

## Effect of Root Pruning on Vegetative Growth and Leaf Mineral Content of Le Conte Pear Trees

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**Abstract:** The present study aimed to evaluate the effect of root pruning on vegetative growth and leaf mineral content of "Le Conte" pear trees grown in Agricultural and Experiments Researches Station of the Faculty of Agriculture, Cairo University at Giza Governorate, Egypt. This study was conducted on 11-year old "Le Conte" pear trees grown in loamy soil at 5X5 m during three successive seasons. Root pruning treatments involved 30, 60 and 90 cm at a depth of 50 cm from both sides of trunk at bud break and full bloom stage during seasons 2008, 2009 and 2010. Results indicated that the direct and residual effect of all treatments significantly decreased shoot length, diameter and leaves number per shoots. However, the direct and residual effect of the 30 cm root pruning treatments produced the highest significant leaf area. Meanwhile, the residual effects of all treatments produced the highest significant of leaf N, P, K in all seasons. On the other hand, leaf concentration of N was significantly higher in the control trees in the direct effect.

**Key words:** "Le Conte" Pear · Root Pruning · Vegetative Growth · Leaf Mineral Content

### INTRODUCTION

In Egypt, Pear cultivation is mainly concentrated in the Delta of the Nile valley which is very expensive and limited. "Le Conte" is the main pear cultivar grown in Egypt, resulted as a hybrid between *Pyrus communis* x *Pyrus serotina*. Productivity of pear orchards varies in Egypt from year to year and from location to other. Pruning also makes the canopy more open and improves best control by allowing better spray penetration into the tree, air movement throughout the canopy increased, which improves drying condition and reduces severity of many diseases [1]. Root pruning should always be combined with a good fertilization, after root pruning, the absorption of nutrients is presented in sufficient amount. Also indicated that it was the best to add low units of nitrogen to the standard fertilization on the tree strip, where the nutrients are not in balance the roots should not be pruned [2]. Root pruning increased flower cluster density by 33% in the 1st year after treatments. Fruit set/Spur decreased in both years after treatment of apple trees [3]. Also, root pruning seemed to interfere with

the flower bud formation and induced a biannual bearing tendency in pear "conference" [4].

Therefore, this study was carried out to investigate the effect of root pruning at bud break, full bloom stages and different distances from trunk on vegetative growth and leaf mineral content of "Le Conte" pear trees.

### MATERIALS AND METHODS

This study was carried out during three successive seasons 2008, 2009 and 2010 on 11 years old Pear "Le Conte" budded on *Pyrus communis* rootstocks in Agricultural Experiments and Researches Station of Faculty of Agriculture, Cairo University, Giza Governorate, Egypt. Trees were planted at 5 x 5 meters apart, grown in loamy soil and were irrigated with closed basin surface system and scheduled in the program of the station. Effects of the studied treatments were measured on the treated trees during the seasons of treatment application and the following season another group of trees were used for treatments application. In the

second and third season 2009 and 2010, the residual effects of applied treatments of seasons 2008 and 2009 were measured. The applied treatments as follow: unpruned trees (control), root pruning at 50 cm depth 30, 60 and 90 cm on both sides of the trunk at bud break stage and at full bloom. Each treatment was comprised of three replicate trees. The following determinations were carried out:

#### Vegetative Growth:

$$\text{Shoot Length: [Increment/m of shoot length \%} = \frac{\text{Final- Initial shoots length (cm)}}{\text{Initial shoot length (cm)}} \times 100]$$

**Shoot Diameter:** Shoot diameter in (mm) was measured at the base of shoot by using vernier caliper at mid of April and October in both seasons.

**Leaves Number Per Shoot:** Number of total leavers on each of the labeled shoots from the middle part of extension of tree was recorded at 2 times during each season (April and October).

**Leaf Area:** Leaf area was determined on samples of mature leaves by using a leaf area meter model (C1-203 AREA METER, CL, INC. USA).

**Leaf Dry Weight (LDW):** Leaves of known area were dried in an electric oven at 70°C until a constant was weight reached.

#### Chemical Leaf Characteristics

**Leaf Mineral Content:** Adequate sample of leaves (5-6 months old) was taken, dried at 70°C for 48h, (constant weight) and used for determining the N% by using modified micro-kjeldhal method as described by Pregl [5]. Phosphorus % was determined by using the method described by Chapman and Pratt [6]. Potassium % was determined by using flame photometer according to Brown and Lilleland [7].

**Statistical Analysis:** The obtained data was statistical analyzed by using factorial experiment in randomized complete block design. Results of the measured parameters were subjected to computerized statistical analysis using MSTAT and the significant differences among the various treatments were compared by using LSD at 0.05 according to Snedecor and Cochran [8].

## RESULTS AND DISCUSSION

**Shoot Length:** Data presented in Table 1 indicated that the direct affect of all treatments significantly decreased shoot length, while at full bloom dates were significantly superior at bud break. Meanwhile, the lowest shoot length ranged from 7.56 and 6.23 % resulted from 30 cm root pruning treatments in both seasons (2008 and 2009). However, the residual effect of all treatments significantly decreased shoot length, while the shoot length was significantly increased with control trees which ranged from 34.14 and 35.43 % in both seasons (2008 and 2009), respectively. However, at full bloom dates it was also recorded more increases at bud break during both seasons (2009 and 2010). In general, after root pruning growth is redistributed in favor of the roots and the shoot length rate was decreased. These results are in agreement with those obtained by Asin *et al.* [9], Asin and Vilardell [10] and Mass [11]; they reported that root pruning decreased shoot length of pear trees.

**Shoot Diameter:** Data in Table 2 indicated that the direct effect of all treatments significantly decreased shoot diameter, the highest shoot diameter was significantly increased with control trees which ranged from 21.39 and 28.03% in both seasons (2008 and 2009). Meanwhile, the lowest shoot diameter resulted from 30 cm root pruning treatment, which ranged from 13.23 and 13.58%. On the other hand, at bud break was increased more than full bloom date in both seasons (2008 and 2009). The residual effect of all treatments significantly decreased shoot diameter, while the highest shoot diameter was increased at the control treatment, which ranged from 31.06 and 30.18 % in both seasons (2009 and 2010). However, at bud break increased shoot diameter more than that full bloom dates in the both seasons (2009 and 2010). Root pruning was shown previously to be effective in achieving a reduction in top growth (shoot diameter). These results are in general agreement with the finding of Schupp [12] and Khan *et al.* [13], who pointed out that root pruning decreased shoot diameter of apple trees.

**Leaves Number per Shoot:** Data in Table 3 indicated that the direct affects of all treatments significantly decreased number of leaves/shoot. The highest number of leaves/ shoot was significant increased with control unpruned trees, which ranged from 19.17 and 21.01 leaves/shoot in both seasons (2008 and 2009).

Table 1: Effect of root pruning distance and dates on increasing (%) shoots length of pear 'Le Conte' trees.

Root pruning distance (cm)	Root pruning date					
	Direct effect of applied treatments					
	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	32.91	32.91	32.91	33.77	33.77	33.77
30	7.52	7.59	7.56	7.98	4.67	6.23
60	6.44	14.88	10.66	9.46	16.40	12.93
90	13.42	11.23	12.33	7.23	23.84	15.33
Mean	15.07	16.65	--	14.61	19.67	--
LSD <sub>0.05</sub>	1.80	1.27	3.77	12.48	NS	NS
Root pruning distance (cm)	Residual effect of applied treatments					
	2009			2010		
		Bud break	Full bloom	Mean	Bud break	Full bloom
0	34.14	34.14	34.14	35.43	35.43	35.43
30	7.83	8.48	8.16	3.20	14.93	9.07
60	10.91	9.71	10.31	10.42	13.76	12.09
90	6.63	22.19	14.41	14.67	13.63	14.15
Mean	14.88	18.63	--	15.93	19.44	--
LSD <sub>0.05</sub>	2.77	1.96	5.81	9.59	6.78	20.12

Table 2: Effect of root pruning distance and dates on shoot diameter increasing (%) of pear 'Le Conte' trees.

Root pruning distance (cm)	Root pruning date					
	Direct effect of applied treatments					
	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	21.39	21.39	21.39	28.03	28.03	28.03
30	15.55	10.90	13.23	25.67	1.50	13.58
60	17.00	10.80	13.90	16.50	20.00	18.25
90	18.00	18.00	18.00	20.00	18.00	19.00
Mean	17.99	15.27	--	22.55	16.88	--
LSD <sub>0.05</sub>	1.88	1.33	3.95	1.68	1.19	3.53
Root pruning distance (cm)	Residual effect of applied treatments					
	2009			2010		
		Bud break	Full bloom	Mean	Bud break	Full bloom
0	31.06	31.06	31.06	30.18	30.18	30.18
30	11.28	13.16	12.22	21.14	5.65	13.39
60	19.39	18.10	18.74	13.85	15.17	14.51
90	23.41	19.57	21.49	27.46	7.71	17.59
Mean	21.29	20.47	--	23.16	14.68	--
LSD <sub>0.05</sub>	1.80	NS	3.77	11.66	8.25	NS

Table 3: Effect of root pruning distance and dates on number of leaves/shoot of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
Root pruning distance (cm)	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	19.17	19.17	19.17	21.01	21.01	21.01
30	9.80	14.27	12.03	6.67	9.77	8.22
60	13.52	13.73	13.63	7.97	15.41	11.69
90	15.00	17.43	16.22	17.04	9.53	13.29
Mean	14.37	16.15	--	13.17	13.93	--
LSD <sub>0.05</sub>	1.67	1.18	3.51	8.95	NS	NS
Residual effect of applied treatments						
Root pruning distance (cm)	2009			2010		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	23.69	23.69	23.69	25.33	25.33	25.33
30	8.76	13.46	11.11	4.75	19.72	12.23
60	10.67	19.17	14.92	10.52	15.67	13.10
90	20.16	13.50	16.83	16.27	17.19	16.73
Mean	15.82	17.46	--	14.22	19.48	--
LSD <sub>0.05</sub>	1.45	1.03	3.05	5.17	3.65	10.84

Table 4: Effect of root pruning distance and dates on leaf area (cm<sup>2</sup>) of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
Root pruning distance (cm)	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	38.02	38.02	38.02	47.01	47.01	47.01
30	37.30	50.37	43.84	57.21	61.52	59.36
60	43.19	43.33	43.26	55.63	57.15	56.39
90	42.16	42.67	42.41	49.60	61.68	55.64
Mean	40.17	43.60	--	52.36	56.84	--
LSD <sub>0.05</sub>	1.92	1.35	0.77	3.65	2.58	7.66
Residual effect of applied treatments						
Root pruning distance (cm)	2009			2010		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	61.01	61.01	61.01	56.89	56.89	56.89
30	71.60	75.48	73.54	64.00	61.29	62.65
60	70.65	70.65	70.65	58.46	62.61	60.54
90	75.46	56.38	65.92	60.71	55.62	58.17
Mean	69.68	65.88	--	60.01	59.10	--
LSD <sub>0.05</sub>	2.00	1.42	4.21	0.24	0.17	0.50

Meanwhile, the lowest number of leaves/shoot resulted from 30 cm root pruning treatment, which ranged from 12.03 and 8.22 leaves/shoot at seasons 2008 and 2009. The residual effect of all treatments significantly decreased numbers of leaves/shoot, while at full bloom were more than at bud break, the highest leaves number resulted from the control trees, which ranged from 23.69 and 25.33 leaves/ shoot in both seasons (2009 and 2010). These results are in harmony with the findings of Ferree [14], Retameles *et al.* [15] and Yang *et al.* [16], they found that root pruning decreased vegetative growth of pome fruits.

**Leaf Area:** Data presented in Table 4 indicated that the direct effect of 30 cm root pruning treatments increased leaf area at full bloom than bud break in first season (2008 and 2009), which reached 43.84 cm<sup>2</sup>. The highest values of leaf area were produced from 30 cm root pruning in the second season (2009), which reached 59.32 cm<sup>2</sup>. Meanwhile, the lowest value of leaf area was produced from control trees (38.02 and 47.01 cm<sup>2</sup>) in 2008 and 2009 seasons, respectively. However, the residual effects of 30 cm root pruning increased leaf area value as average of 73.54cm<sup>2</sup>, while at full bloom increased leaf area compared with bud break dates in the first season (2009). On the other hand, the residual effect of all treatments increased leaf area in the second season (2010). The highest value of leaf area was produced from 30 cm root pruning (62.65 cm<sup>2</sup>) followed those other treatments. Meanwhile, the lowest value of leaf area was produced from control trees (61.01 and 56.89 cm<sup>2</sup>) in 2009 and 2010 seasons, respectively. These results partially are in agreement with the findings of Ferree [14] and Abod and Webster [17], who reported that root pruned at full bloom increased leaf area of apple trees.

**Leaf Dry Weight (LDW):** Data in Table 5 indicated that the direct effect of 30 cm root pruning treatment significantly produced the highest leaf dry weight value (0.47 and 0.46g) in 2008 and 2009 seasons, respectively, while, the lowest (0.33 and 0.35g) was produced with control in both seasons, respectively. In addition, the residual effects of all treatments produced the highest leaf dry weight with control trees as average of 0.33 and 0.35g in both seasons, respectively. The residual effects of all treatments produced the highest leaf dry weight with 30 cm root pruning treatment as average of 0.52 g and 0.33 g in both seasons, respectively. Nevertheless; the lowest values leaf dry weight was produced with control trees as average of 0.32 g and 0.27 g in both seasons, respectively.

#### **Leaf Mineral Content**

**Nitrogen Content:** It is clear from data in Table 6 that leaf N % concentration was significantly higher (1.4%) in control trees than the other treatments 90, 60 and 30 cm root pruning (1.39,1.20 and 1.13%) in the first season, respectively. Also, the direct effect of all treatments significantly produced the highest leaf N concentration (1.93%) with control trees compared with the other treatments in the second season. However, the residual effect of all treatments significantly produced the highest leaf N concentration in both seasons. Meanwhile, the highest leaf N concentration was produced with 30 cm root pruning as average of 1.57% followed by other treatments in the second season, while the lowest leaf N concentration (1.11%) was produced with control trees in the second season. Apple trees root pruned at both times had higher foliar levels of nitrogen than unpruned trees. Similar results were reported by Retameles *et al.* [15] and Schupp and Ferree [18].

**Phosphorus Content (P):** Table 7 shows that the highest percentage of phosphorus content (0.27 and 0.34%) resulted in from root pruning treatments in both seasons, respectively, while, the lowest percentage of phosphorus content (0.25%) was produced from control trees in the 2008 season 2009 In addition, the highest P content was noticed with control (unpruned) trees as average of 0.26% in the first season. Meanwhile, the residual effect of all treatments produced the highest leaf P% which ranged between 0.25 and 0.27 % in the second season 2010. On the other hand, root pruning near bloom (root pruning on 9 May reduced N, P, K and Cu foliar levels, while root pruning on 29 June reduced Mg and Ca of apple 'Coxs Orange Pippin' trees [15].

**Potassium Content (K):** Data in Table 8 demonstrated that the direct effect of all treatments on leaf K concentration produced the highest values of K concentration with 90 cm root pruning as average of 1.10% followed by the other treatments, while full bloom date produced more K concentration than that bud break in the first season. On the other hand, the lowest leaf K concentration was produced from control trees as average of 0.81%. However, the direct effect of all treatments gave the highest significant values with 30 cm root pruning which produced the highest leaf K concentration (1.19%) and bud break was superior to full bloom date in the second season. In this regard, the lowest K value (0.92%) was observed with control trees.

Table 5: Effect of root pruning distance and dates on leaves dry weight of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
Root pruning distance (cm)	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	0.33	0.33	0.33	0.35	0.35	0.35
30	0.50	0.44	0.47	0.45	0.46	0.46
60	0.40	0.42	0.41	0.37	0.50	0.44
90	0.39	0.41	0.40	0.41	0.42	0.42
Mean	0.39	0.38	--	0.39	0.43	--
LSD <sub>0.05</sub>	0.05	NS	NS	0.03	0.02	0.02
Residual effect of applied treatments						
Root pruning distance (cm)	2009			2010		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	0.32	0.32	0.32	0.27	0.27	0.27
30	0.55	0.49	0.52	0.45	0.32	0.39
60	0.49	0.44	0.47	0.31	0.36	0.34
90	0.46	0.33	0.39	0.35	0.31	0.33
Mean	0.45	0.39	--	0.34	0.31	--
LSD <sub>0.05</sub>	0.20	0.02	0.01	0.03	0.02	0.01

Table 6: Effect of root pruning distance and dates on leaf nitrogen content (%) of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
Root pruning distance (cm)	2008			2009		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	1.40	1.40	1.40	1.93	1.93	1.93
30	1.01	1.25	1.13	1.28	1.28	1.28
60	1.04	1.37	1.20	1.40	1.51	1.46
90	1.21	1.57	1.39	1.71	1.83	1.77
Mean	1.16	1.39	--	1.58	1.64	--
LSD <sub>0.05</sub>	0.13	0.09	0.37	0.07	0.05	0.11
Residual effect of applied treatments						
Root pruning distance (cm)	2009			2010		
	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	1.31	1.31	1.31	1.11	1.11	1.11
30	1.42	1.71	1.57	1.27	1.22	1.25
60	1.61	1.07	1.34	1.40	1.45	1.42
90	1.24	1.04	1.14	1.37	1.16	1.27
Mean	1.40	1.28	--	1.29	1.23	--
LSD <sub>0.05</sub>	0.12	0.09	0.18	0.07	0.05	0.15

Table 7: Effect of root pruning distance and dates on leaf phosphorus content (%) of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
	2008			2009		
Root pruning distance (cm)	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	0.25	0.25	0.25	0.25	0.25	0.25
30	0.34	0.32	0.33	0.33	0.31	0.32
60	0.33	0.35	0.34	0.30	0.30	0.30
90	0.30	0.34	0.32	0.29	0.25	0.27
Mean	0.31	0.31	--	0.29	0.28	--
LSD <sub>0.05</sub>	0.03	NS	NS	0.04	NS	NS
Residual effect of applied treatments						
	2009			2010		
Root pruning distance (cm)	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	0.26	0.26	0.26	0.19	0.19	0.19
30	0.25	0.23	0.24	0.34	0.20	0.27
60	0.28	0.23	0.25	0.26	0.26	0.26
90	0.24	0.24	0.24	0.34	0.15	0.25
Mean	0.26	0.24	--	0.28	0.20	--
LSD <sub>0.05</sub>	0.01	0.01	0.02	0.01	0.01	0.01

Table 8: Effect of root pruning distance and dates on leaf potassium content (%) of pear 'Le Conte' trees.

Root pruning date						
Direct effect of applied treatments						
	2008			2009		
Root pruning distance (cm)	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	0.81	0.81	0.81	0.92	0.92	0.92
30	1.08	1.06	1.07	1.19	1.19	1.19
60	0.95	1.11	1.03	1.26	1.06	1.16
90	1.07	1.12	1.10	1.15	1.02	1.09
Mean	0.98	1.03	--	1.13	1.05	--
LSD <sub>0.05</sub>	0.06	0.04	0.08	0.05	0.04	0.11
Residual effect of applied treatments						
	2009			2010		
Root pruning distance (cm)	Bud break	Full bloom	Mean	Bud break	Full bloom	Mean
0	1.11	1.11	1.11	0.78	0.78	0.78
30	1.23	1.42	1.33	0.95	1.21	1.08
60	1.31	0.94	1.12	0.93	1.07	1.00
90	1.15	1.02	1.08	1.03	1.15	1.09
Mean	1.20	1.12	--	0.92	1.05	---
LSD <sub>0.05</sub>	0.05	0.03	0.07	0.04	0.03	0.06

However, the residual effect of all treatments produced the highest leaf K concentration (1.33%), while leaf K% at bud break was more than that at full bloom date. Also, the lowest value of K concentration (0.78%) was observed with control trees in the second season. The obtained results are in agreement with those obtained by Retameles *et al.* [15] indicated that, root pruning before bloom root pruning reduced N, P, K and Cu of apple trees.

Generally, compared to the control the nutrient concentrations in rhizosphere soil under severe and moderate root pruning treatments were higher, it is possibly correlated with the fact that the nutrients of N, P and K in rhizosphere soils were less absorbed by damaged root system after root pruning [16]. Although higher nitrogen, phosphorus and potassium concentrations in rhizosphere soil could accelerate plant growth, severe and moderate root pruning reduced the large size of root system and hence lowered competitive ability for water and mineral uptakes [19], which resulted in lower N, P and K contents in leaves and consequently inhibited jujube tree growth.

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