Effect of Calcium and Boron Treatments on Yield, Fruit Quality, Leaf and Fruit Mineral Contents of Pear Trees Grown in Calcareous Soils

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ABSTRACT

The "Le Conte" pear trees grown in calcareous soils were sprayed with boric acid at 0.1 and 0.2% at fruit set and at one month later and chelated calcium at 0.2 and 0.3% at fruit set and at two months later, each alone or combined together during 2005 and 2006 seasons. All treatments increased the yield (kg)/tree and fruit weight as compared to the control. The highest yield and fruit weight were recorded with the combination of boric acid at 0.2% + chelated calcium at 0.3% treatment as compared to the control. Chelated calcium increased fruit firmness as compared to the control. The boric acid treatment alone or combined with chelated calcium increased TSS (%) in the fruit juice as compared to the control. All chelated calcium treatments alone or combined with boric acid increased both leaf and fruit calcium content (%). All boric acid treatments alone or combined with chelated calcium increased both leaf and fruit boron content (ppm). Generally, both boric acid and chelated calcium sprays are recommended to increase pear tree yield and improve fruit quality of "Le Conte" pear trees grown in calcareous soils.

INTRODUCTION

"Le Conte" pear cultivar is one of the most important deciduous fruit that shows a great success and is wide spreading in the new reclaimed soils (mostly are of calcareous soils).

Calcium deficiency can be influenced by different orchard factors (Wilkinson and Pering, 1967). Several factors affected the productivity of trees such as the macro and microelements deficiencies. Calcium deficiency occurs or increases a host of physical disorders in deciduous trees (Shear, 1975). Calcium can be affected by either orchard sprays or postharvest drenches with Ca-containing compounds (Goor, 1971; Turner, *et al.*, 1977; and Greene and Smith, 1979). Meny types of Ca are used for spraying orchard with low concentrations. Calcium concentrations may not be high enough to avoid serious losses from bitter pit or senescent breakdown. Thus it would be advantageous to find a material that would either provide Ca to pears more efficiently without phytotoxicity by $CaCl_2$ or $Ca(NO_3)_2$ or to find a formula that would increase fruit Ca uptake without any phytotoxicity. Calcium is perhaps the most important mineral determining the quality of fruit. A number of researchers reported that pre- or post-harvest application of calcium extended the shelf-life of climacteric fruits by maintaining firmness, reducing respiration rate and increasing marketability (Lidster *et al.*, 1978 on cherries; Haggag, 1987 on pear and Singh *et al.*, 1993 on mango). In addition, El-Naggar *et al.* (2005) found that preharvest spraying of calcium on seedless guava increased the fruit firmness, calcium and vitamin C content as compared to the control.

Boron deficiency causes fruit disorders and cracking or seaming (Benson *et al.*, 1983). Boron element plays an important role in protein synthesis, sugar transport, hormone anabolism and catabolism and growth of pollen tube (La Rue and Johnson, 1989). Kilany and Kilany (1991) working on "Anna" apple reported that boron sprays significantly increased the shoot length and diameter. Boron has been recognized as an essential element for plant growth for more than later sixty years, the low concentrations and narrow range of boric acid were used to cure deficiency and prevent toxicity and obtain higher fruit yield (Haggag *et al.*, 1995 on mango). On Blueberry (*Vaccinium angustifolium* Ait.) clones, all the three treatments (B, Ca, B + Ca) increased the average of pollen grain germination. More seeds per berry with the B-alone treatment imply more ovules fertilized when B deficiency is remedied (Chen *et al*, 1998). Also, on "Anna' apple trees, boric acid caused insignificant effect on fruit diameter, length volume and weight, but sprays increased acidity, total sugars and anthocyanin content (Mostafa *et al.*, 1999). Peryea *et al.* (2003) on 'Scarlet Gala' apple found that sprays of boron at the recommended annual boron maintenance rate of 0.56 Kg./ha. consistently increased fruit boron concentration but had a weaker effect on leaf boron concentration in early August (the recommended timing for sampling leaves for mineral element analysis). Results of these experiments indicated that applying B sprays at the pink flowering stage timing and tank-mixing B with $CaCl_2$ sprays applied for bitter pit control are useful practices to enhance B spray efficacy. All treatments of Ca + Mg + Titanium elements increased tree performance (branch elongation, flowering and fruit set intensities) and fruit size of peach fruits (López *et al.*, 2004).

The present study was carried out to study the effect of pre-harvest sprays of calcium and boron treatments on the leaf and fruit mineral composition, yield and fruit quality of "Le Conte" pear trees.

MATERIALS AND METHODS

The current study was performed in the newly reclaimed calcareous soil (Private orchards) at Borg El-Arab, Alexandria Governorate, during 2005 and 2006 seasons under flood irrigation system, using forty five trees, 15 years' old of "Le Conte" pear trees (***Pyrus communis*** **L. x** ***Pyrus***

pyrifolia **N.**) grafted on ***Pyrus communis*** rootstock and planted at 5 x 6 m apart. The studied trees were similar as possible in vigor and subjected to common orchard management in both successive seasons. The soil of the experimental orchard was calcareous with pH 8.1, EC. 1.35 ds/m and contained 4.82, 6.97, 4.68 and 4.03 meq/l of HCO_3^-, Ca^{++}, Mg^{++} and Cl^-, respectively.

The following foliar sprays were performed:

1. 0.1% H_3BO_3 at fruit set and at two months later.
2. 0.2% H_3BO_3 at fruit set and at two months later.
3. 0.2% chelated Ca at fruit set and one month later.
4. 0.3% chelated Ca fruit set and one month later.
5. 0.1% H_3BO_3 + 0.2% chelated Ca at fruit set and at two months later.
6. 0.2% H_3BO_3 + 0.2% chelated Ca at fruit set and at two months later.
7. 0.1% H_3BO_3 + 0.3% chelated Ca at fruit set and at two months later.
8. 0.2% H_3BO_3 + 0.3% chelated Ca at fruit set and at two months later.
9. Control (untreated).

Randomized complete block design was outlined. Each treatment included five replicates (one tree for each replicate) and four branches were chosen for determine different obtained data. In both seasons, leaf mineral contents were determined in mid August. Samples of 30 leaves/tree were taken at random from the previously tagged shoots of each tree. Leaf and fruit samples were washed with tap water, rinsed twice in distilled water, oven dried at 70 °C to a constant weight and then grounded. The ground samples were digested with sulphuric acid and hydrogen peroxide according to Evenhuis and Dewaard (1980). N and P were calorimetrically determined according to Evenhuis (1976) and Murphy and Riley (1962), respectively. Potassium was determined against a standard by flame photometer according to Chapman and Pratt (1961). Calcium, magnesium, iron, zinc and Manganese were determined using Perken Elemer Atomic Absorption Spectrophotometer. Boron was determined calorimetrically by the carmine method according to Hatcher and Wilcox (1950). The concentrations of N, P, K, Ca and Mg were expressed as percent (%), while the Fe, Zn, Mn and B were expressed as part per million (ppm) on dry weight basis.

Yield was recorded for each treatment as number of fruits per tree and yield weight (kg.) was estimated by multiplying the number of fruits by the average of fruit weight.

Ten mature fruits of each replicate were taken to determine the fruit weight (g), fruit firmness and dimensions (cm). Magness and Taylor (1925) pressure tester, which has a standard 5/16 of inch plunger and recorded as lb/Inch^2 was used to determine fruit firmness.

Total soluble solids (T.S.S.%) was determined by ATAG hand refractometer, acidity (%) was determined (as malic acid) by titration with 0.1N sodium hydroxide with phenol- phethalin as an indicator and vitamin C content was determined in fruit juice using 2, 6-dichlorophenol-indophenol dye as mg ascorbic acid per 100 ml juice (A.O.A.C., 1980).

The starch was determined in 0.1 gm of the residue by hydrolysis with concentrated HCl for 3 hours under reflux condenser (A.O.A.C., 1980).The total reducing starch was determined by Malik and Singh (1980), and factor 0.9 was used to calculate the starch content (Woodman, 1941).

The total sugars were determined calorimetrically using phenol and sulphuric acid according to Malik and Singh (1980). The reducing sugars were determined by the Nelson arsenate- molybdate colorimetric method (Dubois *et al.*, 1956) then, non-reducing sugars was calculated by the difference between total soluble sugars and reducing sugars.

All obtained data were statistically analyzed according to Steel and Torrie (1980) and L.S.D. test at 0.05 level was used for comparison between means of treatments.

RESULTS AND DISCUSSION

Fruit yield/tree:

The obtained results of fruit yield (Kg)/ tree as affected by the different treatments of boric acid at 0.1% and 0.2% and chelated calcium at 0.2% and 0.3% both alone or combined together are shown in Fig. (1). All treatments increased significantly fruit yield (kg)/tree as compared to the control. The highest yield values (85.31 and 86.54 Kg/tree) were recorded by the boric acid treatment (H_3BO_3) at 0.2% + chelated calcium at 0.3% as compared to the lowest values (75.78 and 77.92 Kg/tree) of the control for the two seasons of the study, respectively. The other treatments showed intermediate values.

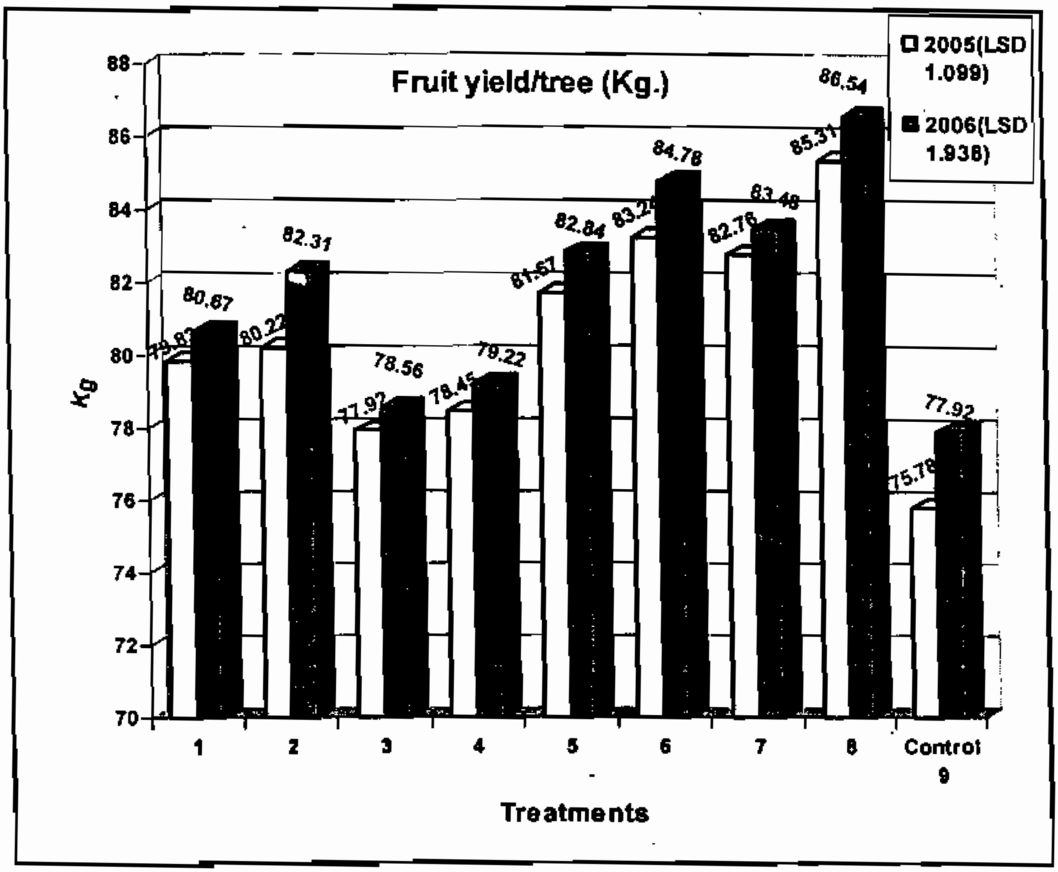

Fig. (1): Effect of chelated calcium and boron treatments on the yield/tree (Kg) of "Le Conte" pear trees during 2005 and 2006 seasons

1. 0.1% H_3BO_3 at fruit set and at two months later.
2. 0.2% H_3BO_3 at fruit set and at two months later.
3. 0.2% chelated Ca at fruit set and one month later.
4. 0.3% chelated Ca at fruit set and one month later.
5. 0.1% H_3BO_3 + 0.2% chelated Ca at fruit set and at two months later.
6. 0.2% H_3BO_3 + 0.2% chelated Ca at fruit set and at two months later.
7. 0.1% H_3BO_3 + 0.3% chelated Ca at fruit set and at two months later.
8. 0.2% H_3BO_3 + 0.3% chelated Ca at fruit set and at two months later.
9. Control (untreated).

The present results are in harmony with the previous results of Haggag *et al.* (1995) who obtained higher fruit yield on mango by using boron and of Peryea *et al.* (2003) on 'Scarlet Gala' apple, who found that mixing Ca with B increased the B efficiency and also, agree with López *et al.* (2004) on peach.

Fruit weight, dimensions and firmness:

The effect of different foliar spraying concentrations of boric acid at 0.1% and 0.2% and chelated calcium at 0.2% and 0.3% both alone or combined together on fruit weight, dimensions and firmness are presented in Table (1). All treatments increased significantly fruit weight (g) as compared with the control (unsprayed) in the two studied seasons. The highest significant fruit weights (157.82 and 159.36 g) were obtained by the spraying of 0.2% boric acid + 0. 3% Ca-chelated followed by 0.1% boric acid + 0.3% Ca-chelated which recorded fruit weights (152.32 and 155.31 g.) as compared to the lowest fruit weights (139.36 and 140.85g.) obtained by the control (unsprayed) in the two seasons, respectively. As regard to fruit length, all treatments increased significantly fruit length in the two studied seasons as compared to the control except the treatments of chelated Ca at 0.2 and 0.3% in the first season and those of 0.1% boric acid and 0.2% Chelated Ca in the second season that recorded insignificant increment in fruit length as compared to the control. The highest significant fruit length values (6.84 and 6.89 cm) were recorded by the treatment of 0.2% boric acid + 0.3% chelated Ca as compared to the control (6.5 and 6.5 cm) in the two studied seasons, respectively. Fruit diameter was increased significantly by all treatments except the treatments of 0.2% and 0.3% cheated Ca in the two seasons and 0.1% boric acid in the second seasons where the increment was insignificant, the highest significant values (6.21 and 6.27cm) were recorded by the treatment of 0.2% boric acid + 0.3% chelated Ca as compared to the lowest values of the control (5.99 and 6.00 cm) in the two studied seasons, respectively. As regard to fruit firmness, all treatments of chelated Ca alone increased fruit firmness, but the treatment of 0.1% boric acid + 0.3% chelated Ca recorded the highest fruit firmness values (16.71 and 17.71 lb/Inch^2) as compared to the control (15.65 and 16.46) in the two studied seasons, respectively. All boric acid treatments alone showed insignificant values as compared to the control.

The present results are in line with Haggag (1987 on pear and 1995 on mango) and with López *et al.* (2004) on peach.

Table (1): Effect of chelated calcium and boron treatments on some fruit physical characters of "Le Conte" pear trees during 2005 and 2006 seasons.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness ($lb/inch^2$)	
	2006	2006	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	148.37	146.45	6.67	6.52	6.09	6.08	15.62	16.41
0.2% H_3BO_3	150.46	149.25	6.70	6.69	6.12	6.11	15.54	16.37
0.2% chelated Ca	140.18	141.91	6.49	6.52	5.98	6.00	16.24	17.20
0.3% chelated Ca	142.74	143.15	6.53	6.57	6.01	6.03	16.21	17.22
0.1% H_3BO_3 + 0.2% chelated Ca	149.85	151.11	6.67	6.74	6.11	6.13	16.22	16.31
0.2% H_3BO_3 + 0.2% chelated Ca	151.22	153.22	6.71	6.77	61.13	6.15	15.31	16.22
0.1% H_3BO_3 + 0.3% chelated Ca	152.32	155.31	6.75	6.81	6.15	6.20	16.71	17.71
0.2% H_3BO_3 + 0.3% chelated Ca	157.82	159.36	6.84	6.69	6.21	6.27	15.21	16.31
Control (untreated)	139.36	140.85	6.50	8.50	5.99	8.00	15.65	16.46
L.S.D. at 0.05	1.119	2.246	0.068	0.032	0.035	0.105	0.377	0.164

Fruit chemical characteristics:

Tables (2 and 3) show the fruit chemical characteristics as affected by different treatments of foliar sprays of boric acid at 0.1% and 0.2% and chelated calcium at 0.2% and 0.3% both alone or combined together. All treatments increased significantly TSS fruit juice content (%) as compared to the control except both treatments of 0.2 and 0.3% in the first season only, where the increment was insignificant. The highest values of TSS contents (12.8 , 12.90 and 12.80%) were recorded by boric acid at 0.2% in the two seasons and by 0.2% boric acid + 0.3% chelated Ca in the first season, respectively, as compared with the lowest TSS values (11.60 and 11.40%) that recorded by the control (unsprayed trees). As regard to acidity, boric acid treatment alone (0.1 and 0.2%) decreased significantly the acidity (%) as compared to the control. On the other hend, chelated calcium treatments alone (0.2% and 0.3%) increased significantly the juice acidity (%) and the highest values (0.56 and 0.46%) were gained by 0.3% chelated calcium as compared to the values of the control (0.48 and o.40%) in both studied seasons, respectively. Boric acid increased significantly TSS/acid ratio as compared to the control, only the combination spraying of 0.2% boric acid + 0.3% increased significantly the TSS/acid ratio as compared to the control. The other treatments combinations did not gave a clear or significant effect of TSS/acid ratio. The highest TSS/acid ratio value (30.73) resulted from boric acid treatment at 0.1% in the first season and (36.86) resulted from boric acid at 0.2% in the second season as compared with the control (24.17 and 28.50) in the two seasons, respectively.

As concern to vitamin C, the treatments of chelated calcium alone at 0.2% or 0.3% or combined with boric acid at 0.2% increased significantly vitamin C content (mg/100 ml juice) as compared to the control. There were no significant differences between the two concentrations of 0.2% and 0.3% chelated in the two seasons of the study. The highest vitamin C contents (28.24 and 29.28 mg/100 ml juice) were recorded by the treatment of 0.3% in the first season and by 0.2% in the second season, respectively, as compared with the values of the control (23.81 and 24.99 mg/100 ml juice) in the first and second seasons, respectively. As regard to the total starch, the treatment of 0.2% of chelated Ca treatment in the first end second seasons and the 0.3% in the first season increased significantly the total sterch contents (%) as compared to the control, but there were no significant differences between the remained treatments and the control. Many results are in accordance with the previous data such as Drake and Spayed (1983) on apple and Gobara (1998) on pear trees.

Total sugars values as affected by the different treatments differed from season to season and the treatments of boric acid at 0.1% and0.2% in the first season and the treatment of 0.2% boric acid + 0.2% in the second season caused significant increment in total sugars as compared to the control. Regarding the reducing sugars contents, all treatments of boric acid alone or 0.2% boric acid + 0.2% chelated Ca increased significantly reducing sugars in the two studied seasons as compare to the control. The highest significant reducing sugars values (6.18 and 5.94%) were obtained by 0.2% boric acid spraying as compared to the control values (5.39 and

5.47%) in both studied seasons, respectively. The remainder of the treatments recorded insignificant differences as compared to the control.

As for non-reducing sugars, the highest value of non-reducing sugars (1.79%) was recorded by the treatment of 0.2% boric acid + 0.3% chelated Ca in the first season and (1.98%) as result of spraying 0.2% boric acid + 0.2% chelated Ca in the second season as compared to the control (unsprayed) (1.5 and 1.47%) for the 1st and 2nd seasons, respectively. The rest of treatments did not give constant values in both seasons of the study.

Table (2): Effect of chelated calcium and boron treatments on some fruit chemical characteristics of "Le Conte" pear trees during 2005 and 2006 seasons.

Treatments	TSS (%)		Acidity (%)		TSS/acid ratio		Vit. C (mg/100 ml juice)		Starch (%)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	12.60	12.80	0.41	0.37	30.73	34.59	20.61	22.15	2.58	2.67
0.2% H_3BO_3	12.80	12.90	0.42	0.35	30.48	36.86	20.55	22.02	2.57	2.64
0.2% chelated Ca	11.80	11.90	0.55	0.45	21.45	26.16	28.18	29.28	3.07	3.14
0.3% chelated Ca	11.70	11.80	0.56	0.46	20.89	25.65	28.24	29.31	3.06	3.10
0.1% H_3BO_3 + 0.2% chelated Ca	12.20	12.30	0.50	0.38	24.40	32.37	23.37	24.33	3.00	3.04
0.2% H_3BO_3 + 0.2% chelated Ca	12.80	12.60	0.43	0.34	29.77	37.06	23.57	24.86	2.97	2.98
0.1% H_3BO_3 + 0.3% chelated Ca	12.00	12.10	0.49	0.42	24.49	28.61	24.60	25.31	3.03	3.06
0.2% H_3BO_3 + 0.3% cheleted Ca	12.30	12.50	0.45	0.39	27.33	32.05	24.89	25.41	2.92	3.04
Control (untreated)	11.60	11.40	0.48	0.40	24.17	28.50	23.81	24.99	2.98	3.05
L.S.D. at 0.05	0.238	0.252	0.023	0.018	0.751	1.555	1.079	0.396	0.048	0.067

The obtained results agree with Haggag (1987 on pear and 1995 on mango) and with Mostafa *et al.* (1999) on "Anna" apple trees.

Table (3): Effect of chelated calcium and boron treatments on total, reducing and non- reducing sugars (%) of "Le Conte" pear trees during 2005 and 2006 seasons.

Treatments	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	7.81	7.18	6.18	5.90	1.65	1.28
0.2% H_3BO_3	7.92	7.22	8.18	5.94	1.74	1.28
0.2% chelated Ca	6.93	6.90	5.44	5.17	1.49	1.73
0.3% chelated Ca	6.91	6.85	5.42	5.18	1.49	1.67
0.1% H_3BO_3 + 0.2% chelated Ca	8.82	6.67	5.37	5.41	1.45	1.46
0.2% H_3BO_3 + 0.2% chelated Ca	7.12	7.81	5.64	5.83	1.48	1.98
0.1% H_3BO_3 + 0.3% chelated Ca	8.93	7.12	5.40	5.40	1.53	1.72
0.2% H_3BO_3 + 0.3% chelated Ca	7.21	7.11	5.42	5.38	1.79	1.67
Control (untreated)	8.89	6.94	5.39	5.47	1.50	1.47
L.S.D. at 0.05	0.407	0.417	0.056	0.109	0.122	0.024

Leaf mineral contents:

The pear leaf macro elements (N, P, K, Ca and Mg%) and micro elements (Fe, Zn, Mn and B ppm) as affected by different treatments as foliar spray of boric acid at 0.1% and 0.2% and chelated calcium at 0.2% and 0.3% both alone or combined together are shown in Tables (4 and 5). Regarding leaf nitrogen (N) content (%), the 0.1% and 0.2% boric acid, 0.1% boric acid + 0.2% chelated calcium, 0.2% boric acid + 0.2% chelated calcium and 0.2% boric acid + 0.3% chelated calcium treatments (in the first season) and the 0.2% boric acid and 0.2% boric acid + 0.2% chelated calcium (in the second season) significantly increased leaf N content as compared with the control, while the remained treatments showed insignificant differences as compared with the control in both seasons. The highest leaf N content values (1.978 and 1.973%) were recorded by the treatment of 0.2% boric acid + 0.2% chelated calcium as compared to the control (1.820 and 1.896%) in the 1st and 2nd seasons, respectively. As for the phosphorus content (P%), the differences between all treatments were insignificant in the first season as compared to the control, while in the second season the treatments of 0.2% boric acid, 0.1% boric acid + 0.2% chelated calcium and 0.2% boric acid + 0.2% chelated calcium treatments gave significant differences as compared to the control. As concerned to potassium (k%) and Magnesium (Mg%) leaf contents, all treatments in the two studied seasons decreased leaf potassium and magnesium content as compared to the control. As for leaf calcium (%), boric acid treatments alone did not affect significantly the Ca (%) leaf content as compared to the control. On the other hand, all treatments of chelated calcium alone or combined with boric acid increased significantly leaf calcium content (Ca %) as compared to the unsprayed control in the two studied seasons. Regarding the leaf iron (Fe%), there were no significant differences between all treatments and the control in the first season, but in the second season, the two treatments of .0.2% boric acid + 0.2% chelated calcium and 0.1% boric acid + 0.3% chelated calcium increased significantly leaf Fe content as compared and recorded value of (201 ppm) as compared to the value of the control (192 ppm). As for zinc content (Zn ppm), there were insignificant increment in Zn content in the first season as compared to the control, but in the second season, all treatments of chelated calcium alone or combined with boric acid increased significantly Zn content (ppm) as compared with the control. In the meantime, boric acid caused insignificant increment in leaf Zn content as compared to the control.

Regarding to manganese leaf content (Mn ppm), all treatments increased significantly Mn content in the two studied seasons as compared to the control, except the treatments of boric acid at 0.1 and 0.2% in the both seasons and 0.2% chelated Ca in the second season. As for leaf boron content (ppm), all the treatments of boric acid alone or combined with chelated calcium increased significantly leaf boron content in both studied seasons as compared with the control. These results seemed to be in agreement with those previously obtained by Greene and Smith (1979) on apple trees and Haggag (1987) on pear trees.

Fruit mineral contents:

Tables (6 and 7) show pear fruit macro elements (N, P, K, Ca and Mg%) and microelements (Fe, Zn, Mn and B ppm) as affected by different treatments of foliar spray of boric acid at 0.1% and 0.2% and chelated calcium at 0.2% and 0.3% both alone or combined together. Regarding to fruit N (%) content in the two studied seasons, the treatments of 0.2% boric acid, 0.1% boric acid + 0.2% chelated Ca, 0.2% boric acid + 0.2% chelated Ca, 0.1% boric acid + 0.3% chelated Ca, and 0.2 boric acid + 0.3% chelated Ca increased significantly fruit N content as compared to the control. The highest fruit N content values (1.621 and 1.639%) were recorded by the treatment of 0.2% boric acid + 0.2% chelated Ca as compared to the control values (1.314 and 1.342%) in the first and second seasons, respectively. The treatment of 0.1% boric acid gave no significant N content increment in the first season, and the two treatments of 0.2% and 0.3% chelated Ca caused significant N content increment in the second season only. As for fruit P content, only the treatment of 0.2% chelated Ca gave significant increment in fruit P content as compared to the control in the first season only, but the remained of the treatments did no gave significant increment in P content as compared to the control. Regarding to fruit K content (%), all treatments of 0.1% boric acid + 0.2% chelated Ca, 0.2% boric acid + 0.2% chelated Ca, 0.1% boric acid + 0.3% chelated Ca, and 0.2 boric acid + 0.3% chelated Ca decreased significantly the fruit K content as compared to the control in both studied seasons. The rest of the treatments did not show statistically significant values as compared to the control in both studied seasons. As for fruit Ca content (%), all the treatments of chelated calcium either alone or combined with boric acid increased significantly Ca content as compared to the control.

In the meantime, the boric acid treatments alone did not cause significant increment in Ca content as compared to the control. As concerned of the fruit Mg content (%), all treatments of boric acid alone did not significantly increased the fruit Mg content as compared to the control, but all the treatments of calcium alone or combined with boric acid decreased significantly the fruit Mg content (%) as compared to the control in both studied seasons.

Table (4): Effect of chelated calcium and boron treatments on microelements content (%) of "Le Conte" pear leaves during 2005 and 2006 seasons.

Treatments	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	1.950	1.948	0.316	0.320	1.658	1.650	1.098	0.989	0.716	0.679
0.2% H_3BO_3	1.953	1.959	0.319	0.321	1.660	1.653	1.100	0.995	0.718	0.681
0.2% chelated Ca	1.839	1.904	0.315	0.319	1.649	1.640	1.684	1.615	0.701	0.639
0.3% chelated Ca	1.843	1.906	0.317	0.320	1.653	1.643	1.701	1.623	0.703	0.640
0.1% H_3BO_3 + 0.2% chelated Ca	1.921	1.932	0.319	0.322	1.652	1.640	1.611	1.301	0.699	0.648
0.2% H_3BO_3 + 0.2% chelated Ca	1.976	1.973	0.328	0.321	1.635	1.632	1.643	1.389	0.701	0.651
0.1% H_3BO_3 + 0.3% chelated Ca	1.911	1.932	0.328	0.316	1.632	1.633	1.821	1.799	0.693	0.631
0.2% H_3BO_3 + 0.3% chelated Ca	1.973	1.921	0.326	0.318	1.618	1.625	1.831	1.532	0.691	0.629
Control (untreated)	1.820	1.696	0.321	0.318	1.676	1.662	1.103	0.997	0.724	0.687
L.S.D. at 0.05	0.099	0.060	N.S.	0.003	0.008	0.005	0.014	0.021	0.004	0.003

Table (5): Effect of chelated calcium and boron treatments on microelements content (%) of "Le Conte" pear leaves during 2005 and 2006 seasons.

Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)		B (ppm)	
	2005	2006	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	196	193	24	25	47	46	91	96
0.2% H_3BO_3	197	193	24	26	49	48	93	98
0.2% chelated Ca	193	192	20	29	54	48	75	79
0.3% chelated Ca	194	195	21	30	55	50	77	80
0.1% H_3BO_3 + 0.2% chelated Ca	189	191	23	36	59	52	85	88
0.2% H_3BO_3 + 0.2% chelated Ca	200	201	24	33	61	53	90	95
0.1% H_3BO_3 + 0.3% chelated Ca	196	201	22	34	58	55	86	91
0.2% H_3BO_3 + 0.3% chelated Ca	199	198	23	32	53	51	91	99
Control (untreated)	195	192	23	25	48	44	78	81
L.S.D. at 0.05	7.463	8.583	2.313	1.960	3.403	4.356	2.048	2.965

As for fruit iron (Fe) content (ppm), the lonely treatment of (0.2% boric acid + 0.3% chelated Ca application caused significant increment in Fe content (%) in the first season only, but the rest of the treatments did not gave significant increments in both studied seasons as compared to the control. As regard to fruit zinc (Zn) content (ppm), all the treatments of the two studied seasons did not gave significant increment of Zn content as compared with the control. As regard to fruit Mn content (ppm), all treatments did not increase significantly Mn content (ppm) in both studied seasons as compared to the control except the treatments of 0.2% boric acid + 0.2% chelated calcium and 0.1% boric acid + 0.3% chelated calcium (in the two seasons) and treatment of 0.1% boric acid + 0.2% chelated calcium (in the second season) which increased significantly Mn content as compared to the control. The highest Mn content values (44 and 54 ppm) were obtained by the treatment of 0.1% boric acid + 0.3% chelated calcium as compared to the control 39 and 42 ppm) in the first and second seasons, respectively. As regard to fruit boron content (ppm), all the treatments of boric acid alone or combined with chelated calcium increased significantly the fruit boron content as compared to the control in both studied seasons. All treatments of calcium alone gave insignificant differences as compared to the control in the two studied seasons. These results seemed to be in complete agreement with those observed by previous numerous investigators such as Mika and Antoszewski (1983), Bramlage *et al.* (1985), Meheriuk and Moyls (1989) and Ahmed (1995) working on apple trees.

Generally, both boric acid and chelated calcium seemed to be important factors for increasing pear tree yield and improving the fruit quality of "Le Conte" pear trees grown in calcareous soils.

Table (6): Effect of chelated calcium and boron treatments on microelements content (%) of "Le Conte" pear fruits during 2006 and 2006 seasons.

Treatments	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2006	2006	2005	2006	2006	2006	2006	2006	2006	2006
0.1% H_3BO_3	1 460	1.342	0.215	0.209	0.927	0.948	0.334	0.339	0.360	0.371
0.2% H_3BO_3	1 463	1.344	0.216	0.209	0.926	0.948	0.336	0.340	0.362	0.374
0.2% chelated Ca	1.316	1 429	0 220	0.205	0.919	0.941	0.760	0.779	0.309	0.330
0.3% chelated Ca	1 318	1 429	0.219	0.209	0.920	0 945	0.781	0.781	0.311	0.331
0.1% H_3BO_3 + 0.2% chelated Ca	1.421	1.431	0.218	0.213	0.912	0.941	0.560	0.423	0.331	0.361
0.2% H_3BO_3 + 0.2% chelated Ca	1.621	1.639	0.218	0.212	0.997	0.930	0.561	0.411	0.321	0.352
0.1% H_3BO_3 + 0.3% chelated Ca	1.432	1.548	0.216	0.212	0.899	0.929	0.721	0.681	0.311	0.341
0.2% H_3BO_3 + 0.3% chelated Ca	1.538	1.611	0.212	0.210	0.897	0.923	0.731	0.610	0.302	0.340
Control (untreated)	1.314	1.342	0.214	0.208	0.925	0.952	0.334	0.339	0.365	0.372
L.S.D. at 0.05	0.005	0.004	0 005	N S.	0.008	0.010	0.009	0.005	0 007	0.005

Table (7): Effect of chelated calcium and boron treatments on microelements content (%) of "Le Conte" pear fruits during 2005 and 2006 seasons.

Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)		B (ppm)	
	2005	2006	2005	2006	2005	2006	2005	2006
0.1% H_3BO_3	86	89	14	13	41	42	52	50
0.2% H_3BO_3	87	89	13	12	42	43	53	49
0.2% chelated Ca	84	90	12	14	40	43	27	34
0.3% chelated Ca	84	90	12	13	41	44	28	35
0.1% H_3BO_3 + 0.2% chelated Ca	86	90	15	16	39	52	35	42
0.2% H_3BO_3 + 0.2% chelated Ca	87	92	16	13	43	51	38	41
0.1% H_3BO_3 + 0.3% chelated Ca	87	88	14	15	44	54	36	40
0.2% H_3BO_3 + 0.3% chelated Ca	89	91	13	14	41	53	38	39
Control (untreated)	85	90	13	14	39	42	29	35
L.S.D. at 0.05	2.857	N.S.	N.S.	1.577	2.370	2.986	2.704	2.521

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الملخص العربي

تأثير معاملات الكالسيوم والبورون على المحصول وجودة الثمار والمحتوى المعدنى لأوراق وثمار الكمثرى المنزرعة تحت ظروف الأراضى الجيرية

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رشت أشجار كمثرى صنف ليكونت منزرعة فى أراضى جيرية مستصلحة بحمض البوريك بتركيزين ٠,١ و ٠,٢% عند عقد الثمار وكذلك بعدها بشهرين والكالسيوم المخلبي بتركيزين ٠,٢ و ٠,٣% بعد عقد الثمار وكذلك بعدها بشهر منفردين أو مخلوطين معا أثناء موسمين متتالين (٢٠٠٥ و ٢٠٠٦). وقد زاد محصول ثمار كل الأشجار ووزن الثمار الناتجة كنتيجة لرش كل المعاملات عند مقارنتها بالكنترول. وقد نتج أعلى محصول ووزن الثمرة كنتيجة لرش مخلوط حمض البوريك ٠,٢% والكالسيوم المخلبي ٠,٣% عند المقارنة بالأشجار الكنترول (غير المرشوشة). وقد زادت صلابة الثمار كنتيجة لرش الكالسيوم المخلبي. وأدت كل معاملات حمض البوريك منفرداً أو مخلوطاً بالكالسيوم المخلبي إلى زيادة النســـبة المئوية للمواد الصلبة الذائبة (TSS%) عند مقارنتها بالكنترول. ولقد زاد محتوى الكالســـيوم (%) فى الأوراق والثمار كنتيجة لرش الكالسيوم المخلبى منفرداً أو مخلوطاً بحمض البوريك عند مقارنتها بالكنترول. أما رش حمض البوريك منفرداً أو مخلوطاً بالكالســـيوم المخلبي فقد أدى إلى زيادة محتوى البورون (جزء/مليون) فى الأوراق والثمار عند مقارنتها بالكنترول. وبصفة عامة، فانه يمكن التوصية برش حمض البوريك مخلوطاً بالكالسيوم المخلبي لزيادة المحصول وتحسين جودة ثمار أشجار الكمثرى الليكونت المنزرعة تحت ظروف الأراضى الجيرية.