

## Effect of Root Pruning on Flowering and Fruiting of 'Le Conte' Pear Trees

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**Abstract:** This investigation aimed to evaluate the effect of root pruning treatments to improve flowering, fruit set and fruit characteristics of 'Le Conte' pear trees. This study was conducted on 11-years-old 'Le Conte' pear trees during three successive seasons. Root pruning treatments involved 30, 60 and 90 cm from both sides of trunk either at bud break or full bloom stage during seasons 2008, 2009 and 2010. Residual effects of the applied treatments were measured in the second and third seasons of this investigation. Direct effects of all the applied treatments significantly increased initial fruit set, final fruit set and yield compared to the control trees in both seasons of treatments application. Moreover, residual effects of the applied treatments showed that 30 cm root pruning from the trunk at bud break stage resulted in the highest significant effect of floral spurs/m, flowers number/spur, final fruit set and yield. Similarly all the residual effects of the applied treatments significantly increased fruit weight, fruit shape index L/D and TSS/Acid ratio during both seasons. Thus, it could be recommended from results of the present study to apply 30 cm root pruning at bud break stage as it significantly increased productivity of 'Le Conte' pears trees.

**Key words:** 'Le Conte' pears • Root pruning • Flowering • Fruit set • Yield and Fruit characteristics

### INTRODUCTION

Pear is considered one of the most important economic fruit crop among deciduous fruit trees and the fourth among all fruit crops in its global distribution [1]. '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 one location to another. This might be attributed to limited ovules viability and stigma receptivity, poor pollen germinability, ovule abortion, excessive flower abscission and low fruit set. There was a sharp decline of pear cultivation in Egypt due to the wide spread of fire blight during 80's and 90's, as it started to drop gradually to reach 6960 feddan (one feddan=4200 m<sup>2</sup>) at 2005 [2]. However, it started to increase gradually as a package of protective cultural practices of fire blight was developed to reach 20400 feddan [3]. In order to improve productivity in terms of increase in return bloom, fruit set and fruit quality several investigations were carried out by applying root pruning in pear [4]. Root pruning in sour cherry (*Prunus cerasus*) 'Stevnsbaer' at 30-35 cm from the trunk and 75 cm increased fruit set by 15% [5]. Root pruning significantly increased tree yield in pear and

apple trees [4, 6, 7]. Root and summer pruning are important tools for production of high fruit quality in 'Independence' peach tree grafted on GGGF305 [8].

The present investigation aimed to study the effect of root pruning at bud break and full bloom stages and different distances from trunk on improving flowering, fruiting, yield and fruit characteristics of "Le Conte" pear trees.

### MATERIALS AND METHODS

This study was carried out in the Experimental and Agricultural Research Station of the Faculty of Agriculture Cairo University at Giza Governorate, Egypt during three successive seasons 2008, 2009 and 2010. The effects of the studied treatments were measured on the treated trees during the seasons of treatments application and the following season another group of trees were used for treatments application. In the second and third season 2009 and 2010 residual effects of the applied treatments of seasons 2008 and 2009 were measured. Forty two healthy and uniform 'Le Conte' pear trees of 11-years-old budded on *Pyrus communis* rootstock, grown in loamy soil were selected such that 21 trees were

used for each of the two seasons of treatments application. Trees were planted at 4x6 meters apart and were irrigated with closed basin surface system and received normal fertilization and cultural practices as scheduled in the program of the station. The applied treatments comprised of: Control unpruned trees, root pruning at 50 cm depth 30, 60 and 90 cm on both sides of the trunk either at bud break stage or at full bloom. Each treatment was comprised of three replicate trees. The effects of the previous treatments were studied by evaluating their influence on the following parameters:

**Flowering Characteristics:** Flowering characteristics involved number of floral spurs per meter and average number of flowers/spur which were measured as residual effect only during the following seasons of treatments application (2009–2010). At the beginning of the growing season on each replicate tree five three years old shoots distributed on different sides were chosen randomly, tagged, their lengths were measured and their flowers were counted at full bloom. All inflorescences on each shoot were counted and recorded.

**Average Number of Floral Spurs/Meter on Three Years Old Branches:** Numbers of floral spurs of the tagged shoots were counted.

**Average Number of Flowers per Spurs:** Numbers of flowers per spurs of the tagged shoots were counted.

**Fruiting Measurements:** Fruiting parameters were measured during the season of treatments application and were measured on the same trees during the following season as residual effect of the applied treatments.

**Initial Fruit Set:** Number of developing fruit-lets per each branch was also counted and recorded in different treatments at 21 days from full bloom: Initial fruit set % = (No. of fruit-lets/total no. flowers at full bloom) x 100 [9].

**Final Fruit Set:** The number of fruit-lets on each tagged branch was counted, at 60 days from full bloom in all seasons: Final fruit set % = (No. of fruit-lets at 60 days from full bloom/total no. flowers at full bloom) x 100 [9].

**Yield:** The produced fruit yield on each replicate tree resulting from the applied treatments was expressed as weight of fruits in kg/tree, which was attained at harvest stage. This was determined 135 days after flowering in each season of the study [10].

**Fruit Characteristics:** Samples of 10 fruits from each replicate tree *i.e.* 30 fruits for each of the applied treatments was picked randomly at harvest to determine:

**Physical Characteristics:**

- Average fruit weight (g/fruit)
- Fruit shape index (L/D ratio)

**Chemical Fruit Characteristics:**

- Total soluble solids/acid ratio was calculated for each replicate of the applied treatments according to A.O.A.C. [11].

**Histological Study:** Histological study was carried out to study the residual effect of the different treatments on ovary formation in pear flowers at the following season of applying treatments (2008/2009). At full bloom stage, samples of 10 king flowers were collected in FAA (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%), from different experimental trees. Sections were prepared according to Johansen [12], at 15-17  $\mu$ m thick using rotary microtome, mounted on glass slides and stained with aqueous Fast Green (0.1% in 95% ethanol) and observed under light microscope as described by Ruzin [13].

**Statistical Analysis:** Experiments of the present study followed as factorial experiment in randomized complete block design, Results of the measured parameters were subjected to computerized statistical analysis using MSTAT package for analysis of variance (ANOVA) and means of treatments were compared using LSD at 0.05 according to Snedecor and Cochran [14].

## RESULTS AND DISCUSSION

### Flowering Characteristics

**Average Number of Floral Spur/meter:** The residual effects of the applied treatments showed that the highest significant average number of floral spurs/m was produced from root pruning 30 cm at bud break and full bloom as it averaged 26.47 and 28.81/m in both seasons of the study (Fig. 1a). Nevertheless, the lowest significant average number of floral spurs/m was produced from control trees as it averaged 16.8 and 18.4 /m in both seasons.

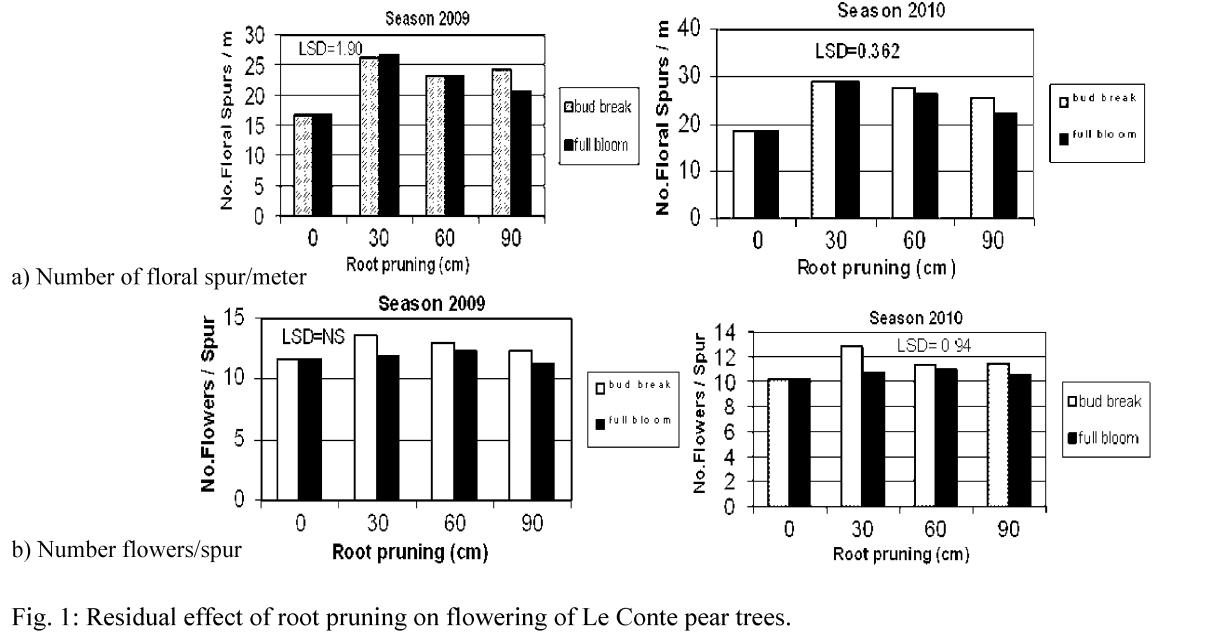


Fig. 1: Residual effect of root pruning on flowering of Le Conte pear trees.

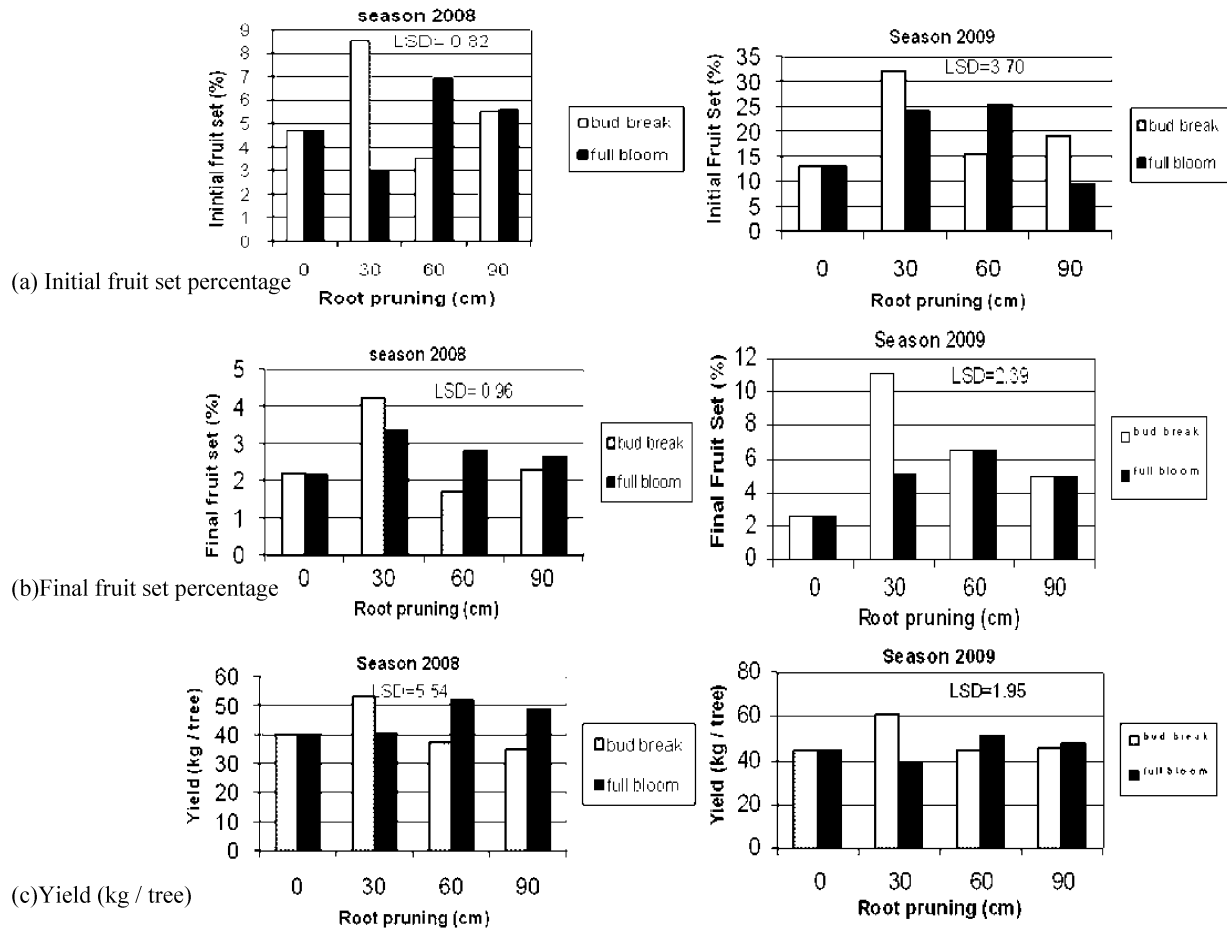


Fig. 2: Direct effect of root pruning on fruiting of Le Conte pear trees.

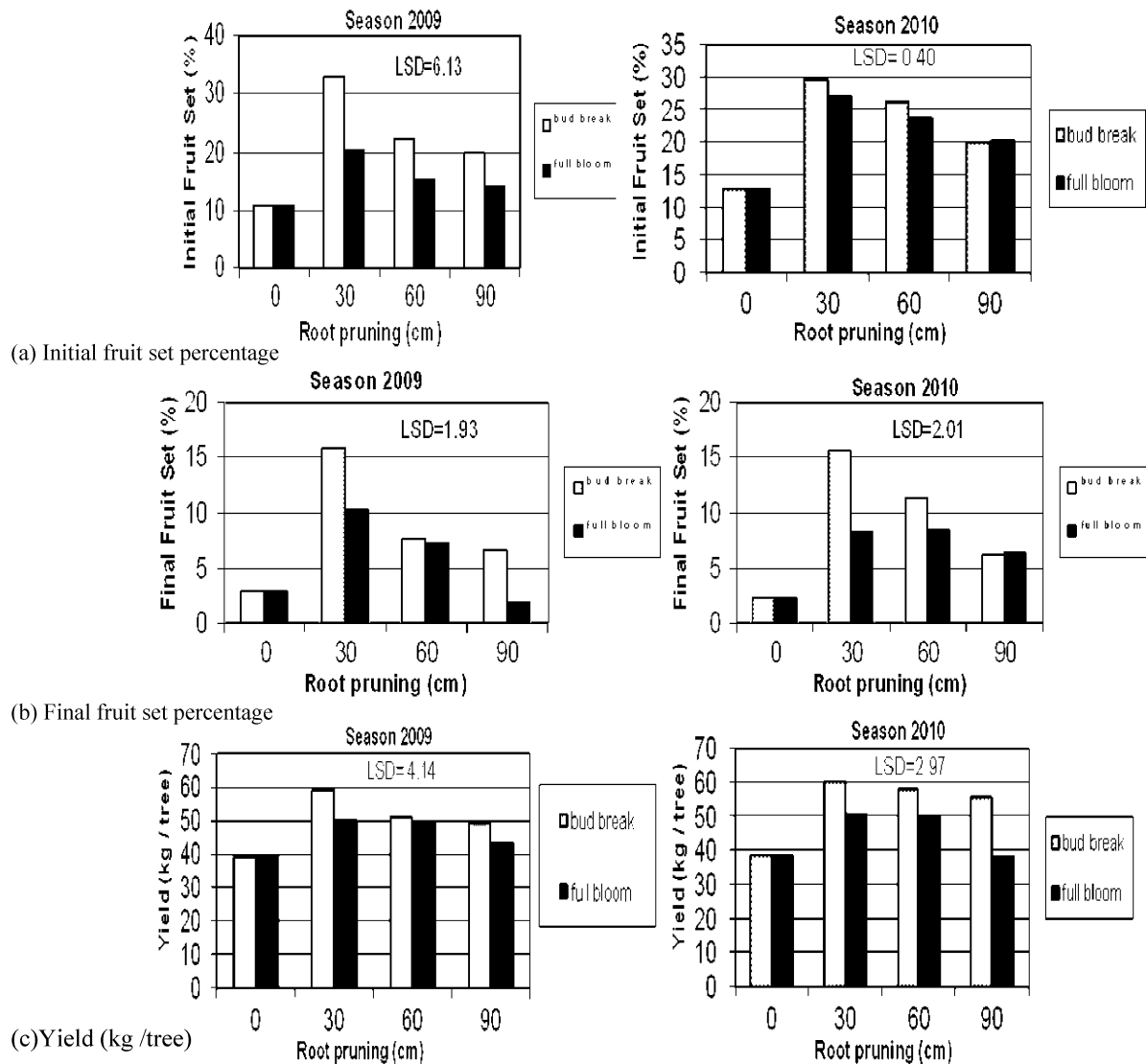


Fig. 3: Residual effect of root pruning on fruiting of Le Conte pear trees:

**Average Number of Flowers/spur:** The highest significant number of flowers/spur was produced from root pruning 30 cm at bud break as it averaged 12.77 and 11.84 at seasons 2009 and 2010 (Fig.1b). However the lowest significant flowers/spur was produced from control trees as it averaged 11.58 and 10.22 /m in both seasons. Similar findings were reported by Asin *et al.* [4] on "Blanquilla" pear orchard, that root pruning produced an increase in return bloom. Also, root pruning promoted flowering by stimulating root regeneration [15] and number of flowering per spurs [16, 17] on apple trees.

**Fruiting:** In both seasons of the study direct effect of the applied treatments showed that 30 cm root pruning at bud break produced the highest significant initial, final fruit set

and yield. In the second season 30 cm root pruning at bud break resulted in 28.28% initial fruit set, 8.08% final fruit set and 49.74 kg/tree respectively (Figs 2a, b and c). The lowest significant initial, final fruit set and yield were observed in the control trees as it averaged 13.13%, 2.54% and 44.89 kg/tree in the second season, respectively. In addition residual effects showed that all treatments significantly improved fruiting where 30 cm root pruning at bud break produced the highest significant initial fruit set as it reached 26.61% and 28.38% at both seasons. Nevertheless, the lowest significant initial fruit set 10.62%, 12.83% was produced from the control trees in both seasons (Figs 3a, b and c). Meanwhile, the residual effect of 30 cm root pruning at bud break produced the highest significant final fruit set and yield as it reached 13.14%,

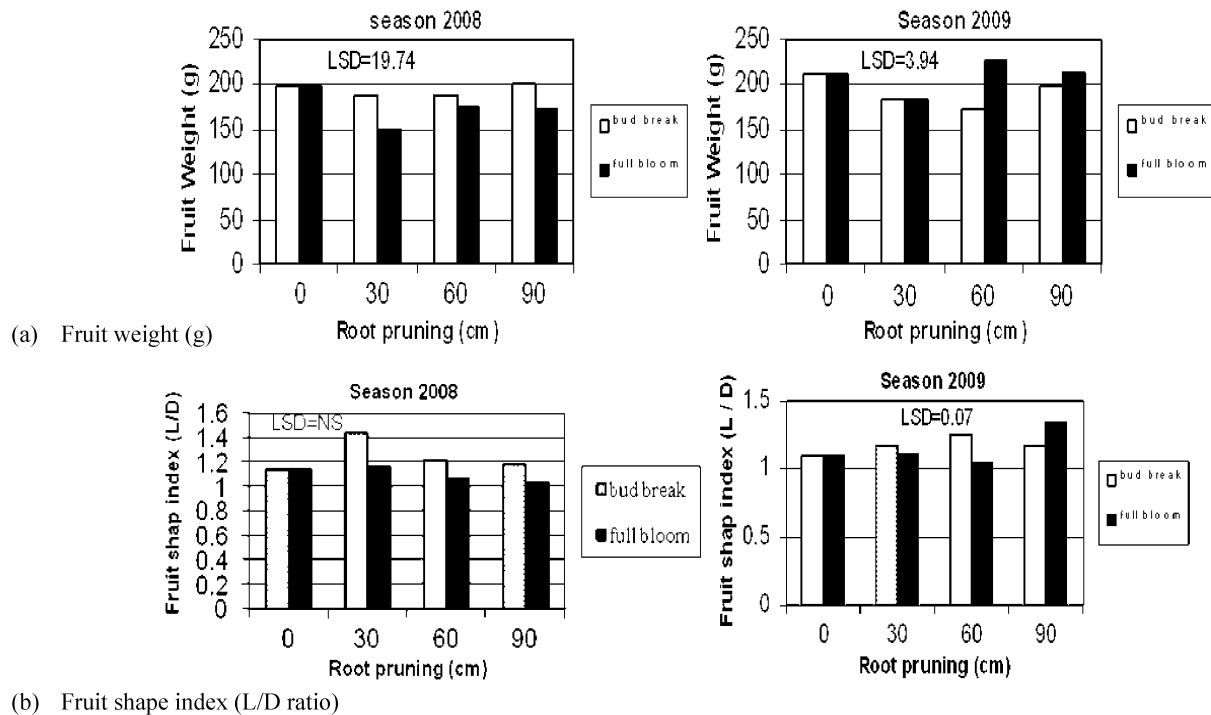


Fig. 4: Direct effect of root pruning on physical characteristics of Le Conte pears

11.89% and 54.69, 55.5 kg/tree in both seasons of the study. The lowest significant final fruit set and yield were observed in the control trees as it averaged 2.88%, 2.33% and 39.15, 38.56 kg/tree in both seasons.

Results of the present study are in agreement with previous findings of *Asin et al.* [4] and *Young et al.* [18] as they found that root pruning increased yield of pear trees. In addition, *Khan et al.* [19] reported that root pruning resulted in higher root total carbohydrates which were associated with higher total yield of apple trees.

**Fruit Characteristics**

**Physical Characteristics:** The highest significant fruit weight was produced from the control trees as resulted in 197.31, 211.93 g. However, the direct effect of 30 cm root pruning at bud break and 90 cm resulted in the highest significant average of shape index as it averaged 1.3 and 1.26 in both seasons of the study. The lowest significant fruit weight was observed in the 30 cm root pruning at bud break as it averaged 168.75, 183.15 g in the first season and at full bloom in the second season. The lowest significant average of shape index was produced from the control trees as it averaged 1.14, 1.10 L/D ratio in seasons 2008 and 2009 (Figs 4a and b). Similarly, the residual effects of the applied treatments on fruit weight

and fruit shape index (L/D ratio) showed that the highest significant fruit weight was produced from the control 193.92g and 207 g in both seasons of the study. Meanwhile, the residual effects of 30 cm root pruning at bud break produced the highest significant L/D ratio as it averaged 1.21 and 1.22 during both seasons (Figs 5a and b).

**Chemical Fruit Characteristics:** The direct effects of applied treatment showed that 90 cm root pruning at full bloom produced the highest significant percentage of TSS/Acidity 48.66 in the first season and 41.58 for 30 cm root pruning at bud break in the second season (Fig.6). Also, the residual effects revealed that the applied treatments significantly improved percentage of TSS/Acidity. The residual effect of 30 cm root pruning at full bloom produced the highest significant TSS/Acidity ratio as it averaged 43.67 in the first season. All treatments produced higher significant TSS/Acidity ratio compared to the control as it averaged between 39.25 and 43.10 in second seasons (Fig.7). Similarly, it was suggested that root pruning can be considered as an additional tool to obtain optimal fruit quality [18]. Also, root pruning was correlated with higher fruit quality in ‘Independence’ peach [8].

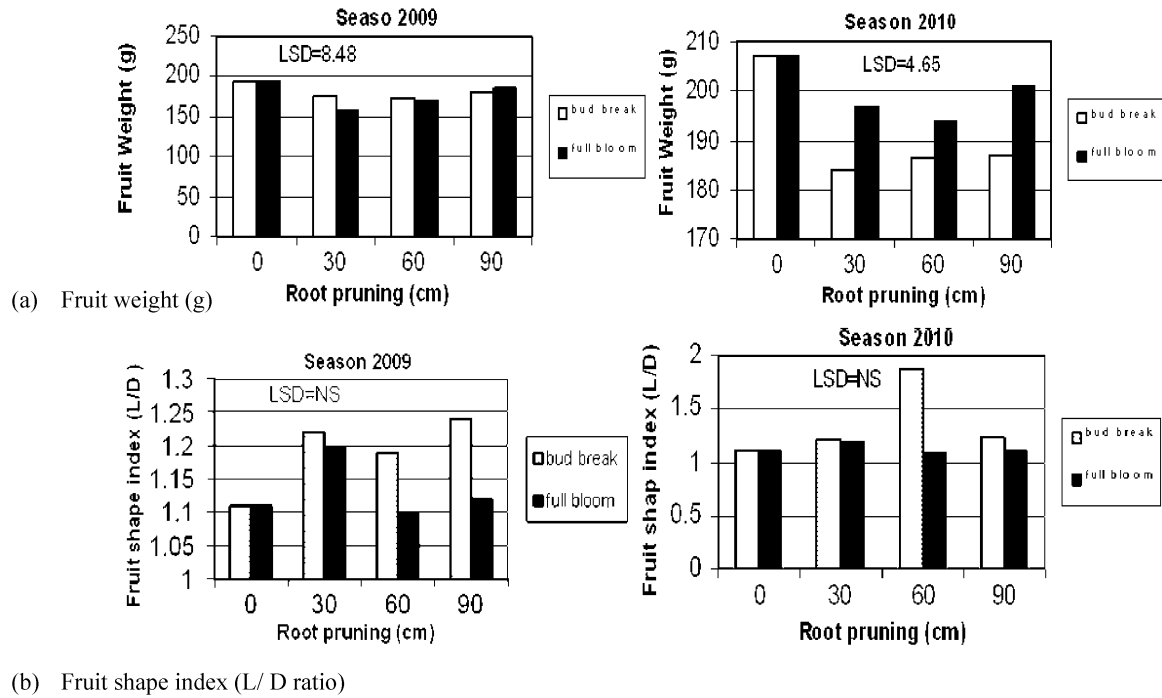


Fig. 5: Residual effect of root pruning on Physical characteristics of Le Conte pears

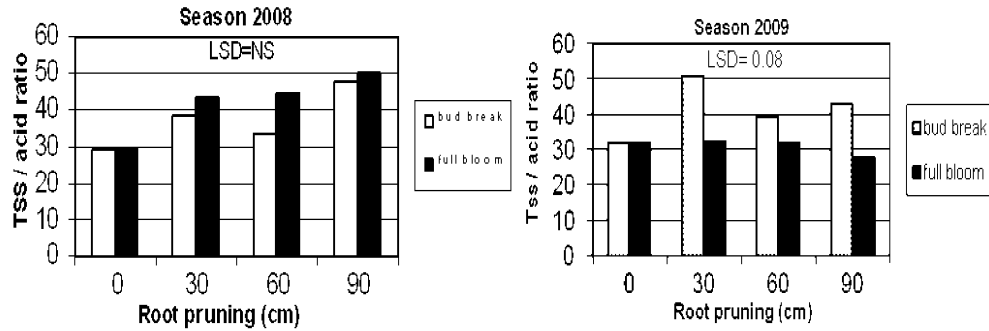


Fig. 6: Direct effect of root pruning on TSS /Acidity of Le Conte pears

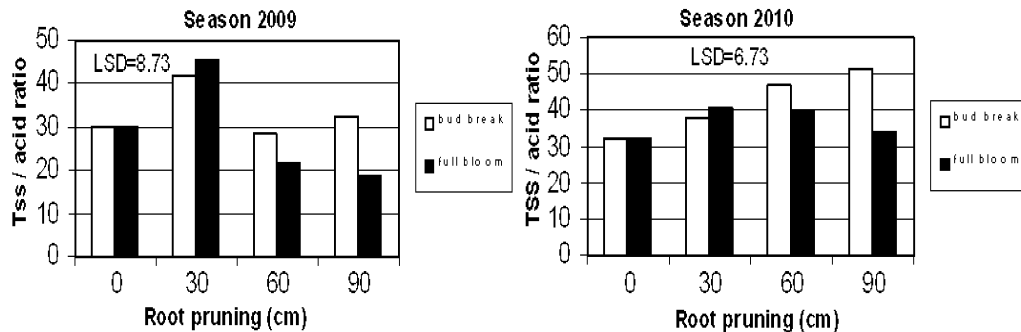


Fig. 7: Residual effect of root pruning on TSS/Acidity of Le Conte pears

**Histological Study:** The residual effects of the applied treatments showed noticed improvements in the histological development of the studied sections. The residual effect of 30 cm root pruning showed

the best formation of 2 ovules in each of the five carpels. The carpels are regular in their shape, symmetrical with each other; the developed motioned ovules were similar in size and shape. The central empty core of these ovaries

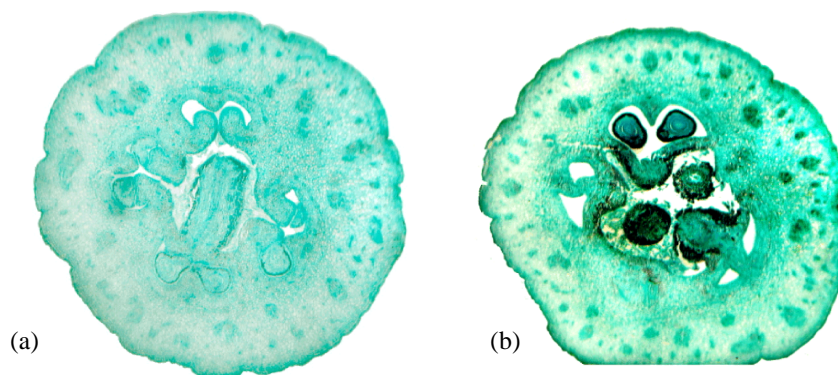


Fig. 8a: C.S in Le Conte pear ovary (control) (Notice: 4 carpels with two ovules / carpel)  
 Fig. 8b: C.S in Le Conte pear ovary (Notice: a) 3 carpels, b) Empty carpels)

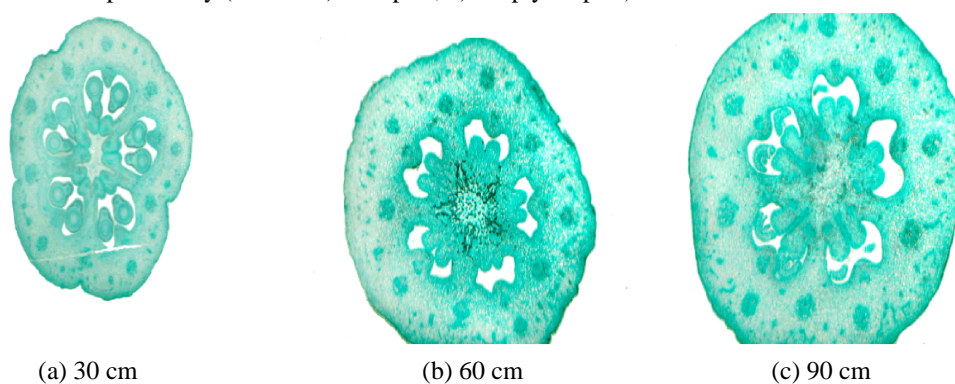


Fig. 9: Effect of root pruning at bud break on Le Conte pear ovary C.S. (Notice: 5 carpels with two ovules / carpel)

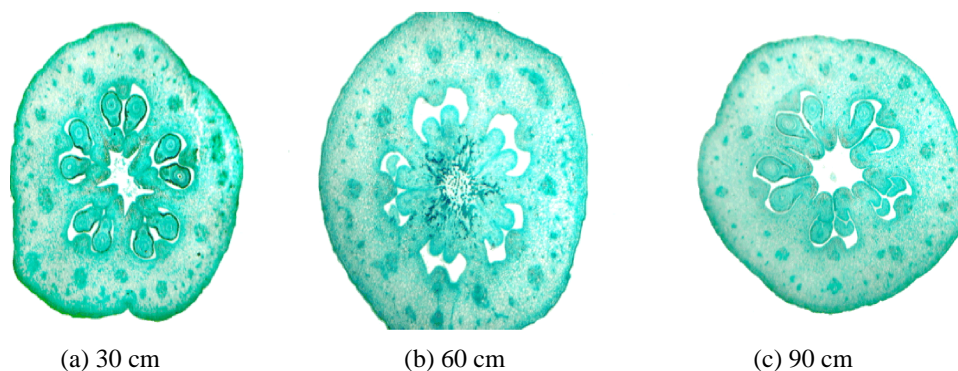


Fig.10: Effect of root pruning at full bloom on Le Conte pear ovary C.S. (Notice: 5 carpels with two ovules / carpel)

was clearly and uniformly developed. A single normal ovule is composed of the following morphological parts, nucleus, integuments, embryo sac, funiculus's and micropyles (Figs 9 and 10). However, different types of abnormal ovaries were consistently formed in the control flowers. Histological features of abnormal development in sections of ovaries from flowers of the control trees are sections with reduced number of developed carpel's, some had only 4 or 3 carpel's (abnormal or malformed ovary), carpels without ovules or absence carpels (Figs 8a and b). A mass of meristimatic cells making differentiated

tissues in the carpels (Fig.8b). It is evident the masses of meristimatic cells represent a stage of undeveloped ovules that leads to reduction in initial, final fruit set and yield.

### CONCLUSION

It can be concluded from results of the present study that 30 cm root pruning at bud break treatment significantly improved flowering, fruiting and fruit quality of 'Le Conte' pear trees, consequently it is recommended to be effectively applied under the same conditions.

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