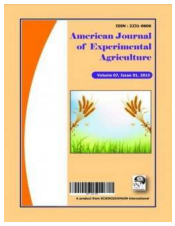

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# The Influence of NAA, $GA_3$ and Calcium Nitrate on Growth, Yield and Fruit Quality of "Le Conte" Pear Trees

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***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** Investigate the effect of gibberellic acid, naphthalene acetic acid and calcium nitrate on vegetative growth parameters, fruit set, yield, fruit quality and leaf mineral content of "Le Conte" pear trees.
**Study Design:** Thirty five uniform trees were selected for the present study. The treatments were applied and arranged in a randomized complete block design. Each treatment included five replicates with one tree for each replicate.
**Place and Duration of Study:** This experiment was carried out during two successive seasons, 2012 and 2013, on 8 years old "Le Conte" pear budded on *Pyrus communis* L. rootstock. The trees were grown in sandy loam soil in a private orchard located at Burg EL-Arab, Alexandria governorate, Egypt.

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**Methodology:** The trees were sprayed with water only (control treatment), naphthalene acetic acid (NAA) at 50 and 100 mg/l, gibberellic acid ($GA_3$) at 50 and 100 mg/l and calcium nitrate at 0.5 and 1 mg/l, three times: in full bloom, which was at the beginning of March, a month later and then two months from the first spray.
**Results:** The obtained results showed that the foliar application of NAA, $GA_3$ and calcium nitrate significantly improved shoot length and thickness, leaf area, fruit set and fruit yield. Additionally, they gave a remarkable increase in weight, size and firmness of fruits and N, P, Ca and Mg content in the leaves over control. Among all the used treatments, calcium nitrate at 1 mg/l had the highest beneficial effect. It caused the best remarkable increase in fruit set percentages, yield (approximately 16 kg/tree), yield (ton/hectare), fruit firmness, acidity and vitamin C content. Moreover, it significantly decreased fruit drop percentage, as compared to the control and the other treatments in both seasons.
**Conclusion:** The foliar application of calcium nitrate at 1% had the highest beneficial effect to increase fruit set percentages, yield, fruit firmness, acidity and vitamin C content in the fruit and to decrease fruit drop percentages of "Le Conte" pear trees compared with the control and the other treatments.

*Keywords: Le Conte pear; NAA; $GA_3$; yield; fruit quality.*

## 1. INTRODUCTION

Pear (*Pyrus communis* L.) is one of the favorite fruits of temperate zone and considered the third highest production of deciduous fruits, the fourth highest production among all fruits in its global distribution and one of the most important deciduous fruits in Egypt. 'Le Conte' pear resulted as a hybrid between *Pyrus communis* L. x *Pyrus serotina* L., is the main pear cultivar grown in Egypt. The total cultivated area for pear fruits were 3741 hectares with total production estimated to 48817 ton [1]. Gibberellins promote seed germination, stimulate stem elongation, leaf expansion, flowering, pollen and seed development and delay fruit ripening [2]. The foliar application with gibberellic acid ($GA_3$) increased weight, volume and length of "Amrapali" mango fruits, because it helps to multiply and lengthen the meristem cells [3]. Spraying "Satluj purple" plum with 10 and 20 mg/l of naphthalene acetic acid (NAA) at different stages of fruit development increased fruit yield due to a higher retention and enhancement of fruit size. Additionally, they significantly increased fruit weight and total soluble solid [4]. The use of plant growth regulators such as NAA and $GA_3$ reduced flower drop, gave a high flower retention and increased yield and fruit quality in mango and other fruit species such as citrus, apple and guava [5]. The spraying of "Keitt" mango trees at full bloom stage with 25 mg/l from $GA_3$ or NAA significantly improved fruit set, fruit retention, number of fruits per cluster and per plant, fruit weight and yield [6]. The effect of early spraying, beginning of June, with 0.4 mg/l and late spraying in August, about 30 days before the harvest, with 0.8 mg/l of Ca (NO3)2 on storability and calcium content, as well as elemental mutual relations in 'Elise' fruit of a 5-year-old apple tree was studied by [7]. The trees were sprayed 3 times at 10 day intervals in the first time of fruit development, beginning of June and 30 days before fruit harvest. The obtained results indicated clearly that the foliar sprayings with calcium before harvesting, 30 days before, increased Ca concentration and significantly decreased N/Ca and K/Ca ratios in fruits in both years. Fruits treated with Ca (NO3)2 had a higher flesh firmness and titratable acidity than control. Foliar application of "Amhat" date palm inflorescence with 1 and 2 mg/l calcium nitrate significantly increased fruit set, fruit retention, fruit yield and length, diameter, weight and volume of fruit [8]. The aim of this study was to investigate the effect of gibberellic acid, naphthalene acetic acid and calcium nitrate on vegetative growth parameters, fruit set, yield, fruit quality and leaf mineral content of "Le Conte" pear trees.

## 2. MATERIALS AND METHODS

The present investigation was carried out during two successive seasons, 2012 and 2013, on "Le Conte" pear trees which is a hybrid between *Pyrus communis* L. X *Pyrus serotina* L. The trees were 8 years old at the start of the experiment, budded on *Pyrus communis* rootstock. They were planted at 5 $\times$ 5 m apart and grown on sandy loam soil under drip irrigation system in a private orchard located at Burg EL-Arab,

Alexandria governorate, Egypt and at 29.55 longitude and 30.90 latitude. They were in normal growth, uniform in vigour and received normal fertilization and agricultural practices as scheduled in the commercial farm. Physical and chemical analysis of the experimental soil are illustrated in Table 1. The trees were sprayed three times at full bloom, which was at the beginning of March, a month later and then two months from the first spray in the two seasons with the following treatments: water only (control), naphthalene acetic acid at 50 and 100 mg/l, gibberellic acid at 50 and 100 mg/l, calcium nitrate at 0.5 and 1 mg/l. Thirty five uniform trees were selected for the present study. The treatments were applied and arranged in a randomized complete block design. Each treatment included five replicates with one tree for each replicate. The effect of the previous treatments was studied by evaluating their influence on the following parameters.

## 2.1 Vegetative Growth Parameters

Four main and uniform branches were chosen and tagged at four cardinal points of each treated tree, and the average of their shoot length in cm and thickness in cm were measured in October, in the two studied seasons. Twenty mature leaves were collected randomly from each replicate to determine leaf area in cm2 which was measured with a CI-203 laser area meter (CID Inc., Washington, USA).

## 2.2 Leaf Mineral Compositions

Twenty leaves from the middle part of the shoots according to [9] were selected randomly from each replicate (at the second week of June) to determine their content from N, P, K, Ca and Mg according to [10]. Determination was carried out on dry weight basis.

## 2.3 Flowering and Fruiting

Four branches, in the different sides of each replicate were tagged for determining the fruit set and fruit drop percentages. Fruit set was calculated according to [11] equation

$$\text{Fruit set \%} = \frac{\text{Number of set fruitlets}}{\text{Number of opened flowers}} \times 100$$

Furthermore, the number of dropped fruits were recorded till harvest time, then estimated as percentage on the basis of initial number of fruitlets according to this equation.

$$\text{Fruit drop \%} = \frac{\text{Number of dropped fruitlets}}{\text{Number of set fruitlets}} \times 100$$

## 2.4 Yield per Tree

Fruit yield on each replicate resulting from the applied treatments was expressed as the weight of fruits in kg per tree which was attained at harvest stage, second week of August.

## 2.5 Yield (Ton/ Hectare)

Yield (ton/ hectare) was expressed by multiplying the weight of fruits per tree $\times$ number of trees/hectare.

## 2.6 Fruit Quality

Twenty fruits from each replicate were chosen randomly for determination physical and chemical characteristics.

### 2.6.1 Fruit physical characteristics

Fruit weight (g), fruit length (cm) and fruit diameter (cm). Fruit firmness was estimated by [12] pressure tester. This instrument measures firmness by recording the amount of force required to depress plunger 5/16 of one inchin diameter and recorded as Ib/inch2.

### 2.6.2 Fruit chemical characteristics

Total soluble solids (TSS) was determined by a hand refractometer, Titratable acidity was determined according to [13] using 0.1 N sodium

**Table 1. Physical and chemical characters of experimental orchard soil**

| Depth (cm) | E.C dS/m | pH | $CaCO_3$ | Cations (mg/l) | | | | Anions (mg/l) | | | Sand | Silt | Clay | Texture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{++}$ | $K^{+}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{--}$ | | | | |
| 0 – 30 | 0.78 | 7.6 | 20.26 | 6.36 | 3.81 | 6.09 | 0.52 | 11.32 | 5.5 | 4.1 | 69.37 | 12.4 | 18.23 | Sandy loam |
| 30 – 60 | 1.02 | 7.58 | 22.36 | 6.17 | 5.27 | 7.36 | 1.27 | 9.85 | 6.12 | 3.46 | 70.64 | 8.93 | 20.43 | Sandy loam |

hydroxide (Petrochemical Egyptian-ABC) and phenolphthalein as an indicator and was expressed as % malic acid, TSS/ acid ratios were calculated for each replicate of the applied treatments, Vitamin C (ascorbic acid) was determined by titration with 2, 6-dichloroindophenol (PWT international company, Alexandria, Egypt) [14] and calculated as mg/100 ml of juice. Total sugar were determined according to [15]. They were extracted from 5 g fresh weight and determined by phenol sulfuric and Nelson arsenate-molybadate (life chemical group compay, Cairo, Egypt) colorimetric methods for total sugars.

## 2.7 Statistical Analysis

The obtained data were subjected to the proper analysis of variance (ANOVA) according to [16]. Least significant difference (LSD) at 0.05% level of significance was used to compare the treatments means.

## 3. RESULTS

Data in Table 2 cleared that the spray of the trees with $GA_3$ at 100 mg/l and calcium nitrate at 1 mg/l significantly increased shoot length, shoot thickness and leaf area in both seasons, as compared to control. $GA_3$ at 50 mg/l significantly enhanced shoot length and leaf area in the first season and in both seasons respectively, in comparison to the control. NAA at 50 and 100 mg/l, $GA_3$ at 50 mg/l and calcium nitrate at 0.5 mg/l significantly improved shoot thickness in the two seasons compared with the control. The treatments of NAA at 50 and 100 mg/l and calcium nitrate at 0.5 mg/l gave a slight increase which was insignificant in shoot length and leaf area, as compared to control in both study seasons.

From the data listed in Table 3, it can be concluded that the application of NAA or $GA_3$ at 50 mg/l and calcium nitrate at 0.5 or 1 mg/l gave a remarkable increase in fruit set percentages, yield in kg/tree and yield in ton/hectare, over control in the two seasons. On the opposite side, the treatments of NAA or $GA_3$ at 100 mg/l did not give any significant increase in fruit set percentages, yield in kg/tree and yield in ton/hectare, compared with control in the two seasons. Calcium nitrate at 1 mg/l had the highest positive effect to reduce fruit drop percentages in the two seasons, as compared to control. NAA or $GA_3$ at 50 mg/L, and calcium nitrate at 0.5 mg/l greatly decreased the percentages of fruit drop in the second year, with comparing to control. On the opposite side, NAA or $GA_3$ at 100 mg/l did not have any remarkable effect on the reduction of fruit drop percentages in the two seasons, as compared to the control.

The results shown in Table 4 revealed that NAA at 50 or 100 mg/l, $GA_3$ at 50 or 100 mg/l and calcium nitrate at 0.5 or 1 mg/l significantly improved fruit weight and fruit diameter over control in the two seasons. The application of NAA at 50 or 100 mg/l and $GA_3$ at 50 or 100 mg/l gave also significant increases in fruit length in both seasons over control. $GA_3$ at 50 or 100 mg/l and calcium nitrate at 0.5 or 1mg/l statistically enhanced fruit firmness in the two seasons over control. Calcium nitrate at 0.5 or 1 mg/l greatly improved fruit length in the second season, but in the first season, their effect was not remarkable with comparing to control. NAA at 50 or 100 mg/l treatments gave a slight increase, which was not enough to be significant in fruit firmness in the two seasons, as compared to control.

The statistical results in Table 5 indicate that $GA_3$ at 50 or 100 mg/l and calcium nitrate at 0.5 or 1 mg/l significantly improved vitamin C content in the fruits compared with control in both experimental seasons. On the other hand, NAA at 50 and 100 mg/l insignificantly enhanced vitamin C content in the fruits in the two seasons with comparing to the control. $GA_3$ at 100 mg/l and calcium nitrate at 0.5 and 1 mg/l markedly raised the acidity in the fruits in the two seasons, over control. Additionally, $GA_3$ at 50 mg/l in the first season significantly increased the acidity in the fruits but in the second season, the enhancement was slight in comparison to the control. On the opposite side, NAA at 50 and 100 mg/l did not have a great effect on the acidity percentage in the two seasons, compared with control. TSS/acid ratio greatly decreased by the application of $GA_3$ at 100 mg/l and calcium nitrate at 0.5 and 1 mg/l in the two seasons with comparing to the control. $GA_3$ at 50 mg/l and NAA at 50 or 100 mg/l decreased slightly TSS/acid ratio in the two seasons compared with control. All the treatments did not have any significant effect on the percentages of total soluble solids or total sugar content in the two seasons in comparision to control.

Nitrogen, phosphorus and magnesium content in the leaves was significantly improved by the spray of $GA_3$ at 100 mg/l and calcium nitrate at 0.5 or 1 mg/l over the control in the two seasons as shown in Table 6. NAA at 50 and 100 mg/l and $GA_3$ at 50 mg/l significantly increased also

nitrogen and phosphorus content, however their effect on magnesium content was insignificant in the two seasons, compared with control. Calcium content in the leaves was markedly improved by the usage of NAA at 100 mg/l and calcium nitrate at 0.5 and 1 mg/l in the two seasons in comparison to the control. NAA at 50 mg/l and $GA_3$ at 50 mg/l raised slightly calcium content in the leaves. On the opposite side, all the treatments decreased potassium content in the leaves, as compared to the control in both experimental seasons.

**Table 2. Effect of NAA, $GA_3$ and calcium nitrate on vegetative growth of "Le Conte" pear trees during 2012 and 2013 seasons**

| Treatments | Shoot length (cm) | | Shoot thickness (cm) | | Leaf area ($cm^2$) | |
|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Control | 42.25d | 42.67c | 0.68d | 0.75e | 24.11c | 24.85e |
| NAA at 50 mg/l | 42.36d | 43.27c | 0.71c | 0.78d | 24.25c | 25.64de |
| NAA at 100 mg/l | 42.53d | 43.57c | 0.72c | 0.79d | 24.46c | 25.74cde |
| $GA_3$ at 50 mg/l | 43.75c | 44.12bc | 0.76b | 0.82c | 25.92b | 26.17bcd |
| $GA_3$ at 100 mg/l | 45.78a | 46.08a | 0.87a | 0.89 b | 27.18a | 27.86a |
| Calcium nitrate 0.5 % | 42.87d | 43.54c | 0.78b | 0.80cd | 24.62c | 25.73cde |
| Calcium nitrate1% | 44.65b | 44.85b | 0.89a | 0.92a | 26.46ab | 26.73bc |

*Least significant difference (LSD) at 0.05 % level of significance was used to compare the treatment means. Means not sharing the same letter(s) with in each column, are significantly different at 0.05 level of probability according to the proper analysis of variance (ANOVA)*

**Table 3. Effect of NAA, $GA_3$ and calcium nitrate on fruit set, fruit drop and yield of "Le Conte" pear trees during 2012 and 2013 seasons**

| Treatments | Fruit set (%) | | Fruit drop (%) | | Yield (kg/ tree) | | Yield (ton/ hectare) | |
|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Control | 8.14c | 9.64c | 80.27a | 81.36a | 30.46c | 31.27c | 12.29c | 12.6c |
| NAA at 50 mg/l | 9.36b | 9.85b | 78.65a | 77.63b | 38.56b | 40.34b | 15.55b | 16.27b |
| NAA at 100 mg/l | 7.96c | 8.14c | 79.85a | 81.17a | 29.37c | 30.39c | 11.83c | 12.26c |
| $GA_3$ at 50 mg/l | 10.24b | 10.47b | 79.35a | 78.47b | 43.64a | 45.73a | 17.59a | 18.43a |
| $GA_3$ at 100 mg/l | 8.05c | 8.12c | 80.95a | 82.14a | 29.65c | 30.81c | 11.95c | 12.43c |
| Calcium nitrate 0.5% | 9.25b | 9.75b | 78.14a | 78.25b | 37.85b | 39.75b | 15.26b | 16.03b |
| Calcium nitrate 1% | 11.37a | 12.08a | 74.15b | 75.08c | 46.92a | 48.37a | 18.91a | 19.51a |

*Least significant difference (LSD) at 0.05 % level of significance was used to compare the treatment means. Means not sharing the same letter(s) with in each column, are significantly different at 0.05 level of probability according to the proper analysis of variance (ANOVA)*

**Table 4. Effect of NAA, $GA_3$ and calcium nitrate on fruit weight, length, diameter and fruit firmness of "Le Conte" pear trees during 2012 and 2013 seasons**

| Treatments | Fruit weight (g) | | Fruit length (cm) | | Fruit diameter (cm) | | Fruit firmness (lb/ $in^2$) | |
|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Control | 140.65f | 141.72g | 8.26e | 8.29f | 5.32e | 5.41f | 13.47d | 13.85d |
| NAA at 50 mg/l | 152.46d | 154.82d | 8.51d | 8.92d | 5.62d | 5.92d | 13.51d | 13.92d |
| NAA at 100 mg/l | 168.63c | 170.25c | 9.12c | 9.37c | 6.12c | 6.27c | 13.55d | 13.96d |
| $GA_3$ at 50 mg/l | 174.25 | 178.67b | 9.56b | 9.87b | 6.41b | 6.87b | 15.56c | 15.73c |
| $GA_3$ at 100 mg/l | 178.61 | 184.37a | 9.92a | 10.02a | 6.93a | 7.04a | 16.86c | 16.92b |
| Calcium nitrate 0.5% | 146.37 | 148.25f | 8.40de | 8.86d | 5.58d | 5.82d | 17.27b | 17.83a |
| Calcium nitrate 1% | 151.67 | 152.14e | 8.46de | 8.50e | 5.57d | 5.60e | 18.76a | 18.67a |

*Least significant difference (lsd) at 0.05 % level of significance was used to compare the treatment means. Means not sharing the same letter(s) with in each column, are significantly different at 0.05 level of probability according to the proper analysis of variance (anova)*

**Table 5. Effect of NAA, $GA_3$ and calcium nitrate on some chemical fruit characteristics of "Le Conte" pear trees during 2012 and 2013 seasons**

| Treatments | TSS (%) | | Acidity (%) | | TSS/ acid ratio | | Vitamin C (mg/ 100 ml juice) | | Total sugar (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Control | 11.60a | 11.50a | 0.46d | 0.47c | 25.22a | 24.47a | 20.37c | 21.45c | 7.51a | 7.62 a |
| NAA at 50 mg/l | 11.50a | 11.60a | 0.48cd | 0.49c | 23.96ab | 24.29a | 20.84c | 21.76c | 7.48a | 7.61 a |
| NAA at 100 mg/l | 11.70a | 11.80a | 0.47cd | 0.48c | 24.89a | 24.58a | 21.65c | 22.48c | 7.52a | 7.60 a |
| $GA_3$ at 50 mg/l | 11.60a | 11.70a | 0.50bc | 0.51bc | 23.20ab | 22.94ab | 24.86b | 25.21b | 7.42a | 7.58 a |
| $GA_3$ at 100 mg/l | 11.50a | 11.60a | 0.53b | 0.54ab | 21.70bc | 21.48b | 27.46b | 28.36a | 7.40a | 7.57 a |
| Calcium nitrate 0.5 % | 11.50a | 11.60a | 0.56a | 0.55ab | 20.54c | 20.73b | 27.35b | 28.46a | 7.46a | 7.58 a |
| Calcium nitrate 1 % | 11.60a | 11.50a | 0.58a | 0.57a | 20.00c | 20.18b | 30.17a | 30.75a | 7.40a | 7.52 a |

*Least significant difference (LSD) at 0.05 % level of significance was used to compare the treatment means. Means not sharing the same letter(s) with in each column, are significantly different at 0.05 level of probability according to the proper analysis of variance (ANOVA)*

**Table 6. Effect of NAA, $GA_3$ and calcium nitrate on some leaf minerals of "Le Conte" pear trees during 2012 and 2013 seasons**

| Treatments | Nitrogen (%) | | Phosphorus (%) | | Potassium (%) | | Calcium (%) | | Magnesium (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Control | 1.86e | 1.92f | 0.34d | 0.35c | 1.38a | 1.42a | 1.47e | 1.50d | 0.39d | 0.38 c |
| NAA at 50 mg/l | 1.92d | 1.98e | 0.38bc | 0.40b | 1.36ab | 1.38bc | 1.50de | 1.54d | 0.40cd | 0.39 c |
| NAA at 100 mg/l | 2.07c | 2.14c | 0.45a | 0.46a | 1.34ab | 1.35bc | 1.55c | 1.60c | 0.41bcd | 0.40 c |
| $GA_3$ at 50 mg/l | 2.22b | 2.37b | 0.37c | 0.39b | 1.37a | 1.40ab | 1.48e | 1.51d | 0.43bc | 0.42 bc |
| $GA_3$ at 100 mg/l | 2.42a | 2.54a | 0.44a | 0.45a | 1.36ab | 1.37bc | 1.52cd | 1.53d | 0.46ab | 0.45 ab |
| Calcium nitrate 0.5 % | 1.94d | 2.01e | 0.37c | 0.38b | 1.35ab | 1.39ab | 1.67b | 1.73b | 0.48a | 0.46 ab |
| Calcium nitrate 1 % | 2.03c | 2.07d | 0.40b | 0.41b | 1.32b | 1.35c | 1.80a | 1.91a | 0.49a | 0.48 a |

*Least significant difference (LSD) at 0.05 % level of significance was used to compare the treatment means. Means not sharing the same letter(s) with in each column, are significantly different at 0.05 level of probability according to the proper analysis of variance (ANOVA)*

## 4. DISCUSSION

The experimental results indicated that the foliar application of $GA_3$ significantly improved fruit weight, size and firmness of "Le Conte" pear trees. Moreover, it increased the acidity in the fruits and this explained and this explained why it delayed their ripening. These results were in parallel with the findings of [17] who mentioned that sweet cherries (*Prunus avium* L.) $GA_3$-treated fruits were significantly firmer, larger and higher in their titratable acidity than that of untreated fruits and could be harvested later. $GA_3$ significantly improved leaf mineral content and the percentage of fruit set and yield and statistically decreased fruit drop percentage. These results agreed with the findings of [18] who found that the spray of gibberellic acid on "Le Conte" pear trees greatly enhanced the fruit set percentage thereby yield percentage, fruit characteristics, e.g. fruit weight, size, dimensions, firmness, acidity, leaf mineral contents and significantly decreased fruit drop percentage, as compared to the control. The foliar application of gibberellic acid on "Gola" pear [*Pyrus pyrifolia* (Brum.) Nakai] positively reduced fruit drop and improved fruit growth, productivity and fruit quality compared with the control [19]. NAA had a positive effect on fruit set, yield, vegetative growth and fruit quality of "Le Conte" pear trees. These results coincided with the findings of [20] who stated that NAA reduced premature fruit drop in California "Bartlett" pears. NAA markedly decreased preharvest fruit drop and increased yield and fruit quality of guava [5]. Spraying "Costata" persimmon trees with NAA remarkably improved vegetative growth, fruit retention, fruit weight and tree yield compared with the control [21]. The application of NAA with 20 mg/l at young fruit period enhanced fruit growth and improved final fruit size of pear [22]. In our experiment, NAA increased fruit acidity and this explains why it delayed the ripening of fruits. These data agreed with findings of [23] who noticed that treating "Diamante" peaches by 30 mg/l NAA delayed the fruit harvesting time. Calcium nitrate significantly improved fruit set, yield, fruit quality and leaf mineral content of "Le Conte" pear trees, over control in the two seasons. These findings were in the same trend with the findings of [24] who stated that calcium might be the most important mineral element determining the quality of fruit, particularly in apples and pears, because these fruits are stored for long periods of time. Pre and postharvest application of calcium helps to retain fruit firmness and increase vitamin C content in apple [25]. The foliar spray of "Kelsey" plum with Ca $(NO_3)_2$ greatly enhanced the fruit set, leaf content of nitrogen and calcium, retained fruits, fruit weight and tree yield, over control [26]. Calcium plays an important role in regulating the metabolism in apple fruit, maintaining adequate concentration for fruit firmness and delaying fruit ripening [27]. The beneficial effect of calcium in increasing fruit set may be due to the high efficiency of photosynthesis and these chemicals are also associated with hormone metabolism, which promotes synthesis of auxins, essential for fruit set and growth [28].

## 5. CONCLUSION

- The foliar application of calcium nitrate at 1 % had the highest beneficial effect to increase fruit set percentages, yield, fruit firmness, acidity and vitamin C content in the fruit and to decrease fruit drop percentages of "Le Conte" pear trees compared with the control and the other treatments.
- Treatments with $GA_3$ and NAA improved to a lesser extent vegetative growth, fruit set, yield, fruit quality and mineral content of the leaves, as compared to the control.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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