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Research Article

Vegetative growth, fruit set, yield and fruit quality of "Le-Conte" pear grown under calcareous soil conditions as affected by different levels of nitrogen, phosphorus and potassium

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Abstract: "Le-Conte" pear fruiting trees grown in newly reclaimed soils were fertilized with different levels of nitrogen, phosphorus and potassium fertilization during three successive seasons of 2006, 2009 and 2010. However, results were calculated for the two seasons of 2009 and 2010. Tree vegetative growth (shoot length and diameter and leaf area), fruit set, yield increased significantly with increasing fertilization level. Fruit quality was increased significantly with increasing fertilization rate. The results also indicated that increasing N, P and K fertilization level lead to a gradual increment in leaf N, P and k content. Total sugars in fruits increased significantly with increasing the fertilization levels. On the other hand, starch decreased gradually with increasing the fertilization levels. The most effective level (650g. Ammonium nitrate + 325g. Potassium sulphate + 600g. Calcium superphosphate) leads to the highest vegetative growth, mineral leaf content, fruit yield and the best fruit quality as compared with other levels of fertilization. The lowest vegetative growth, yield and fruit weight and dimensions were recorded at the lowest level (250g. Ammonium nitrate + 125g. Potassium sulphate + 200g. Calcium superphosphate).

Keywords: *Pyrus communis*, Vegetative Growth, Fruit Set, Yield, Quality, Calcareous Soil, Mineral Fertilization.

1. Introduction

"Le-Conte" pear (*Pyrus communis*) cultivar budded on *Pyrus communis* rootstock are grown and widely spread in newly reclaimed lands in Egypt, such soils of low holding capacity and lack of fertility. The researches of nitrogen (N), phosphorus (P) and potassium (K) fertilization in newly reclaimed lands are insufficient, especially on pear trees.

Sugar *et al*., (1992) reported that management of pear (*Pyrus communis* L.) trees for low N and high Ca content in the fruit reduced the severity of postharvest fungal decay. They found that application of N fertilizer 3 weeks before harvest supplied N for tree reserves and for flowers the following spring without increasing fruit N. Calcium chloride sprays during the growing season increased fruit Ca content. Nitrogen and Ca management appear to be additive factors in decay reduction.

Sánchez (2002) described briefly the nitrogen dynamics in pear trees and revealed that nitrogen is needed to support growth and yield but N management should pursue the goal of promoting flowering and fruit set in non-vigorous trees with low N-fruit. By altering N timing, amounts, and method of application (foliar, ground), trees can be managed for both optimum vigour and N concentration of various tissues.

Pear trees that grow vigorously are very susceptible to fire blight. Therefore, less nitrogen is applied to pear trees than to apple trees (Marini, 2002). He reported that if phosphorous or potassium is in the medium or high range, there is no need for additional applications. If phosphorous or potassium is in the low range, he recommended applying 1/4 pound of fertilizer containing 10% K_2O or 10% P_2O_5 such as 10-10-10 or 5-10-10 or apply 0.125 pounds of 10-20-20 fertilizer per tree. Commercially, nitrogen fertilizers such as urea, ammonium nitrate, or calcium nitrate are preferred because these are the least expensive sources of nitrogen. Each spring applies fertilizer in the spring, about a month before bloom, at the rate of about 0.10 pounds of actual nitrogen per tree: this is equivalent to 1.0 pounds of 10-10-10, 2.0 pounds of 5-10-10, or 1.25 pounds of 8-8-8 fertilizer (Marini, 2002). He added that for trees growing in sandy soils or if for some reason

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shoot growth is less than desired, the nitrogen application can be doubled.

The foliar fertilization with phosphorus (P) and potassium (K) on pear (*Pyrus communis* L.) increased the contents of glucose, sorbitol, soluble solids, malic acid, citric acid, and potassium (Hudina & Stamper, 2002).

In addition to studies on pear fertilization, there are many researches on some fruit crops like persimmon, apple, apricot, peach, mandarins, cherries and olives as mentioned below.

Abo El-Maged (1992) found that increasing the rate of N application on "Costata" persimmon trees from 0, 600 to 1200g N/tree increased number of shoots/tree; shoot length and total shoot length per tree as well as leaf area. The dose of nitrogen application on persimmon differed from "on" year season to "off" year one where the high level (500g/tree/year) gave the best growth in "on" year but, the level of 300g/tree/year gave the best growth in "off" year season (Mikhael, 2001).

Marked declines in tissue K and N concentrations toward the end of the season may indicate a need for supplemental N and K fertilization in highly productive peach and fig orchards (Brown, 1994).

In apple, regression analysis indicated a significant positive relationship between the total amounts of K applied and leaf K content regardless the source of potassium. Significant positive relationships were found between average fruit weight and percent leaf potassium (Stiles, 1994). Zayan *et al*., (1994) on "Anna" apple trees indicated that shoot length and total growth, as well as leaf area, were significantly increased by increasing nitrogen rate from 480, 720 to 960gm N/tree. Fertigation of 15g K/tree/year generally increased leaf K, fruit K and Mg concentrations, fruit size and yield and fruit titratable acidity and red coloration at harvest of apple (Neilsen *et al*., 2004).

On sour cherries, good availability of nitrogen is ensured during spring and early summer (May-June) only, which would also reduce the risk of nitrogen leaching during autumn and winter (Lindhard and Hansen, 1997).

On peach, the number of shoots that developed depending on nitrogen availability in the period following bud break. Increasing nitrogen availability during developmental leaf emergence stage prolonged the stage increased the number of leaves produced (Lobit *et al*., 2001).

Kristalon (foliar fertilizer contains N 19%, P 19%, K 19%, Mg 1.5% , B 0.025%, Mo 0.001%, Cu 0.01% and S 1%) at 0.1% plus provide (GA_{4+7}) increased young apricot "Canino" tree growth (Wally, 1997). Radi *et al*., (2003) reported that apricot "Canino" fruits from trees fertilized with 80 Kg N/ha showed a significantly higher content in phenolic compounds, a slightly higher sugar concentration and a lower organic acid concentration than those fertilized with 150 Kg/ha. In contrast, fertilization with K level (60 Kg/ha) resulted in lower concentrations in phenolic compounds and sugar content when compared with the fruits which received the highest K level (120 Kg/ha.). On apricot (cv. Bergeron), high N fertilization enhanced vegetative growth, yield and average fruit weight and aggravated fruit pit burn incidence. Increasing K fertilization enhanced fruit soluble solids and coloring, but did not affect pit burn (Bussi *et al*., 2003).

On “Canino” apricot trees of two-years old grown in new reclaimed sandy soil, the two levels of 250g. ammonium nitrate + 125g. potassium sulphate + 400g. calcium superphosphate or 300 g. ammonium nitrate + 150g. potassium sulphate + 500g. calcium superphosphate, increased tree vegetative growth (Mikhael *et al*., 2005).

Recently, on olive trees (*Olea europaea* L. cv. *Barnea*), Erel *et al*., (2010) indicated that each of nitrogen, phosphorus and potassium plays a fundamental role in processes affecting olive tree productivity.

The aim of this investigation is to study the effect of N, P and K at different levels of fertilization on vegetative growth, yield and fruit quality of "Le-Conte" pear trees and to determine the most effective level.

2. Materials and Methods

This study was conducted through three successive seasons of 2008, 2009 and 2010 on “Le-Conte” pear cultivar budded *Pyrus communis* rootstock and grown in a private Orchard in Nubaria region. The trees of 15 years old were planted in calcareous soil at 5 meters apart. Five levels of fertilization/tree/year were applied through irrigation water as follows:

1. 250g. ammonium nitrate + 125g. potassium sulphate + 200g. Calcium superphosphate (serviced as a control).
2. 350g. Ammonium nitrate + 175g. potassium sulphate + 300g. calcium superphosphate.
3. 450g. ammonium nitrate + 225g. potassium sulphate + 400g. calcium superphosphate.
4. 550g. ammonium nitrate + 1275g. potassium sulphate + 500g. calcium superphosphate.
5. 650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate.

Table 1. Some chemical and physical properties of the experimental soil (O.M. = Organic Matter).

Soil Depth Cm	Texture	pH	EC (ds/m)	Total $CaCO_3$	O.M.	Total N (%)	Soluble cations (mg/L.)			Soluble anions (mg/L.)		
							Ca^{++}	Mg^{++}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{-}
0-30	Sandy Loam	8.1	1.11	33.08	0.41	0.011	7.35	5.41	2.19	5.69	3.97	5.87
30-60	Sandy Loom	8.09	1.89	31.98	0.29	0.014	6.86	5,58	1.86	5.38	4.10	5.67

Nitrogen and potassium fertilizers were divided into four equal doses (the first dose at bud swelling stage, the second at one week after fruit set, the third at one month before picking a date and the fourth was applied one week after picking). The phosphorus fertilizer was applied once in the mid of November.

The selected trees were subjected to the same orchard management and arranged in a complete randomized block design with three replicates each one was represented by four trees and four branches were chosen for measuring different obtained data.

Soil characteristics at the start of the experiment were summarized in Table (1). Leaf mineral contents before starting the experiment are presented in Table (2).

Table 2. Leaf mineral contents before starting the experiment are presented.

N (%)	P (%)	K (%)
1.60	0.11	0.79

The following measurements were estimated during 2009 and 2010 seasons:

Number, length and diameter of new branches were calculated.

Leaf area: To determine the leaf area, samples of mature leaves was collected at random from each studied tree in mid August. The determination of leaf area was carried out using leaf area meter model (1-203, CID, Inc., USA).

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 samples were washed with tap water, rinsed twice with distilled water, oven dried at 70°C to a constant weight and then ground. The ground samples were digested with sulphuric acid and hydrogen peroxide according to Evenhuis and de Waard (1980). Nitrogen was determined by the micro-Kjeldahl gunning method (A.O.A.C., 1990). Phosphorus was determined colourimetrically by the hydroquinone method (Snell and Snell, 1967). Potassium was determined against a standard curve by flame photometer (Chapman and Pratt, 1961).

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

Ten mature fruits of each replicate were taken to determine the average 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. %) were determined by ATAGO hand refractometer, acidity (%) was determined (as malic acid) by titration with 0.1 normal sodium hydroxide with phenolphthalein as an indicator (A.O.A.C., 1990) and T.S.S./acid ratio was calculated.

The starch was determined in 0.1gm of the residue by hydrolysis with concentrated HCl for 3 hours under a reflux condenser (A.O.A.C., 1990).

The total sugars were determined colourimetrically using phenol and sulphuric acid according to Malik and Singh (1980).

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

3. Results and Discussion

3.1. Effect of Different Levels of N, P and K Fertilizers on Vegetative Growth of "Le-Conte" Pear Trees

3.1.1 Effect on number of new shoots

Numbers of new shoots of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) are presented in Table (3). Number of new shoot increased significantly with increasing the levels of N, P and K. The highest numbers of new shoots (11.4 and 12.8) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest numbers of new shoots (8.4 and 8.7) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between the values of a number of new shoots.

3.1.2 Effect on shoot length

Tables (3) show the results of shoot length (cm) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K). Shoot length increased significantly with increasing the levels of N, P and K. The highest shoot length (43.8 and 45.4cm) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest shoot length (39.5 and 40.8cm) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between the values of shoot length (cm).

The present results agree with Neumann and Neumann (1981) on apples who reported that NPK combinations as a fertilization treatment added in triple rates increased the number of shoots and average shoot length.

3.1.3 Effect on shoot diameter

The results in Table (3) indicate the shoot diameter (cm) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K). The results of shoot diameter values indicated the same trend as values of shoot number and length. Shoot diameter increased significantly with increasing the levels of N, P and K. The highest shoot diameter (0.94 and 0.96cm) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest shoot diameter (0.80 and 0.85cm) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between the values of shoot diameter (cm).

3.1.4 Effect on leaf area

Results of leaf area (cm^2) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) are shown in Table (3). Leaf area increased significantly with increasing the levels of N, P and K in the two successive studied seasons. The highest leaf area (27.23 and 27.32cm^2) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest leaf area (25.81 and 26.14cm^2) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between the values of leaf area (cm^2).

The present results are in line with the previous results on pear fertilization obtained by Sugar, *et al*., (1992); Sánchez (2002); Marini (2002) and Hudina and Stamper (2002).

3.1.5 Fruit set

Results of fruit set (%) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) during 2009 and 2010 seasons are presented in Table (3). Fruit set (%) increased significantly with increasing the levels of N, P and K in the two successive studied seasons. The highest fruit set percentages (5.21 and 5.39%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit set percentages (4.33 and 4.56%) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit set (%).

Table 3. Effect of different levels of N, P and K on some vegetative growth parameters and fruit set percentage of "Le-Conte" pear trees during 2009 and 2010 seasons.

Fertilization Level	No, of new shoots		Shoot length (cm)		Shoot diameter (cm)		Leaf area (cm^2)		Fruit set (%)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
1 (control)	8.4	8.7	39.5	40.8	0.80	0.85	25.81	26.14	4.33	4.56
2	9.6	10.0	40.2	42.9	0.85	0.89	26.20	26.42	4.65	4.82
3	10.2	11.2	41.3	43.2	0.87	0.90	26.72	26.61	4.76	4.89
4	10.8	12.1	42.6	44.4	0.91	0.92	26.91	27.10	5.12	5.24
5	11.4	12.8	43.8	45.4	0.94	0.96	27.23	27.32	5.21	5.39
L.S.D. at 5%	**0.11**	**0.10**	**0.10**	**0.07**	**0.01**	**0.01**	**0.07**	**0.08**	**0.03**	**0.03**

1. = 250 g. ammonium nitrate + 125 g. potassium sulphate + 200 g. calcium superphosphate.
2. = 350 g. ammonium nitrate + 175 g. potassium sulphate + 300 g. calcium superphosphate.
3. = 450 g. ammonium nitrate + 225 g. potassium sulphate + 400 g. calcium superphosphate.
4. = 550 g. ammonium nitrate + 1275 g. potassium sulphate +500 g. calcium superphosphate.
5. = 650 g. ammonium nitrate + 325 g. potassium sulphate + 600 g. calcium superphosphate.

Table 4. Effect of different levels of N, P and K fertilization on the percentages of N, P and K leaf contents of "Le-Conte" pear trees during 2009 and 2010.

Fertilization Level	N (%)		P (%)		K (%)	
	2009	2010	2009	2010	2009	2010
1 (control)	1.84	1.89	0.13	0.15	0.90	0.92
2	1.89	1.95	0.15	0.16	0.94	0.95
3	1.92	2.00	0.16	0.17	0.99	1.00
4	1.94	2.20	0.17	0.18	1.00	1.10
5	1.96	2.30	0.17	0.20	1.00	1.20
L.S.D. at 5%	**0.03**	**0.01**	**0.01**	**0.01**	**0.02**	**0.01**

1. = 250 g. ammonium nitrate + 125 g. potassium sulphate + 200 g. calcium superphosphate.
2. = 350 g. ammonium nitrate + 175 g. potassium sulphate + 300 g. calcium superphosphate.
3. = 450 g. ammonium nitrate + 225 g. potassium sulphate + 400 g. calcium superphosphate.
4. = 550 g. ammonium nitrate + 1275 g. potassium sulphate +500 g. calcium superphosphate.
5. = 650 g. ammonium nitrate + 325 g. potassium sulphate + 600 g. calcium superphosphate.

3.2 Effect of Different Levels of N, P and K Fertilizers on Leaf Content (N, P and K %) of "Le-Conte" Pear

Results regarding leaf content (N, P and K %) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization are indicated in Table (4). Leaf content (N, P and K %) increased with increasing the levels of N, P and K in the two successive studied seasons. As regards N content, the highest leaf contents (1.96 and 2.3%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest leaf contents (1.84 and 1.89%) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded between the values of leaf N contents (%). As regards phosphorus (P) contents, the values take the same trend as that of N contents, where they increased gradually by increasing fertilization levels. The highest leaf P contents (0.17 and 0.20%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest leaf P contents (0.13 and 0.15%) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded between the values of leaf P contents (%). The highest leaf K contents (1.00 and 1.20%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest leaf K contents (0.90 and 0.92%) in the 2009 and 2010 seasons, respectively which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between the values of leaf k contents (%).

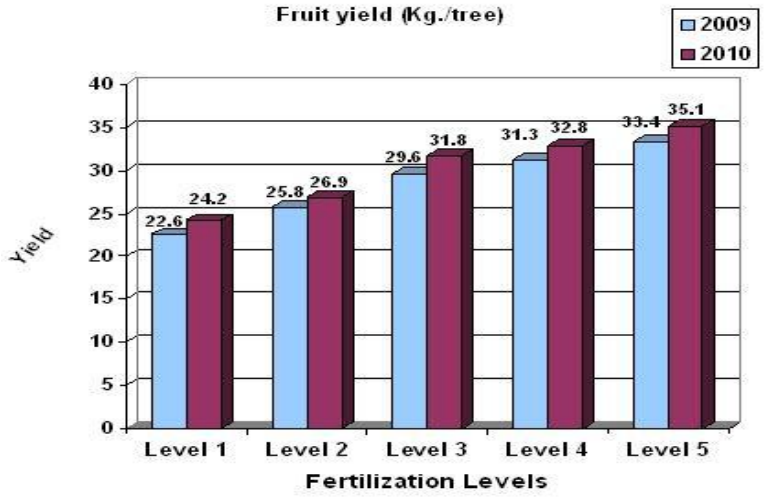
The present results are in harmony with those of Krivoruchko (1980) who found that the NPK fertilization on apple and pear trees gave a higher percentage of phosphorus in leaf comparing with unfertilized one and with Kassem (1991) who showed that the application of NPK caused an appreciable increase in leaf N, P and K content on apple.

3.3 Effect of Different Levels of N, P and K Fertilizers on Yield of "Le-Conte" Pear

The results in Fig. 1 indicates fruit yield (Kg/tree) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. The results of fruit yield values indicated the same trend as values of vegetative growth. Fruit yield increased significantly with increasing the levels of N, P and K fertilization. The highest fruit yield (33.4 and 35.1 Kg/tree) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit yield (22.6 and 24.2 Kg/tree) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit yield (Kg/tree). There are significant statistical differences between yields values resulted from all levels of fertilization.

The present results are in harmony with the previous results on pear fertilization (Sugar *et al*., 1992; Sánchez, 2002; Marini, 2002 and Hudina and Stamper, 2002).

Fig. 1. Effect of different levels of N, P and K on fruit yield (Kg/tree) of "Le-Conte" pear during 2009 and 2010 seasons. (L.S.D. 5% = 0.65 and 0.63, for 2009 and 2010, respectively).



1. = 250 g. ammonium nitrate + 125 g. potassium sulphate + 200 g. calcium superphosphate.
2. = 350 g. ammonium nitrate + 175 g. potassium sulphate + 300 g. calcium superphosphate.
3. = 450 g. ammonium nitrate + 225 g. potassium sulphate + 400 g. calcium superphosphate.
4. = 550 g. ammonium nitrate + 1275 g. potassium sulphate +500 g. calcium superphosphate.
5. = 650 g. ammonium nitrate + 325 g. potassium sulphate + 600 g. calcium superphosphate.

3.4 Fruit Physical Characters

3.4.1 Fruit weight

Results of fruit weight (g.) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization during 2009 and 2010 seasons are presented in Table (5). Fruit weight (g.) increased significantly with increasing the levels of N, P and K fertilization in the two successive studied seasons. The highest fruit weight (145.8 and 155.4g.) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit weight (126.4 and 127.6g.) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit weight (g.).

The present results are in line with the results of Dimitrovski *et al.*, (1972) who found that the highest average fruit weight of the peaches were produced with increasing the rate of NPK combination and with Kassem (1991) on Apple who reported that NPK application significantly increased average fruit weight.

3.4.2 Fruit length

The results in Table (5) indicate fruit length (cm) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. The results of fruit length values indicated the same trend as values of fruit weight. Fruit length increased significantly with increasing the levels of N, P and K fertilization. The highest fruit length (8.50 and 9.00cm) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit length (6.40 and 6.50cm) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit length (cm). There are significant statistical differences between fruit length values resulted from all levels of fertilization.

3.4.3 Fruit diameter

The Results in Table (5) indicate fruit diameter (cm) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. The results of fruit diameter values indicated the same trend as values of fruit weight. Fruit diameter increased significantly with increasing the levels of N, P and K fertilization. The highest fruit diameter (6.20 and 7.20cm) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit diameter (5.10 and 5.40cm) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit diameter (cm). There are significant statistical differences between fruit diameter values resulted from all levels of fertilization.

3.4.4 Fruit firmness

The Results of fruit firmness (lb/In^2)) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization during 2009 and 2010 seasons are presented in Table (5). Fruit firmness (lb/In^2) decreased significantly with increasing the levels of N, P and K fertilization in the two successive studied seasons. Only the difference between the level 1 and level 2 and between level 4 and 5 were not significant. The highest fruit firmness (16.29 and 16.23lb/In^2) in the 2009 and 2010 seasons, respectively were recorded by applying the lowest level of fertilization (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate) as compared with the lowest firmness values (15.11 and 15.18lb/In^2) which resulted from applying the highest level (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit firmness (lb/In^2).

Table 5. Effect of different levels of N, P and K on fruit physical characters of "Le-Conte" pear during 2009 and 2010 seasons.

Fertilization Level	Fruit weight (g.)		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness (lb/In^2)	
	2009	2010	2009	2010	2009	2010	2009	2010
1 (control)	126,4	127.6	6.40	6.50	5.10	5.40	16.29	16.23
2	132.6	136.8	7.00	7.20	5.40	5.90	16.12	15.83
3	138.7	144.8	7.90	8.20	5.60	6.30	15.43	15.71
4	140.6	149.8	8.10	8.4	5.80	6.80	15.19	15.25
5	145.8	155.4	8.50	9.00	6.20	7.20	15.11	15.18
L.S.D. at 5%	**1.08**	**1.02**	**0.08**	**0.10**	**0.08**	**0.07**	**0.218**	**0.474**

1. = 250 g. ammonium nitrate + 125 g. potassium sulphate + 200 g. calcium superphosphate.
2. = 350 g. ammonium nitrate + 175 g. potassium sulphate + 300 g. calcium superphosphate.
3. = 450 g. ammonium nitrate + 225 g. potassium sulphate + 400 g. calcium superphosphate.
4. = 550 g. ammonium nitrate + 1275 g. potassium sulphate +500 g. calcium superphosphate.
5. = 650 g. ammonium nitrate + 325 g. potassium sulphate + 600 g. calcium superphosphate.

3.4.5 Fruit T.S.S.

The results in Table (6) indicate fruit juice T.S.S. (%) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. Fruit juice T.S.S. increased significantly with increasing the levels of N, P and K fertilization. The highest fruit juice T.S.S. (12.8 and 13.6%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit juice T.S.S. (11.1 and 11.3%) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit juice T.S.S. (%). There are significant statistical differences between fruit juice T.S.S. Values resulted from all levels of fertilization.

Abou-Aziz *et al.*, (1987) agree with the present results and reported that potassium application increased significantly T.S.S. (%) while it decreased significantly acidity (%) in "Le-Conte" pear.

3.4.6 Fruit acidity

The Results in Table (6) show fruit juice acidity (%) of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. Fruit juice acidity decreased significantly with increasing the levels of N, P and K fertilization. The lowest fruit juice acidity (0.23 and 0.23%) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the highest fruit juice acidity (0.33 and 0.36%) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit juice acidity (%). There are significant statistical differences between fruit juice acidity values resulted from all levels of fertilization.

3.4.7 T.S.S./acid ratio

The results in Table (6) indicate fruit juice T.S.S./acidity ratio of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization. Fruit juice T.S.S./acidity ratio increased significantly with increasing the levels of N, P and K fertilization. The highest fruit juice T.S.S./acidity ratio (55.66 and 59.13) in the 2009 and 2010 seasons, respectively were recorded by applying the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) as compared with the lowest fruit juice T.S.S./acidity ratio (33.64 and 31.39) which resulted from applying the control (250g. ammonium nitrate + 125g. potassium sulphate + 200g. calcium superphosphate). The other levels of fertilization recorded in between values of fruit juice T.S.S./acidity ratio. There are significant statistical differences between fruit juice T.S.S./acidity values resulted from all levels of fertilization.

3.4.8 Total sugars and starch

The Results presented in Table (6) show fruit total sugars and starch of "Le-Conte" pear as affected by different levels of nitrogen (N), phosphorus (P) and potassium (K) fertilization during 2009 and 2010. Total sugars increased significantly with increasing the levels of N, P and K fertilization. The highest contents of the total sugars resulted from the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) in the two studied seasons. On the other hand, fruit starch content (%) decreased significantly with increasing the levels of N, P and K fertilization. The lowest contents of starch (%) resulted from the highest level of fertilization (650g. ammonium nitrate + 325g. potassium sulphate + 600g. calcium superphosphate) in the two studied seasons.

Table 6. Effect of different levels of N, P and K on fruit chemical characters of "Le-Conte" pear during 2009 and 2010 seasons.

Fertilization Level	T.S.S. (%)		Acidity (%)		T.S.S./acid ratio		Total sugars (%)		Starch (%)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
1	11.1	11.3	0.33	0.36	33.64	31.39	6.14	6.15	4.02	3.34
2	11.9	12.1	0.33	0.33	36.06	36.67	6.69	6.70	3.75	3.72
3	12.3	12.6	0.30	0.31	41.00	40.65	6.76	6.79	3.48	3.46
4	12.61	13.1	0.27	0.28	46.67	46.79	6.80	6.83	3.38	3.35
5	12.80	13.6	0.23	0.23	55.66	59.13	6.88	6.89	3.33	3.32
L.S.D. at 5%	**0.07**	**0.08**	**0.013**	**0.011**	**2.688**	**2.746**	**0.01**	**0.09**	**0.11**	**0.01**

1. = 250 g. ammonium nitrate + 125 g. potassium sulphate + 200 g. calcium superphosphate.
2. = 350 g. ammonium nitrate + 175 g. potassium sulphate + 300 g. calcium superphosphate.
3. = 450 g. ammonium nitrate + 225 g. potassium sulphate + 400 g. calcium superphosphate.
4. = 550 g. ammonium nitrate + 1275 g. potassium sulphate +500 g. calcium superphosphate.
5. = 650 g. ammonium nitrate + 325 g. potassium sulphate + 600 g. calcium superphosphate.

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