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The Impact of Pruning on Growth, Flowering and Productivity of Pecan Trees

Elsoda A. S.*, El-Husseiny A. M., Hend, I. Ali, and Hammad, A. A.

Olive and Semi-Arid Zone Fruit Research Department, Horticulture Research Institute (HRI), Agricultural Research Center, Giza, Egypt.

***Corresponding author:** elsoda.as@gmail.com

Abstract: Throughout two consecutive seasons in 2022 and 2023, the experiment was conducted at a private orchard located 90 kilometers distant along the Cairo-Alexandria desert road in the Behera governorate on 8-year-old of desirable pecan trees planted in sandy soil under drip irrigation, the trees under study were pruned by four different pruning techniques to study their effect on the growth, flowering, and productivity. The first pruning method was pinching, which involves removing the apical meristem of the tip of one-year-old shoots; the second was mild pruning, which involves removing 25% of the branch length. Continually, the third one was severe pruning, which included cutting off half of the branch length, and the fourth was unpruned trees (control). The maximum bud burst percentage, number of new shoots, shoot length, number of leaves, leaflet dimension, fruit set percentage, nut weight, nut dimension, and nut kernel percentage were generally recorded by severe pruning. Conversely, the pinching treatment resulted in the highest number of pistillate (female) inflorescences, the greatest number of flowers per pistillate inflorescence, and the most nuts per tree, leading to the highest overall yield with moderate nut quality. The unpruned trees seemed to be the worst. Therefore, it might be advised to use the pinching method that yielded the highest amount of nuts with a moderately high quality.

Key words: Pecan, desirable, pruning, flowering, yield, Fruit quality.

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1. Introduction

The pecan tree is native to North America and is a deciduous tree that is found primarily in northern Mexico and the southern United States. Because of the warm environment, pecan trees can be cultivated in places where walnuts cannot be grown. Pecan trees thrive in semi-arid areas, with long, hot summers, short, cold winters, and little humidity or precipitation. Egypt's climate is classified as semi-arid, including Mediterranean, semi-arid, and arid climates. With enough irrigation, pecan trees can be grown in these climate zones **(Sparks, 2005 and Hamed *et al.*, 2022)**. Pecan trees are valued for their robust, long-lasting wood and tasty, nutrient-rich nuts. Pruning greatly improves the health, structure, and productivity of pecan trees, making it a crucial component of trees management. Accomplishing particular objectives, such as forming the tree, promoting fruit yield and quality, and controlling

bearing, entails the selective removal of branches. According to **Sparks (1988)**, pruning increased fruit set, boosted the development of surviving branches, and decreased fruit drop in pecans. Pruning has been shown to improve nut size and quality, terminal shoot growth, and tree vigor (**Worley and Mullinix, 1997)**. Pruning has an impact on the vegetative system and rise in the N, P and Mg content of leaves, according to **Mika (1986), Li (2001) and Zivdar *et al.* (2016)**, they demonstrated that, for new shoots and leaves to develop more quickly, plant physiological processes require hormones and carbohydrates to build up in the cut branches when old and mature shoots are pruned. Also, new vegetative buds appear as a result of the translocation of nutrients and growth-promoting phytohormones called "gibberellins, cytokinins" acropetally in response to wound repair **(Bajguz and Piotrowska, 2023).**

According to **Bagchi *et al.* (2008),** pruning branches causes molecular changes that lead to more shoots and leaves with higher levels of the enzymes polyphenol oxidase, catalase, and peroxidase, as well as lipid, proline, and tryptophan in the shoots. However, phenolic levels were significantly lower than in control plants. More leaves expanded the photosynthetic surface, increasing the amount of carbohydrates assimilated by new shoots. This, in turn, hastened the induction of floral buds in pruned plants. Similarly, **Vosnjak *et al.* (2022)** found that pruning practices manage the amounts of fructose and sorbitol in cherry branches to promote the formation of floral buds.

Only efficient tree training and pruning will help with vigor control and tree size because pecan trees are huge **(Andersen and Crocker, 2004)**. Unpruned pecan trees are sometimes too big and crowded, making it difficult to harvest nuts, get sunshine, spray, etc. low photosynthetic rates brought on by less sunshine, and a large number of pests and diseases cause pecan nuts to be smaller and of lower quality, which leads to either inadequate nut fill or the development of empty nuts (**Latham and Goff, 1990)**. One of the most significant cultural techniques influencing fruit quality, productivity, and vigor, as well as controlling bearing, is pruning. To accomplish these goals, optimal pruning techniques can be applied. Pecan growth, size, and quality are all positively impacted **(Upadhyay *et al.*, 2011)**.

The pecan tree is still grown on a limited scale, even though it has been around for more than a century. Low yield is the primary limiting issue. The reason for the decrease in pecan production is that, in orchards with optimal incident sun radiation, the highest production occurs on basal branches, which are more impacted by shading than other branches. If the orchard is very crowded, there is little light coming through the canopy, branches may die and stop producing **(Worley, 1990)**. For superior nut growth, production, and quality, adult orchards require a high amount of sun radiation **(Arreola *et al.*, 2006)**. To reduce the amount of shade that low branches receive, it is essential to either thin or prune the trees **(Wood, 2009)**. Since there hasn't been any research on pecan tree pruning, the current study was carried out to identify the best pruning technique and investigate how growth, yield, and nut quality are affected by several pruning intensities.

So, the purpose of this study was to examine the best of four different pruning techniques that significantly affect the growth, flowering, and productivity of Desirable pecan trees.

2. Materials and Methods

This study was conducted on 8-year-old Desirable pecan trees throughout two consecutive seasons in 2022 and 2023. In a private orchard in Cairo-Alex. Desert Road (about 90 kilometers from Cairo), in the Behera Governorate of Egypt, Trees budded on seedling pecan rootstock, and they were trained by a modified central leader. Trees were grown in sandy soil at a distance of 4 by 5 meters under a drip irrigation system. On the suggestions of the Horticultural Research Institute, Ministry of Agriculture, Egypt, the trees were given normal cultural treatments. Twelve healthy, productive trees were included in the study. Four treatments were used in the experiment, and each was duplicated three times, using a single tree for each replication.

2.1. Pruning treatment layout

Four different pruning techniques were performed in the present study to evaluate their effect on the growth, flowering, and productivity of desirable pecan trees. The pruning procedures were

performed in February in both seasons. Each treatment was assigned to three trees, each serving as a replicate. The treatments were arranged as follows:

1. Unpruned trees (Control).
2. Pinching: removing the apical meristem of the tip of one-year-old shoots.
3. Mild pruning involves removing 25% of the branch length.
4. Severe pruning involves removing 50% of the branch length.

2.2. Morphological characteristics

1- The effects of pruning severity on vegetative growth, including the proportion of dormant and burst buds, the length of new shoots (in centimeters), the average leaflet length and width, and the length of the leaves, were measured by randomly selecting and marking twenty twigs of each tree (5 per direction) in both seasons.

2- Flowering characteristics and fruit set percentage: the number of pistillate (female) and staminate (male) inflorescences, as well as the number of flowers per pistillate inflorescence, were counted in April.

Fruit set (%): The following formula was used to determine the fruit set (%).

Number of fruitlets x 100/number of pistillate flowers equals

3- Yield and nut properties: by the first week of October, when the outer, inedible shell has split and is easily removed, pecan nuts were manually gathered. The nuts were dried at room temperature (20–30 ˚C) for three to four weeks following harvest and shelling, after that, number of nuts/ tree, yield (kg/tree, kg/feddan), nut weight (g), nut length (cm), nut width (cm), and kernel and shell percentage were calculated.

4- Crop productivity (kg/ m^2): was determined according to **(Biradar *et al.*, 2008).**

Crop productivity (kg/ m^2) = crop weight / crop area

5- Experimental design and statistical analysis: the experiments conducted in this study followed the randomized complete block design. The data obtained were tabulated and statistically analyzed according to **Snedecor and Cochran (1980)**. Differences between means were compared by Duncan's multiple range test at 5% probability level according to **Duncan (1955)**.

3. Results and discussion

3.1. Effect of pruning levels on vegetative growth

The effects of varying degrees of pruning severity on the dormant and burst buds of the "Desirable" pecan trees throughout 2022 and 2023 seasons were amply demonstrated by the results compiled in Table (1). In comparison of the unpruned trees and methods of pruning, it could be noticed that the control treatment had the highest percentage of dormant buds and the lowest burst buds in both seasons. Moreover, the trees pruned at 50% of the branch length had the lowest significant dormant buds (%) and the highest significant burst buds (%). As regards the number of new shoots, data shows the superiority of pecan trees that were pruned by a severe method, which produced the greatest number of shoots per branch (6.61, 6.83) in both seasons. With unpruned trees, the smallest number of shoots per branch was noted (3.66, 3.95). In general, as the severity of the pruning increased, the number of new shoots per branch also increased. The pruning treatments had a major impact on the shoot length. Trees with 50% severity pruning had the longest shoots (16.05, 16.75 cm), followed by trees with moderate pruning, then pinching in both seasons. Otherwise, the control trees had the smallest one.

The vegetative measurements were directly improved by increasing the pruning severity. High amounts of stored carbohydrates from the previous growing season may have contributed to this,

creating an environment that was conducive to rapid vegetative growth. These results concur with those of **Dalkilic *et al.*, 2005** on walnut, **Upadhyay *et al.* (2011)** on pecan, **Singh *et al.* (2016)** on mandarin, **Jadhav *et al.* (2020)** on apple, **Narbayeva and Akca (2022**) on walnut, and **Adel *et al.* (2023)** on grape. They discovered that the percentage of burst buds, the number of shoots, and shoot lengths are directly increased with severe pruning. The redistribution of glucose stores to tissues may cause a rise in growth characteristics.

Table (1). Effect of pruning on percentage of dormant and burst buds, number of new shoots, and shoot length of the Desirable pecan cultivar in the 2022 and 2023 seasons

Pruning treatments	Dormant bud (%)		Burst bud (%)		No. of new shoots		Shoot length (cm)	
	2022	2023	2022	2023	2022	2023	2022	2023
Unpruned	49.75 a	48.50 a	50.25 d	51.15 d	3.66 d	3.95 d	12.63 d	13.16 d
Pinching	44.59 b	43.07 b	55.41 c	56.93 c	4.40 c	4.83 c	13.55 c	14.30 c
Moderate pruning removing 25% of the branch length	41.27 c	39.31 c	58.73 b	60.69 b	5.33 b	5.65 b	14.67 b	15.34 b
Severe pruning removing 50% of the branch length	36.43 d	33.25 d	63.57 a	66.75 a	6.61 a	6.83 a	16.05 a	16.75 a

Means followed by the same letter(s) in each column are not significantly different according to Duncan's multiple range test at 5% level.

According to the impact of pruning levels on leaf features in Table (2), the data revealed that, compared to the unpruned trees (control), all pruning levels significantly increased the number of leaves and leaf features of the Desirable pecan trees. The highest significant number of leaves per new stem, leaf length, leaflet length, and leaflet width were boosted by severe pruning (cutting back 50%), followed by 25% cutting back, and the pinching method was last. Otherwise, the control treatment had the lowest values for these parameters.

These findings are in close conformity with those reported by **Hassan *et al.* (2016)** on sour lime**, Salama *et al.* (2018)** on orange trees, **Adel *et al.* (2023**) on lemon and **Gomasta *et al.* (2024)** on guava, they demonstrate that, various pruning procedures can increase leaf characteristics. Similarly, **Rani *et al.* (2018)** in lemon realized the available photosynthesis and nutrients in extensively pruned trees, which enhance vegetative development by promoting cell division and tissue creation, which might be responsible for the increase in leaf area. **Gopikrishna (1997) and Adhikari and Kandel (2015)** reported that reduced number of shoots per branch and increased shoot length as a result of increased nutrient availability to these shoots may lead to an increase in the leaf area with severe pruning**.**

Table (2). Effect of pruning on the number of leaves/new shoots, leaf length, leaflet length, and width of the Desirable pecan cultivar in the 2022 and 2023 seasons

Pruning treatments	Number of leaves / new shoot		Leaf length (cm)		Leaflet length (cm)		Leaflet width (cm)	
	2022	2023	2022	2023	2022	2023	2022	2023
Unpruned	10.19 d	11.26 d	18.20 d	18.33 d	7.03 d	7.87 d	1.72 d	1.67 c
Pinching	10.93 c	12.23 c	18.73 c	18.86 c	8.23 c	9.18 c	2.10 c	1.85 b
Moderate pruning removing 25% of the branch length	11.84 b	13.12 b	19.38 b	19.65 b	8.74 b	9.40 b	2.30 b	2.25 a
Severe pruning removing 50% of the branch length	12.95 a	14.33 a	20.35 a	20.47 a	9.52 a	10.22 a	2.60 a	2.30 a

Means followed by the same letter(s) in each column are not significantly different according to Duncan's multiple range test at 5% level.

3.2. Effect of pruning levels on flowering and fruit set percentage

Data presented in Table (3) revealed significant mark variation on flowering and fruit set percentage as an impact of pruning treatments. The pinching treatment produced the highest number of staminate, pistillate inflorescences (13.71, 12.85 - 3.95, 4.12) respectively in both seasons, and the highest number of flowers/pistillate inflorescences (8.67, 9.33) followed by 25% pruning. Otherwise, the least number of staminate flowers was recorded by 50% pruning in both studied seasons. While, the lowest value (1.96, 2.09 - 5.20, 6.30) of pistillate number and number of flower/pistillate inflorescence respectively was attained by the control treatment.

Table (3). Effect of pruning on number of staminate (male) and pistillate (female) inflorescences, number of flowers /pistillate inflorescence, and fruit set (%) of the Desirable pecan cultivar in the 2022 and 2023 seasons

Pruning treatments	Number of staminate inflorescences \twig		Number of pistillate inflorescences \twig		Number of flower / pistillate inflorescences		Fruit set (%)	
	2022	2023	2022	2023	2022	2023	2022	2023
Unpruned	10.23 c	10.08 c	1.96 d	2.09 d	5.20 d	6.30 d	79.56 d	81.05 d
Pinching	13.71 a	12.85 a	3.95 a	4.12 a	8.67 a	9.33 a	82.73 c	82.69 c
Moderate pruning removing 25% of the branch length	11.54 b	10.71 b	3.16 b	3.26 b	6.60 b	7.75 b	83.40 b	84.33 b
Severe pruning removing 50% of the branch length	9.26 d	9.43 d	2.15 c	2.31 c	6.26 c	7.43 c	85.76 a	85.15 a

Means followed by the same letter(s) in each column are not significantly different according to Duncan's multiple range test at 5% level.

Concerning the fruit set percentage in Table (3), it could be noticed that, the greatest (85.76, 85.15 %) was scored by extensive pruning (50% pruning) compared to unpruned trees that acquired the minimal one (79.56, 81.05 %) in both studied seasons. The fruit set percentage improved from the pinching to moderate treatments, reaching the maximum with 50% intensity pruning. Based on the data, it was shown that fruit sets significantly increased as pruning intensity increased. The severity of the pruning increased vegetative growth and gibberellin hormones in the shoots that inhibit floral induction, which may have contributed to the decline in pistillate blooms, according to previously published findings by **Marini (1985), Worley (1985), and Li *et al*. (1989)**. Our findings confirm the conclusions of **Szklarz *et al*. (2011)** regarding apricots, as well as those of **Dahapute *et al*. (2018)** and **Jadhav *et al*. (2020)** on custard apples. Furthermore, our results are in strong agreement with the research conducted by **Magadum *et al*. (2023)** and **Kumar *et al*. (2023)** on guavas, along with the findings of **Patil *et al*. (2024)** on custard apples. All these studies demonstrate that the highest percentage of fruit set is achieved through effective pruning treatments.

3.3. Effect of pruning levels on yield characteristics

According to data in Table (4), the intensity of pruning had a substantial impact on yield characteristics. The highest values of nuts/tree, yield (Kg/tree - Kg/feddan), and crop productivity (kg/m^2) were achieved by the pinching pruned method in both seasons, followed by moderate and severe pruning. While the parameter's lowest values were obtained via control trees. As for the number of nuts/kg, the control trees produced the most nuts per kilogram. On the other hand, severe pruning produced the lowest value. Moreover, there is an inverse relationship between pruning severity and yield. A decrease in the quantity of nuts and yield (kg/tree - kg/feddan- crop productivity), which was more noticeable with severe pruning than light pruning.

The aforementioned results agree with **Marini (1985), Worley (1985),** and **Li *et al.* (1989),** who noticed that, the intensity of the pruning led to increased vegetative growth and gibberellin hormones in the shoots that prevent floral induction; that could be the cause of this decrease in yield. Additionally, because pecans bear laterally on one-year-old shoots, extensive pruning decreased the bearing area (**Worley and Mullinix, 1997**, and **Upadhyay *et al.*, 2011**). Similar results were in line with those of **Chandel *et al.* (2004)** on kiwifruits, **Lal and Dushyant (2008)** and **Fontena *et al.* (2014)** on blueberries, who discovered that harvest and the quantity of nuts produced per plant declined as pruning intensity increased.

Table (4). Effect of pruning on the number of nuts/tree, yield (kg/tree), number of nuts/kg, yield (kg/feddan), and crop productivity (kg/m^2) of the Desirable pecan cultivar in the 2022 and 2023 seasons

Pruning treatments	Number of nuts/ tree		Yield (kg/tree)		Number of nuts/Kg		Yield (kg\feddan)		crop productivity (kg/m^2)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Unpruned	664.4 d	951.4 d	4.87 d	7.07 d	136.43 a	134.59 a	1022.70 d	1484.50 d	0.24 d	0.35 d
Pinching	1015.0 a	1469.4 a	7.79 a	11.65 a	130.38 b	126.10 b	1634.86 a	2446.99 a	0.39 a	0.58 a
Moderate pruning, removing 25% of the branch length	849.9 b	1275.8 b	6.86 b	10.51 b	123.92 c	121.36 c	1440.33 b	2207.64 b	0.34 b	0.53 b
Severe pruning removing 50% of the branch length	673.9 c	983.0 c	5.69 c	8.37 c	118.48 d	117.51 d	1194.42 c	1756.72 c	0.28 c	0.42 c

Means followed by the same letter(s) in each column are not significantly different according to Duncan's multiple range test at 5% level.

3.4. Effect of pruning severity on nut characteristics

In terms of the impact of pruning methods on nut properties, Table (5) shows that all pruning treatments improved nut attributes (weight, length, width, and kernel %) in both seasons as compared with unpruned trees (control). Even so, this increased as the degree of the pruning increased. The best results in these features were obtained by pruning 50% of the one-year-old shoots, which also decreased the proportion of nut shells in both seasons. One possible explanation for the improvement in nut size is that more intense pruning resulted in fewer flower buds and fewer nuts, which in turn led to larger nuts. The current findings are in line with research on peaches by **Bussi *et al.* (2005) and Kumar *et al.* (2010)**, who discovered that fruit properties were enhanced by more severe pruning. Additionally, **Tarango and Barrios (1999)** pointed out that pruning greatly enhanced nut quality by increasing nut size and kernel percentage. Nut size tended to grow with increasing pruning intensity, but the overall kernel percentage did not change significantly between the control and pruning treatments **(Worley, 1991; Worley and Mullinix, 1997).**

4. Conclusion

Compared to unpruned trees, all pruning treatments significantly affect the plant growth, flowering, fruit yield, and nut quality. The yield and the degree of pruning severity were inversely correlated. The pistillate (female) inflorescences, number of flowers/ pistillate inflorescences, total number of nuts, and yield decreased more with extreme pruning than with the pinching treatment. This was likely because there was more vegetative growth and less floral bud formation. On the other hand, the pinching method resulted in the highest number of pistillate (female) inflorescences, the greatest number of flowers per pistillate inflorescence, and the most nuts per tree, leading to the highest overall yield with moderate nut quality. As a result, it can be suggested based on the previously described data.

Table (5). Effect of pruning on nut weight, nut length and width, nut kernel and shell percentage of the Desirable pecan cultivar in 2022 and 2023 seasons

Pruning treatments	Nut weight (g)		Nut length (cm)		Nut width (cm)		Nut kernel (%)		Nut shell (%)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Unpruned	7.33 d	7.43 d	3.05 d	2.85 d	1.80 d	1.75 d	54.33 d	55.43 d	45.67 a	44.57 a
Pinching	7.67 c	7.93 c	3.30 c	3.51 c	2.03 c	2.14 c	57.68 c	59.38 c	42.32 b	40.62 b
Moderate pruning removing 25% of the branch length	8.07 b	8.24 b	3.83 b	4.12 b	2.20 b	2.33 b	59.53 b	60.27 b	40.47 c	39.73 c
Sever pruning removing 50% of the branch length	8.44 a	8.51 a	4.31 a	4.53 a	2.43 a	2.52 a	61.47 a	63.14 a	38.53 d	36.86 d

Means followed by the same letter(s) in each column are not significantly different according to Duncan's multiple range test at 5% level.

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