	1.4d	0.6a	0.58c	2.1c	2.4c
150ppm Ascorbic acid	19.0b	19.3c	0.19c	0.2b	1.46c	1.5c	0.6a	0.6b	2.4b	2.5b
300ppm Ascorbic acid	19.6a	20.0a	0.22b	0.23a	1.53b	1.58b	0.56b	0.54d	2.7a	2.9a
150ppm Salicylic acid	18.0d	19.1c	0.24a	0.24a	1.61a	1.69a	0.61a	0.67a	2.6a	2.52b
150ppm Asc.+ Salic. acid	18.8c	19.5b	0.2c	0.23a	1.48c	1.51c	0.61a	0.61b	2.46b	2.51b

Means followed by the same letter (S) are not significantly different at 5% level.

The obtained results of vegetative parameters agreed with the findings of Bardisi (2004) on garlic; El-Ghamriny *et al.* (1999) on Tomato; Arisha (2000) on potato and Omer (1999) on grapevines. They mentioned that ascorbic acid or salicylic acid increased leaf area, leaf dry weight and chlorophyll content.

The beneficial effects of ascorbic acid could be attributed to the functions of ascorbic acid which counteract the stress effects (temperature and poisons), antioxidants, protection of chloroplast and electron transport system. It is also, stimulates respiration activates, cell division and many activities of enzymes (Elsayed *et al.*, 2000). On the other hand, Huang Ren Hau *et al.* (2008) reported that the values of antioxidant compounds (carotenoids, ascorbic acid, glutathione, total phenolics and total flavonoids) in orange fruits treated with salicylic acid were high when compared with the control, they added that there are positive relationships between the antioxidants activity and the content of these active compounds.

Tree fruiting

Fruit set percentage

It is obvious from Table 2 that in both seasons (2006 and 2007) trees sprayed with 150ppm salicylic acid showed the highest percentage of fruit set, followed in a descending order by those sprayed with the combination of ascorbic and salicylic acids (150ppm) concentration, 300ppm ascorbic acid, 150ppm ascorbic acid, and the control which showed the lowest percentage.

Fruit shedding

Table shows clearly that all tested treatments decreased fruit shedding percentage as compared to the control in both seasons of study. The treatment of 300 ppm ascorbic acid was superior in comparison with the other treatments in decreasing fruit shedding percentage, followed by the treatment of (150 ppm salicylic acid + 150 ppm ascorbic acid), while the highest fruit shedding percentage came from the control. The other treatments came in between, in this respect this was true in both seasons.

Yield (kg/tree)

It is evident that in both seasons (2006 and 2007), the tested treatments significantly increased yield expressed in kg/tree compared to the control. In the first season, 150ppm salicylic acid induced the highest yield, followed by 150ppm ascorbic acid, the other treatments came in between. In the second season, the treatment of 300ppm ascorbic acid was superior to the other treatments in this concern, followed by the other treatments without significant differences between them Table 2.

No. of fruits/tree

It is clear that in both seasons, all treatments increased No. of fruits/tree as compared to the control. The highest values obtained from 150ppm salicylic acid, in the first season while in the second one, 300ppm ascorbic acid, induced the highest values. On the contrast the lowest values came from the control. The other treatments came in between Table 2.

The obtained results concerning the effect of ascorbic acid on tree fruiting are coincide with the findings of Ahmed *et al.* (2003) on banana, Ahmed *et al.* (2002) on grapevines. They found that ascorbic acid increased tree fruiting.

The results of salicylic acid are in accordance with those reported by Chen *et al.* (2006) on citrus who found that salicylic acid increased fruit retention and with Kumar and Reddy (2007) on mango who reported that salicylic acid increased inflorescences, flowers and hermaphrodite flowers.

TABLE 2. Effect of ascorbic acid and salicylic acid on fruiting of pecan "Cherokee" Cultivar (2006 and 2007) seasons.

Treatments	Fruit set (%)		Fruit shedding (%)		Yield (kg/tree)		No. of fruits (tree)	
	2006	2007	2006	2007	2006	2007	2006	2007
Control	75.0e	78.3e	32.0a	30.0a	5.97e	6.80c	1209.3d	1357.5d
150ppm Ascorbic acid	82.3d	83.0d	26b	24.3b	7.73d	9.00b	1333.3c	1446.5c
300ppm Ascorbic acid	85.0c	87.0c	18.7d	16.6e	8.9b	11.7a	1420.1b	1665.5a
150ppm Salicylic acid	91.3a	93.7a	21.0c	19.7c	9.53a	9.40b	1571.6a	1511.6b
150ppm Asc.+ Salic. Acid	87.3b	89.3b	19.0cd	18.3d	8.60c	9.8b	1417.6b	1559.4b

Means followed by the same letter (S) are not significantly different at 5% level.

The beneficial effects of ascorbic or salicylic acid could be attributed to that ascorbic acid has an auxinic action and also a synergistic effect on flowering and fruiting of fruit trees (Mansour *et al.*, 2000). In addition, Kumar and Reddy, (2007) stated that the physiological effects of ascorbic acid included: stimulation of lipase, catalase and peroxidase isoenzymes activities, also, ascorbic acid was affected the metabolism of gibberellic acid.

Nut physical characteristics

Husk nut weight

It is obvious that in both seasons of the study (2006 and 2007) all tested treatments increased husk nut weight compared to the control. The treatment of (300 ppm ascorbic acid) surpassed other treatments, whereas the lowest values came from both 150 ppm salicylic acid and the control. The other treatments came in between Table 3.

Fresh nut weight

As shown in Table 3 the treatment of 300 ppm ascorbic acid produced the heaviest fresh nut weight, while, the lightest fresh nut weight came from the control, the other treatments came in between without significant differences between them, such trend was true in both seasons.

Nut percentage

It is evident that in both seasons, the treatment of 150 ppm salicylic acid induced the highest percentage of nut, followed by the combination of 150 ppm ascorbic acid and 150 ppm salicylic acid. Whereas, the lowest percentage came from the control, the other treatments came in between Table 3.

Nut length (cm)

It is clear from Table 3 that the treatment of (300 ppm ascorbic acid) gave the highest values of nut length, whereas, the control showed the lowest values, the other treatments came in between, this was true in both seasons of the study.

Nut diameter

Table 3 shows clearly that 300 ppm ascorbic acid induced the highest values of nut diameter, while, the combination of 150 ppm ascorbic acid and 150 ppm salicylic acid induced the lowest values in this concern, the other treatments came in between, this trend was true in both seasons.

TABLE 3. Effect of ascorbic acid and salicylic acid foliar sprays on some fruit physical characteristics of "cherokee" pecan cultivar during 2006 and 2007 seasons.

Treatments	Fresh husk nut weight (g)		Fresh nut weight (g)		Nut (%)		Nut length (cm)		Nut diameter (cm)		Nut shape (L/D)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	11.4d	12.3c	5.0d	5.0c	43.3e	40.9c	2.9c	3.1b	1.4b	1.4bc	2.1b	2.2b
150ppm Ascorbic acid	12.7b	13.8a	5.8c	6.2b	45.8d	44.9b	3.0b	3.3ab	1.4b	1.5b	2.2b	2.2b
300ppm Ascorbic acid	13.1a	14.2a	6.3a	6.7a	48.0c	47.1a	3.2a	3.4a	1.5a	1.6a	2.1b	2.1b
150ppm Salicylic acid	11.9d	13.0b	6.1b	6.1b	51.0a	47.3a	3.0a	3.2b	1.4b	1.5b	2.2b	2.2b
150ppm Asc.+ Salic. acid	12.1c	14.0a	6.1b	6.2b	50.0b	44.4b	3.1ab	3.4a	1.2c	1.3c	2.5a	2.5a

Means followed by the same letter (S) are not significantly different at 5% level.

Nut shape

It is obvious that the combination of (150 ppm ascorbic acid + 150ppm salicylic acid) gave more oblong nuts than those of the other treatments during 2006 and 2007 seasons. No significant differences were detected between these treatments Table 3.

*Kernel characteristics**Curded nut weight*

Table 4 shows clearly that in the two seasons (2006 and 2007), all treatments increased curded nut weight in comparison with the control. It is also obvious that both 300ppm ascorbic acid and the combination of 150ppm ascorbic acid + 150ppm salicylic acid gave the highest curded nut weight without significant differences between them, followed descendingly by 150ppm of ascorbic or salicylic acids, whereas, the lowest values came from the control.

Kernel weight

Data concerning kernel weight reveals that, 300 ppm ascorbic acid induced the highest values, followed descendingly by the combination of (150 ppm ascorbic acid + 150 ppm salicylic acid) in the first season, while, non significant differences were noticed between them in the second season, the control gave the lowest values, the other treatments came in between in this respect(Table 4).

Kernel percentage

It is clear that both (300 ppm ascorbic acid) and (150 ppm ascorbic acid + 150 ppm salicylic acid) gave the highest percentage of kernel without significant differences between them, followed descendingly by 150 ppm of ascorbic or salicylic acids without significant differences between them, while, the control came at last (Table 4).

Kernel moisture percentage

Table 3 shows that the control induced the highest values of kernel moisture percentage in comparison with the tested treatments which performed slight differences between them in this concern in both seasons.

TABLE 4. Effect of ascorbic acid and salicylic acid foliar sprays on some kernel characteristics of "Cherokee" pecan cultivars during 2006 and 2007 seasons.

Treatments	Curded nut weight (g)		Kernel weight (g)		Kernel percentage (%)		Kernel moisture content (%)		Kernel oil content (%)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	3.1c	3.0c	1.9d	1.8c	60.6c	60.3c	2.8a	3.1a	73.1c	66.6c
150ppm Ascorbic acid	3.4b	3.2b	2.3c	2.3b	65.9b	65.8b	2.5b	2.9b	74.1b	71.0b
300ppm Ascorbic acid	3.9a	3.6a	2.9a	2.8a	73.7a	74.1a	2.4bc	2.8bc	75.0a	72.9a
150ppm Salicylic acid	3.4b	3.3b	2.3c	2.4b	66.9b	67.7b	2.3bc	2.6c	74.0b	73.8a
150ppm Asc.+ Salic. acids	3.8a	3.7a	2.7b	2.8a	71.9a	72.0a	2.6b	2.7c	74.8a	70.8b

Means followed by the same letter (S) are not significantly different at 5% level.

Kernel oil content

As shown in Table 4 it is obvious that all treatments increased kernel oil content compared to the control in the first season. Moreover, the treatment of 300 ppm ascorbic acid induced the highest values of kernel oil content, followed descendingly by (150 ppm ascorbic acid+ 150 ppm salicylic acid) without significant differences between them, and by 150 ppm ascorbic or salicylic acid without significant differences between them, while, in the second season, 150 ppm salicylic acid gave the highest values and by 300 ppm ascorbic acid without

Egypt. J. Appl. Agric. Res. (NRC), Vol. 1, No.2 (2008)

significant differences between them followed by (150 ppm ascorbic acid) and (150 ppm ascorbic acid + 150 ppm salicylic acid) without significant differences between them.

The obtained results concerning nut and kernel characteristics are in harmony with the findings of Ahmed *et al.* (2002) and Mansour *et al.* (2000) who found that ascorbic acid improved fruit quality. In addition, Huang Ren Hau, *et al.* (2008) on navel orange mentioned that salicylic acid improved fruit quality.

Conclusion: These results indicated that, the spraying pecan trees with 300ppm ascorbic acid or 150 ppm salicylic acid at the start of female inflorescences emerging and repeated after one month could increase tree fruiting and improve fruit quality and vegetative growth.

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(Received 4/5/2008;
accepted 31/8/2008)

تأثير الرش الورقي بحمضى الاسكوربيك والسليسلبيك على النمو والمحصول وجودة الثمار لأشجار البيكان صنف شبروكى

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البحوث الزراعية - القاهرة - مصر.

أجريت هذه الدراسة خلال موسمين متتالين هما ٢٠٠٦ ، ٢٠٠٧ على أشجار
بيكان صنف شروكى عمر ٣٠ سنة منزرعة بمحطة بحوث البساتين بالقناطر
الخيرية بأرض طينية طميية على مسافة ٧ × ٧م حيث تم دراسة تأثير الرش بكل
من حمض الاسكوربيك بتركيز ١٥٠ ، ٣٠٠ جزء فى المليون وحمض السليسلبيك
بتركيز ١٥٠ جزء فى المليون أو هما معا كلا بتركيز ١٥٠ جزء فى المليون .
وقد أوضحت النتائج ما يلى :

- تأثرت صفات النمو الخضري المختبرة بالمعاملات المختلفة حيث زادت مساحة
الوريقة ووزنها الجاف ومحتواها من الكلورفيل وكانت معاملتا ٣٠٠ جزء فى
المليون حمض الاسكوربيك و١٥٠ جزء فى المليون حمض السليسلبيك هما
الأكثر تأثيراً.
- نجحت جميع المعاملات فى زيادة نسبة العقد وكمية المحصول عدداً ووزناً فى
حين قلت من نسبة تساقط الثمار وكانت معاملتا ٣٠٠ جزء فى المليون حمض
الاسكوربيك و١٥٠ جزء فى المليون حمض السليسلبيك هما الأفضل فى هذا
الخصوص .
- تحسنت الصفات الطبيعية للثمار نتيجة المعاملات المختلفة مقارنة بالأشجار
غير المعاملة (المقارنة) وكانت معاملة ٣٠٠ جزء فى المليون من حمض
الاسكوربيك هي الأكثر تأثيراً فى هذا الصدد.
- تحسنت الصفات الطبيعية والكيمائية للحم الثمرة (Kernel) متمثلة فى وزن
اللحم ونسبته إلى وزن الثمرة ومحتواه من الزيت وكانت معاملة ٣٠٠ جزء فى
المليون حمض الأسكوربيك هي الأكثر تفوقاً .
- توصى الدراسة بإمكانية زيادة محصول البيكان وتحسين صفات ثماره وكذلك
تحسين حالة النمو الخضري للأشجار باستخدام الرش الورقى بكل من حمض
الاسكوربيك بتركيز ٣٠٠ جزء فى المليون أو حمض السليسلبيك بتركيز ١٥٠
جزء فى المليون عند بداية خروج النورات المؤنثة وإعادة الرش بعد ذلك
بشهر .