EFFECT OF FOLIAR APPLICATION OF LIQUID ORGANIC FERTILIZER (AMINOFERT), SOME MICRO NUTRIENTS AND GIBBERELLIN ON LEAF MINERAL CONTENT, FRUIT SET, YIELD AND FRUIT QUALITY OF LE CONTE PEAR TREES

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ABSTRACT

This investigation was carried out during 2006 and 2007 growing seasons on Le-Conte pear trees, grown in a calcareous sandy leam soil in Burg El-Arab region (about 60 kilometers west of Alexandria), aiming to study the effect of foliar sprays with Aminofert (20%Amino acids + 12% organic acids and 3.6% chelated microelements), Gibberellin and a mixture of chelated (Fe , Zn and Mn) alone or in combination (GA_3+ Aminofert or GA_3 + a mixture of chelated " Fe + Zn and Mn ") on fruit set, yield and fruit quality and some leaf mineral content.

Results revealed that Gibberellin or Aminofert alone or in combination (GA_3 + Aminofert or GA_3 + a mixture of chelated "Fe, Zn and Mn") treatments increased significantly fruit set, yield as weight or number of fruits/ trees, as well as fruit quality (firmness, acidity, T.S.S and total sugar) were improved under all treatments as compared with the control. The increase in the yield were in the following descending order:

Aminofert + GA_3 > a mixture of chelated (Fe, Zn and Mn) + GA_3 > Aminofert > GA_3 > a mixture of chelated > control.

Gibberellin or Aminofert alone or in combination (GA_3 + Aminofert or GA_3 + a mixture of chelated "Fe, Zn and Mn") applied to foliage caused a pronounced increase in leaf N, Fe, Zn and Mn, while leaf P decreased in both experimental seasons. Application of Aminofert (Amino acid 20% + organic acid 12% and chelated microelements 3.6%) at 0.25% + GA_3 at 20 ppm was more effective compared to other treatments in both seasons.

INTRODUCTION

Le-Conte pear (*Pyrus communis* L.) is one of the important deciduous fruit cultivars grown in Egypt. This cultivar suffers from several factors which have a negative effects on its production. One of these factors depression of pear yield was occurred during the last 20 years. The growers used some nutrient elements (i, e micro elements), some growth regulators (GA_3) or liquid organic fertilizer (aminofert) in order to increase fruit set and yield of "Le-Conte" pear.

The pear trees grown in calcareous soil, which has high $CaCO_3$ content and a high pH value that caused a precipitation of Fe, Mn and Zn in unavailable from absorbing by plants. Thus, foliar application seems to be valuable in micronutrient deficiency symptoms (Marschner, 1995, Taiz and Zeiger, 1998 and EL- Seginy *et al.*, 2003). Experiments showed an increase in fruit set and yield when gibberellic acid was applied to flower clusters (Makarem and Mokhtar, 1996 and EL- Seginy and Khalil, 2000). However, GA_3 treatment leads to reduction in fruit drop and improving of most fruit characteristics (Mansour, 1979, Helail, 1986 and Pezk, 1988) on pear trees. Also, the effect of GA_3 has at least three important actions, the first one, is that GA_3 intensifies an organ ability to function as a nutrient sink, a second one is that GA_3 ability to increase the synthesis of IAA in plant tissues and the third one involves synthesis acceleration of hydrolytic enzymes as amylase and other hydrolytic enzymes in aleurone cells (Addicott and Addicott, 1982). Moreover, the effect of liquid organic fertilizer such as aminofert was made for the some purpose, also the harmful effect of using hormones can be avoided by using aminofert. However commercial application of liquid organic fertilizer at the orchard is still very limited (EL-Sayed, 2005).

Accordingly, this study was aimed to evaluate the effect of spray application of a mixture of chelated (Fe, Zn and Mn), gibberellic acid and Easterna Aminofert super (Amino acids 20% + organic acid 12% + chelated micro elements Fe, Mn, Zn and B 3.6%) on the fruit set, yield, fruit quality and the leaf mineral contents of "Le-Conte" pear trees.

MATERIALS AND METHODS

The present study was carried out during 2006 and 2007 growing seasons on the 14 years old of Le-Conte pear trees (*Pyrus communis* L. × *Pyrus pyrifolia* N.) budded on *Pyrus communis* rootstock planted at 5 × 5 m. apart and grown in a calcareous sandy loam soil in Borg EL-Arab region, about 60 kilometers west of Alexandria. The experimental soil was analyzed before starting the experimental and the data are presented in Table (1).

All trees were pruned in winter and annually fertilized with organic manure at a rate of 20 m^3/ fed., and calcium super phosphate (15.5% P_2O_5) at a rate of 1 kg/ tree in November and ammonium sulphate at a rate of 2.5 kg/ tree, in two equal doses in mid March and mid May were added. Potassium sulphate (48% K_2O) at a rate 750 g/ tree was added in three equal doses in mid March, April and May. The trees were furrow irrigated with Nile water 4 to 5 times during the growing seasons.

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The selected trees were nearly similar in vigor and sprayed with different treatments in the two seasons, as follows:

T_1- Foliar spray with tap water only (control).

T_2- Foliar spray with a mixture of chelated* (Fe, Zn and Mn) at 0.05%.

T_3- Foliar spray with GA_3 at 20 ppm.

T_4- Foliar spray with Easterna aminofert** (20% amino acid + 12% organic acid + 3.6% chelated micro nutrients (Fe + Mn + Zn +B) at 0.25%.

T_5- Foliar spray with a mixture at chelated (Fe, Zn and Mn) at 0.05 + GA_3 at 20 ppm.

T_6- Foliar spray with Easterna aminofert at 0.25% and GA_3 at 20 ppm.

Table (1): Soil analysis of the experimental orchard:

Soil depth (cm)	Texture	pH	EC. (dS/m)	O.M. (%)	Total $CaCO_3$	Soluble cations (meq/ 100g soil)				DTPA-extractable (mg/ kg)		
						Na^+	K^+	Ca^{++}	Mg^{++}	Fe	Mn	Zn
0- 30	Sandy	8.19	3.06	0.48	25.30	2.89	0.157	9.98	8.84	0.38	0.46	0.29
30- 60	Clay	7.95	2.56	0.50	27.10	3.35	0.074	8.74	3.32	0.37	0.44	0.28
60- 90	calcareous	7.85	2.45	0.53	29.18	2.87	0.096	8.70	4.43	0.33	0.39	0.24

*** A mixture of chelated composition:**

Fe- EDDHA (6% Fe), Zn- EDTA (14% Zn) and Mn- EDTA (12% Mn)

**** Aminofert (Liquid organic fertilizer) composition:**

A-Amino acids (20%)

- *Glycine
- *Glutamic acid
- *Glutamine
- *Methionine
- *Systeine
- *Aspartic acid
- *Lysine
- *Phynylalanine
- *Valine
- *Lecithin

B- Organic acids (12%)

- *Citric
- *Lactic
- *Phosphoric
- *Aminobnzoic
- *Tartaric
- *Acetic
- *Formic

C- Chelated microelements (3.6%)

- * Iron 2%
- * Zinc 1%
- * Manganese 0.5%
- * Boron 0.1%

Trees were sprayed with the above treatments, three times, at 70% full bloom, after fruit set (fruit diameter 2 cm) and after one month of fruit set. Foliar sprays were applied using a hand pressure sprayer. Triton B emulsifier at a rate of 0.1% was used as a surfactant. Each tree received 5 liters of spraying solution; each treatment was surrounded with two rows as guard trees.

Treatments were replicated four times in a completely randomized block design. Each replicate consisted of two trees, totally forty eight trees. The following parameters were determined in the two successive seasons:

1- Fruit set percentage: The total number of flowers on each limb was counted at full bloom. The number of set fruit was counted on the same limbs after one month from full bloom. Fruit set percentage was calculated as follows;

$$\text{Fruit set percentage} = \frac{\text{Number of developing fruitlets}}{\text{Total number of flowers}} \times 100$$

2- Yield per tree: Fruits were harvested at maturity stage (the second week of August), from each tree of various replicates and yield was recorded, as number and weight in kilograms; Also increment percentage compared with the control which calculated the following equation:

$$= \frac{\text{Yield (kg) / treatmen t - Yield (kg) / control}}{\text{Yield (kg) / control}} \times 100$$

3- Fruit quality:

A. Fruit firmness was estimated by Magness and Taylor (1925) pressure tester which has a standard 5/16 of inch plunger and recorded as Ib/ $inch^2$.

B. TSS% by hand refractometer.

C. Acidity was determined (as g malic acid/ 100g fresh weight) according to A.O.A.C. (1980).

D. Total sugars in the fruit pulp tissues, were determined by phenol sulfuric method according to (Dubois *et al.*, 1956).

4- Leaf mineral content: In late July a leaf sample of 30 leaves was collected from each experimental tree from the middle part of the outer shoots and washed with tap water, rinsed twice with distilled water and then dried at 70°C to a constant weight. The dried leaf material of each sample was then ground in porcelain mortar to avoid contamination. 0.3 gm from each ground sample was digested in H_2SO_4 and H_2O_2 according to Evenhuis and DeWaard (1980). Suitable a aliquots were then taken for mineral determination. Total nitrogen and phosphorus were determined calorimetrically according to Evenhuis (1976) and Muphy and Riley (1962), respectively. Potassium determined against a standard by flamephotometer (corning 410). Iron, zinc and manganese by a Perkin Elmer Atomic Absorption Spectrophotometer. The concentrations of nitrogen, phosphorus and potassium were expressed as percent, while those of iron, zinc and manganese were expressed as parts per million, on dry weight basis.

Data were statistically analyzed according to Snedecor and Cochran (1990) and L.S.D. test at 0.05 levels was used for comparison between treatments.

RESULTS AND DISCUSSION

1- Percentage of fruit set:

Data concerning the effect of treatments on fruit set % during the two experimental seasons are listed in Table (2).

The data showed that, in both seasons, the Aminofert alone and GA_3, either alone or combined with the chelated mixture (Fe, Zn and Mn) or Aminofert significantly increased fruit set percentage when compared with the control. Also, spraying GA_3 with liquid organic fertilizer (Aminofert) was more effective than spraying GA_3 and chelated mixture of (Fe, Zn and Mn) or Aminofert alone.

These results may be due to the use of plant hormones, i.e. GA_3 which could lead to an increase in fruit set for deciduous trees (Makarem and Mokhtar, 1996). In addition, micro nutrient elements are needed in relatively very small quantities for adequate plant growth and fruit production. Micronutrients deficiency causes a great disturbance in the physiological and metabolic processes in the plant (EL-Gazzar *et al.*, 1977).

In general these results are in line with those reported by Awad and Atawia (1995b), Makarem and Mokhtar (1996), Kabeel *et al.*, (1998), and EL-Seginy *et al.*, (2003) who worked on pear and apple, EL-Safty *et al.*, (1998) and EL-Sayed (2005)who worked on citrus and Abd- Ella and EL-Sisi (2006) who worked on fig trees.

2- Yield (as number of fruit or kg/ tree):

Results as shown in Table (2) revealed that, for both seasons the chelated mixture treatment exhibited favorable effect on increasing fruit number or kgs per tree. However the difference among them or the control was not big enough to be significant. The fruit production significantly increased as consequence of Aminofert and GA_3 treatments or GA_3 associated with the chelated mixture or Aminofert. In addition, chelated mixture or Aminofert treatment combined with the GA_3 increased the yield significantly than that of GA_3 treatment.

The increased yield values were in the following descending order: Aminofert + GA_3 > chelated mixture + GA_3 > Aminofert > GA_3 > chelated mixture > control. These results are due to the use of GA_3, and micro nutrients or Aminofert which led to an increase in fruit set, and GA_3 played a major role in enlarging fruit size. Moreover, the chelated of Fe, Zn and Mn caused an increase in total yield of Le-Conte pear trees because the Fe has an important function in enzymatic systems and chlorophyll formation and consequently increased photosynthesis which finally increase the yield (Smith, 1957). In addition Mn spray is a minor constituent of plant chlorophyll which is responsible for photosynthesis (Mengel and Kirkly, 1987). Also, the improvement of yield as a results of Zn sprays may be explained by the fact that Zn plays a role in Tryptophan synthesis which is the precursor of endogenous natural hormone (IAA) which is necessary for all plants metabolic processes (Price, 1970 and Jyung *et al.*, 1975).

Also, the liquid organic fertilizer (aminofert) either alone or combined with the GA_3 treatment increased yield (as number of fruits or kgs/ tree) as compared with the control. This supports the idea that Fe, Mn, Zn, organic and amino acids sprayed on the leaves transported to leaves and fruit to improve nutritional statue and to avoid any yield depression (Abd EL- Kader *et al.*, 2002 and EL- Sayed, 2005).

In general these results are in harmony with those obtained by Makarem and Mokhtar (1996) and EL- Seginy and Khalil (2000) They reported that foliar spray of GA_3 increased the fruit set, fruit weight and therefore increased the yield. Also, EL- Seginy *et al.*, (2003) and Abd- Ella and EL-Sisi (2006) reported that foliar spray of GA_3 alone or combined with the chelated mixture increased the fruit set and total yield of Anna apple trees and Sultani fig trees, respectively.

Concerning percentage of yield increment, data in the same table indicated that all treatments had a highly significant effect as compared to untreated trees (control) except treatment 2 (Fe, Zn, and Mn) at 0.05%. In this respect, yield increment (%) reached it's maximum values as a result of (Aminofert at 0.25% +

Table (2): Effect of spray applications of micronutrients, liquid organic fertilizer (Aminofert) and/ or GA_3 on fruit set and yield of Le-Conte pear trees during 2006 and 2007 seasons:

Treatments	Fruit set (%)		No. of Fruits/ tree		Yield/ tree (kg)		Yield increment (%)	
	2006	2007	2006	2007	2006	2007	2006	2007
Control	18.41	19.10	164	170	29.37	30.19	0.00	0.00
(Fe + Zn + Mn) at 0.05% *	19.86	20.73	181	189	31.29	32.24	6.33	6.53
GA_3 at 20 ppm	20.65	21.69	194	197	33.86	35.97	14.62	19.08
Aminofert at 0.25% **	20.88	21.72	198	203	34.43	36.38	17.12	19.86
(Fe+ Zn + Mn) at 0.05% + GA_3 at 20 ppm	20.98	22.89	203	208	37.58	38.95	27.62	28.82
Aminofert at 0.25% + GA_3 at 20ppm	22.91	23.96	211	216	41.25	43.11	40.37	42.93
L.S.D. at 0.05	1.82	2.21	25	20	1.97	2.07	14.16	10.44

* Fe- EDDHA (6% Fe), Zn- EDTA (14% Zn) and Mn- EDTA (12% Mn)

** Amino acids 20% + organic acids 12% and chelated micro elements 3.6

Table (3): Effect of spray applications of micronutrients, liquid organic fertilizer (Aminofert) and/ or GA_3 on the fruit quality of Le-Conte pear trees during 2006 and 2007 seasons:

Treatments	Fruit firmness (lb/ inch^2)		TSS (%)		Acidity		TSS/ acid ratio		Total sugar (%)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	14.14	14.18	12.02	12.18	0.43	0.44	28.35	27.17	8.70	8.76
(Fe + Zn + Mn) at 0.05% *	14.12	14.11	12.07	12.28	0.42	0.41	30.95	31.09	8.88	9.08
GA_3 at 20 ppm	13.98	13.94	12.23	12.41	0.39	0.39	34.16	35.35	9.03	9.20
Aminofert at 0.25% **	13.99	13.95	12.46	12.56	0.38	0.37	35.27	36.32	9.16	9.31
(Fe+ Zn + Mn) at 0.05% + GA_3 at 20 ppm	13.88	13.85	12.49	12.61	0.38	0.37	36.13	37.13	9.23	9.36
Aminofert at 0.25% + GA_3 at 20ppm	13.84	13.81	12.62	12.74	0.36	0.35	38.90	39.38	9.37	9.52
L.S.D. at 0.05	0.16	0.23	0.19	0.23	0.04	0.05	5.69	7.95	0.20	0.34

* Fe- EDDHA (6% Fe), Zn- EDTA (14% Zn) and Mn- EDTA (12% Mn)

** Amino acids 20% + organic acids 12% and chelated micro elements 3.6

Table (4): Effect of spray applications of micronutrients, liquid organic fertilizer (Aminofert) and/ or GA_3 on leaf mineral content of Le-Conte pear trees during 2006 and 2007 seasons:

Treatments	N (%)		P (%)		K (%)		Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	1.96	1.91	0.211	0.215	1.20	1.23	84	86	45	48	41	43
(Fe + Zn + Mn) at 0.05% *	2.03	1.97	0.209	0.211	1.16	1.19	97	99	51	53	47	48
GA_3 at 20 ppm	2.10	2.07	0.192	0.194	1.04	1.07	95	97	50	52	46	46
Aminofert at 0.25% **	2.24	2.30	0.199	0.198	1.22	1.22	102	104	53	57	52	54
(Fe+ Zn + Mn) at 0.05%+ GA_3 at 20 ppm	2.37	2.44	0.195	0.195	1.12	1.14	99	103	52	54	51	52
Aminofert at 0.25% + GA_3 at 20ppm	2.43	2.49	0.205	0.203	1.28	1.30	105	105	55	57	54	57
L.S.D. at 0.05	0.13	0.015	0.005	0.007	0.06	0.05	8	10	5	4	5	3

* Fe- EDDHA (6% Fe), Zn- EDTA (14% Zn) and Mn- EDTA (12% Mn)

** Amino acids 20% + organic acids 12% and chelated micro elements 3.6

GA_3 at 20 ppm) and (Fe + Zn + Mn) at 0.05% + GA_3 at 20 ppm) treatments which gave the highest rate in yield increment (%) as compared with other treatments in both seasons, respectively. These results are in conformity with that previously mentioned by Helail (1986), Gobara (1998) and EL- Sayed (2005).

3- Fruit quality:

The data presented in Table (3) indicated that, in both seasons, the experimental treatments, generally, increased fruit TSS, total sugars, TSS/ acid ratio and decreased fruit firmness, Juice acidity. Treatments 3, 4, 5 and 6 (GA_3 at 20 ppm, Aminofert at 0.25%, "Fe, Zn, Mn' at 0.05% + GA_3 at 20 ppm and Aminofert at 0.25% + GA_3 at 20 ppm, respectively) significantly decreased fruit firmness and acidity as compared with the control and significantly increased fruit TSS, total sugars and TSS/ acid ratio than the control.

However, the differences between the Aminofert treatment and Aminofert + GA_3 were not statistically significant during both years of this study. The results also indicated that the highest significant value of fruit quality was from trees treated with chelated mixture (Fe, Zn and Mn) at 0.05 + GA_3 at 20 ppm and Aminofert (20% amino acids + 12% organic acids + 3.6% chelated micronutrients "Fe+ Mn+ Zn+ B") at 0.25% + GA_3 at 20 ppm in both seasons. However, spraying experimental trees with a separate mixture of (Fe, Zn and Mn) at 0.05% is lower value. These findings agreed with those found by EL-Menshawi *et al.*, (1997), EL- Safty *et al.*, (1998), EL-Sayed (2005) on citrus, Awad and Atawia (1995b), Kabeel *et al.*, (1998), EL- Shazly (1999), EL- Seginy and Khalil (2000), EL- Seginy *et al.*, (2003) on apple and pear and Abd- Ella (2006) on sultani fig tress.

4- Leaf mineral content:

It is clear from the data in Table (4) that leaf N content was significantly increased while leaf P content was significantly decreased as a result of spraying with Aminofert alone and GA_3 whether alone on in combination with chelated mixtures or Aminofert when compared with the control, in both seasons. Also, GA_3 alone or combined with a mixtures of chelated (Fe, Zn and Mn) treatments significantly decreased K level in the leaves than that of the control, however, the aminofert + GA_3 treatment significantly increased K content in the leaf than that of the all treatments. As for microelements concentration, the data revealed that the concentration of Fe, Zn and Mn was increased in all spraying treatments. These results may be due to that GA_3 may intensifies as organ ability to function as a nutrient sink (Addicott and Addicott, 1982).

In addition the effect on plant nutrient status resulted from spraying different solutions might be attributed to quick absorption via leaves and the limited lass of the nutrients when they were sprayed (Marschner, 1995). As for the reductions in leaf P content might be attributed to the antagonism between Fe and P (Nawar, 1991). These results agreed to some extent with Sourour (1992), Awad and Atawia (1995 a), Kabeel *et al.*, (1998), EL- Shazly (1999). EL- Seginy and Khalil (2000), EL- Shobaky *et al.*, (2001), EL- Seginy *et al.*, (2003) and Abd-Ella and EL- Sisi (2006) who worked on deciduous trees and EL- Sayed (2005) who worked on citrus.

CONCLUSION

The obtained results in the present research strongly proved that foliar application of Le-Conte pear trees with GA_3 alone, chelated mixture + GA_3 and Aminofert + GA_3 are recommended to increase fruit set, yield quantity and fruit quality of trees grown in a calcareous soil.

Also, no significant difference were found between Aminofert and Aminofert + GA_3 treatment. Thus, the harmful effect of using hormones can be avoided by using such organic fertilizer or chelated mixture.

The combination from chelated form of microelements or Aminofert and GA_3 appears to give the best responses.

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الملخص العربى

تأثير الرش بالسماد العضوى السائل " أمينوفرت " وبعض المغذيات الصغرى والجبريلين على المحتوى المعدنى للأوراق ونسبة العقد والمحصول وصفات جودة الثمار لأشجار الكمثرى الليكونت

ملكة صبحى محمد نعيمة

محطة بحوث البساتين بالصبحية – الإسكندرية

معهد بحوث البساتين- مركز البحوث الزراعية- مصر

أجرى هذا البحث عامى ٢٠٠٦ ، ٢٠٠٧ على أشجار كمثرى صنف ليكونت عمرها ١٤ سنة المنزرعة فى أرض جيريـــة بمنطقـــة برج العرب (تبعد حوالى ٦٠ كم غرب الإسكندرية) لدراسة تأثير الرش الورقى بالسماد العضوى السائل (أمينوفرت: ٢٠% أحماض أمينيـــة + ١٢% أحماض عضوية + ٣,٦% عناصر دقيقة مخلبية) والجبريلين والمخلوط من الحديد والزنك والمنجنيز المخلبى كلاً بمفرده أو مخلـــوطين معاً (الجبريلين+ أمينوفرت أو الجبريلين+ مخلوط مخلبى من الحديد والزنك والمنجنيز) على نسبة العقد والمحصول وصـــفات جـــودة الثمـــار والمحتوى المعدنى للأوراق، أظهرت النتائج أن الرش بالجبريلين أو الأمينوفرت منفرداً أو مخلوط من الجبريلين+ الأمينوفرت أو الجبـــريلين+ المخلوط المخلبى من الحديد والزنك والمنجنيز أدى إلى زيادة نسبة العقد والمحصول وتحسين جودة الثمار من حيث انخفاض صـــلابة الثمـــرة وانخفاض نسبة الحموضة وارتفاع المواد الصلبة الذائبة وارتفاع نسبة السكريات الكلية وكانت الزيادة فى المحصول بالترتيب التالى: أمينـــوفرت + الجبريلين > مخلوط من الحديد والزنك والمنجنيز + الجبريلين > أمينوفرت > الجبريلين > مخلوط من الحديد والزنك والمنجنيز > الكنترول.

وكان محتوى الأوراق من النيتروجين والحديد والزنك والمنجنيز مرتفعاً بينما انخفض محتوى الأوراق من الفوسفور خـــلال عـــامى الدراسة. أيضاً حققت المعاملة [أمينوفرت ٢٠% أحماض أمينية+ ١٢% أحماض عضوية+ ٣,٦% عناصر دقيقة مخلبيـــة) بتركيـــز ٠,٢٥%+ الجبريلين بتركيز ٢٠ جزء فى المليون] أفضل النتائج خلال عامى الدراسة.