Effect of Seasonal Pruning Models on Flowering, Productivity and Fruit Quality in Olive Trees

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ABSTRACT

The present investigation was conducted during consecutive seasons (2022 and 2023) on 5-year-old "Aggizi Shame" and "Manzanillo" olive trees, which were planted at 6 x 5 m in sandy soil in a private orchard on Western Asuit Road, El-Menia Governorate, Egypt. The study focused on the effect of different seasonal or fruiting pruning models on vegetative growth, flowering characteristics, yield, fruit physical parameters, and the percentage of oil content in the olive trees. Most pruning models coincided in their timing of flowering at the beginning and end of the two studied seasons in Aggizi shame and Manzanillo cvs., except the free vase model, which was slightly later in Aggizi shame and Manzanillo, and introduced the shortest flowering period. The free vase model recorded the best values for vegetative growth parameters and physical fruit characteristics, followed by the modified spherical model, which demonstrated the superiority in fruit set, yield, and oil percentage, particularly in the Manzanillo cultivar. As a result, we recommend the modified spherical model, which combines the benefits of the free vase model, where light is relatively available to the interior shoots, and the spherical model, which protects buds and flowers when temperatures rise, particularly in olive-growing areas, which suffer from high temperatures.

Keywords: *Olea europaea*- Pruning models- Flowering- Productivity.

INTRODUCTION

The olive tree is a perennial evergreen tree from the botanical family Oleaceae and the genus Olea, which includes 30 species growing worldwide. The most prominent species is *Olea europaea* L., which is one of the oldest cultivated plants in the Mediterranean basin, dating back to the formation of some of the world's most ancient civilizations. Olive trees are native to eastern Mediterranean basin's. Despite their widespread distribution throughout the Mediterranean basin's coastal regions, they can also be found in Asia, the Arabian Peninsula, northern Africa, South and North America, and Australia (Ozcan and Matthaus, 2017, Brito et al., 2019 and Su et al., 2018).

In many arid and semiarid environments, olive trees have an adaptation mechanism that allows them to grow effectively and produce fruit despite salinity, drought, and low rainfall (Giuffre, 2017and Lorite et al., 2018). Many Mediterranean countries rely heavily on olive cultivation to boost their economies. As a result, olive tree areas in Egypt expanded significantly; according to the Ministry of Agriculture and Land Reclamation (2023) the overall grown olive area reached 277715 feddans, and the fruiting area (246068 feddans) generated 1185196 tons. 750000 ton as a table olive and the rest (about 435000 ton fruits of oil cultivars) produced 52200 ton of oil.

Pruning is a common activity in all countries that cultivate olives and is seen to be necessary for orchard management. Depending on climatic factors, long-standing traditions, and orchard characteristics, it might take on several forms. Additionally, it must adjust to the trends that are changing in each country, particularly about the creation of new orchards, an increase in the number of trees per hectare, the extension of irrigation, the tendency for particular kinds of training, the mechanization of orchards, and orchard rejuvenation. The goals of pruning must therefore be understood to make the best decisions and get the greatest results. These goals include increasing crop yield, promoting certain fruiting stages, mechanizing cultural techniques, and reducing production expenses. (Tombesi and Tombesi, 2007)

Pruning is necessary to maximize sunlight exposure and maintain the balance between vegetative and reproductive functions in mature trees (Sibbett, 2005and García-Ortiz et al., 2008). Experts also recommend pruning for young trees to reduce the length of the juvenile non-productive period and to establish the necessary framework for supporting fruit load (Vossen, 2007, Gregoriou, 2009and Therios, 2009), modifying tree canopy to the desired training system and harvesting technique (Sibbett, 2005, García-Ortiz et al., 2008 and Therios, 2009), and decreasing alternate bearing severity (Vossen and Devarenne, 2007 and Gregoriou, 2009). To manage tree growth and production, older trees may need rejuvenating and regenerative pruning **(**Sibbett, 2005 and García-Ortiz et al., 2008). The type and degree of pruning modify the tree crown to varying degrees, which significantly impacts the physiology of the tree and, in turn, its fruit yield and fruit quality (Castillo-Ruiz et al., 2015 and Villalobos et al., 2006).

One of the popular sayings in ancient Egyptian heritage is “Bring your enemy to prune your tree.” This saying may have had some truth in the past as an indication of the severity of the seasonal pruning, but with the new changes in climate and their impact on the productive behavior of trees, perhaps the more appropriate saying would be “Bring your close friend to prune your tree.” So, the present study was set up to identify the most suitable modification of the seasonal pruning models to improve flowering, productivity, and fruit quality in Aggizi Shame and Manzanillo olive cultivars.

MATERIALS AND METHODS

This work was conducted over two consecutive seasons (2022 and 2023) on 5-year-old “Aggizi Shame” and “Manzanillo” olive trees. The trees were propagated by cuttings and planted at 6 x 5 m (140 trees per fed.) in a sandy soil within private orchard on Western Assuit Road, El-Menia Governorate, Egypt. They exhibited normal growth and uniform vigor and were irrigated at about (3500-4000 cubic meters/fed/year) by using a drip irrigation system. Twelve trees of each cultivar were selected and divided into four treatments with three replicates (three trees per treatment), arranged in a randomized block design. Soil and irrigation water were analyzed according to the procedures of Jackson (1973), as shown in **Tables (1, 2, and 3).**

Table (1). Physical analysis of the orchard experimental soil.

Sample	Depth cm.	Particles size distribution			Texture
		Clay%	Silt%	Sand%	
Soil	0-60	6.59	1.19	92.22	Sandy soil

Table (2). Chemical properties of the orchard experimental soil

Sample	Depth	Mill equivalent/Liter								SP	pH	EC
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{-}			
Soil	0-60	65.15	33.55	35.65	0.84	-	2.83	85.59	46.77	25.0	7.9	12.41
		Concentration (mg/kg)										
		N	P	K	Cu	Fe	Mn	Zn				
		112	181	5.98	0.02	6.38	0.81	0.33				

Table (3). Chemical analysis irrigation water samples

Soluble cations, anions (mill equivalent/liter), EC, pH and SAR										
EC	pH	SAR	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}
1.63	7.74	1.43	5.74	4.15	3.19	0.23	-	1.2	11.74	0.37

Meteorological data:

Maximum, minimum, and average temperature at Menia-Abo-Korkas was recorded by the Climate Change Information Center & Renewable Energy, Giza, Egypt. **(Table 4)**

Table (4). Maximum, minimum, and average temperature from the experimental area (Menia–Cairo/Asuit Western desert road region) during 2022 and 2023 seasons.

Month	2022			2023		
	Max.	Average	Min.	Max.	Average	Min.
January	17.22	9.71	3.90	21.55	13.49	7.43
February	20.38	12.51	6.00	20.46	12.54	6.25
March	22.90	14.76	7.54	27.55	18.90	11.20
April	33.52	23.79	15.04	31.50	22.94	14.82
May	34.64	26.53	18.40	34.77	26.77	18.69
June	38.13	30.46	22.44	38.83	31.20	23.52
July	38.62	30.82	22.82	40.62	32.48	24.13
August	39.14	31.58	24.16	40.16	32.10	24.11
September	37.65	29.68	22.30	38.06	30.21	23.09
October	31.07	24.14	18.06	32.11	25.25	19.37
November	25.87	18.65	12.70	27.58	20.33	14.52
December	23.25	15.78	9.93	23.11	15.90	10.35

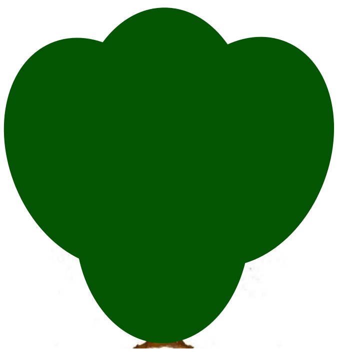
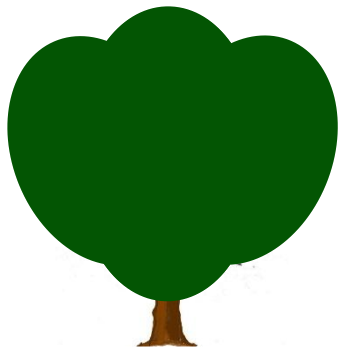
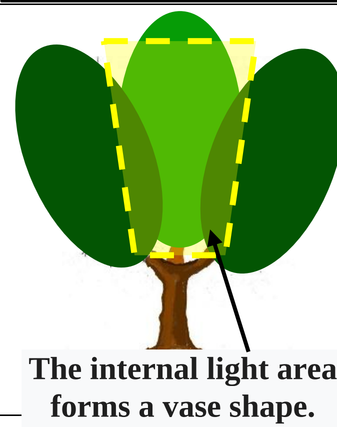
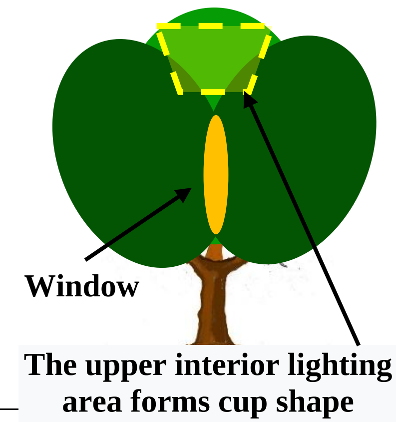
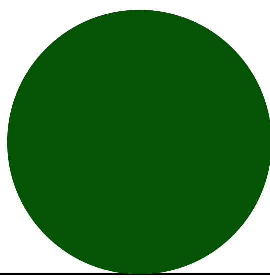
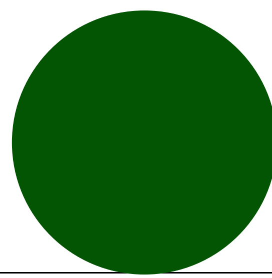
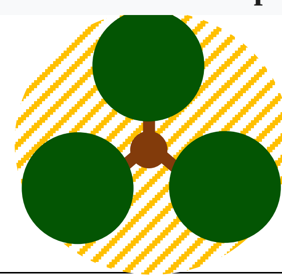
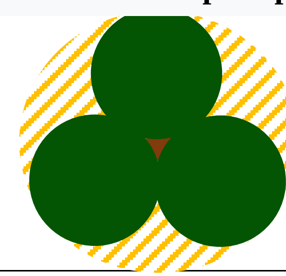
Experimental material

Some modifications of the pruning intensity degree were made in the first week of November to achieve the following fruiting pruning models **(Table 5),** and the treatments were:

1. Without pruning (Control)

2. **Spherical Model (SM):** the lightest degree of fruiting pruning, as follows:
   - Remove only branches touching the soil surface
   - Remove suckers
3. **Free Vase Model (FVM):** the most severe degree of fruiting pruning, as follows:
   - Remove branches touching the soil surface and the internal dry branches
   - Remove suckers
   - Restrict and shorten tall branches to a height not exceeding 2.75 m
   - Make more than one main internal cut for the main internal branches, which prevents light from reaching the tree inside and open the tree's core forming the vase shape **(as shown in the front view of FVM figure)**
   - Perform balanced branch thinning in different directions
   - Remove any unwanted internal branches, such as intertwined and overlapping branches
4. **Modified Spherical Model (MSM):** a medium degree between the last two previous models, as follows:
   - Remove branches touching the soil surface and dry branches
   - Remove suckers
   - Restrict and shorten tall branches to a height not exceeding 2.75 m
   - Make one main internal cut, at a high level that does not reach the tree's core, allowing light to enter without opening the tree's core too much (forming the cup shape). Avoid loosening the branches and instead install three or four windows in dense branches around the tree. **(as shown in the front view of MSM figure)**

Table (5). Photos, front and top view of the studied pruning models

	Unpruned (Control)	Spherical Model (SM)	Free Vase Model (FVM)	Modified Spherical Model (MSM)
Photo				
Front View				
Top View				

Measurements:

Vegetative growth characteristics:

Twenty (one year old) shoots were randomly labeled on each tree (replicate) to record average shoot length (cm), number of leaves/ shoot, and vegetative density (number of leaves per meter) was calculated according to the following equation

Vegetative density = 100* No. of leaves/shoot length (cm)

Flowering:-

Flowering dates and periods:

- Blooming dates: date of blooming start (at 25% anthesis), full bloom (at 75% anthesis) and end of blooming (at 25% of petal fall) were recorded for each cultivar (Hegazi, 1970).
- Blooming periods: calculated as the days between the beginning and the end of blooming dates (Mofeed, 2002).

Flowering characteristics:

- **Flowering density:** flowering density (No. of inflorescences per meter) was calculated according to Mofeed (2009) using the following equation:

$$\textbf{Flowering density} = \frac{\textbf{No. of inflorescences x 100}}{\textbf{Shoot length (cm)}}$$

- **Inflorescence length (cm):** thirty inflorescences were randomly chosen from the inner and outer portions of the tree. The average length of inflorescence in the middle portion of shoots was recorded
- **Number of total flowers per inflorescence:** thirty inflorescences at the middle portion of the shoot were randomly chosen from the inner and outer portions of the tree canopy to determine the total number of flowers per inflorescence.
- **Perfect flower percentage**: calculated according to **Hegazi and Stino (1982),** as the following equation:

$$\textbf{Perfect flower (\%)} = \frac{\textbf{No. of perfect flowers}}{\textbf{No. of total flowers}} \textbf{ x 100}$$

Fruit set:

Initial fruit set as the number of fruits/shoot, was determined after 20 days from full bloom according to **Fernandez and Gomez, (1985)**; by the following equation

Fruit set (%) = Number of fruitlets /shoot length (cm) × 100.

Fruit yield:

The average yield per tree (kg) was recorded at ripe stage (in light green/straw color in Aggizi Shame and superficial pigmentation on more than 50% the skin in Manzanillo cultivars) for each replicate tree.

Oil content percentage:

Oil content was determined by extracting the oil from the dried fruit samples using petroleum ether at 60-80 °C boiling points by Soxhlet fat extraction apparatus as according to A.O.A.C. (2000).

Fruit physical characteristics:

These included fruit length (cm), width (cm) fruit weight (g), flesh weight (g), and percentage of flesh/fruit.

Stone physical characteristics:

These included stone length (cm), width (cm) weight (g) and percentage of stone/fruit.

Statistical analysis:

The experiment was arranged in a randomized complete blocks design, and the obtained data were subjected to analysis of variance, and significant differences among means were determined according to Snedecor and Cochran (1967). In addition, significant differences among means were distinguished according to the Duncan multiple test range **Duncan (1955)**.

RESULTS AND DISCUSSION

Effect of seasonal pruning models on vegetative growth:

According to the data of Aggizi Shame in **Table (6),** free vase model produced the longest shoots (20.73, 21.90 cm), the highest numbers of leaves per shoot (32.06, 33.98), and the highest vegetative density (155.66, 157.16), followed by modified spherical and spherical models in both seasons of the study. Also, Manzanillo's free vase model achieved the highest values of all the studied vegetative characteristics in the 2022 and 2023 seasons. Whereas there were no significant differences between the modified spherical and spherical pruning models in the first season, however, the modified spherical model came in second position in the 2023 season. Additionally, the unpruned trees had authentically the lowest values in all vegetative parameters of Aggizi and Manzanillo cvs. in the two seasons.

Increasing the pruning severity directly improved the vegetative measures. This may have been caused by high levels of stored carbohydrates from the previous growing season, which produced conditions that supported quick vegetative growth. Gucci and Cantini (2000) on olive, Singh et al. (2016) on mandarin, and Gomasta et al. (2024) on guava all support these findings. They found that severe pruning directly increases the number of shoots, the proportion of burst buds, and the length of the shoots. Growth characteristics may increase as a result of the pruning of old and mature shoots, plant physiological functions force hormones and carbohydrates to accumulate in the cut branches for faster emergence of new shoots and leaves **(**Mika 1986 and Li 2001).

Table (6). Effect of seasonal pruning models on vegetative growth of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons.

Pruning models Treatments	Shoot length (cm)		No. of leaves / shoot		Vegetative density	
	2022	2023	2022	2023	2022	2023
			Aggizi Shame			
Unpruned (control)	16.90D	17.61D	25.75D	26.93D	152.37D	152.92D
spherical model	18.83C	19.58C	28.94C	30.17C	152.69C	153.09C
free vase model	20.73A	21.90A	32.06A	33.98A	155.66A	157.16A
modified spherical model	19.84B	20.77B	30.59B	32.12B	154.18B	155.65B
			Manzanillo			
Unpruned (control)	22.96C	17.75D	24.02C	16.85D	104.62C	94.93D
spherical model	24.78B	19.10C	26.08B	18.38C	105.25B	96.23C
free vase model	27.24A	21.77A	28.87A	21.41A	107.98A	99.35A
modified spherical model	24.71B	19.83B	26.00B	19.21B	105.22B	96.87B

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

Effect of seasonal pruning models on flowering dates and characteristics:

From the data in **Figure (1) and Table (7),** it was noticed that there were slight differences in the flowering period on the two studied seasons; the beginning of flowering was earlier in 2023 by 4-5 days in Aggizi Shame cultivar and by 4-6 days in Manzanillo. While the end of flowering was earlier Aggizi shame by 2-4 days and by 3-5 days in Manzanillo, which might be related to slight differences in temperatures during the same period **(Table 5).**

According to the results from Tables (7 and 8) during 2022 and 2023 seasons, in Aggizi Shame, all pruning models coincided in their beginning and end of flowering (29, 24 March and 12, 8 April respectively), except for the free vase model which was slightly later (1 April, 28 March and 13, 11 April respectively). On the other hand, all pruning models of Manzanillo cultivar had the same date of beginning and end of flowering (5, 1 April and 18, 15 April in 2022 and 2023 seasons respectively) except the free vase model which started the flowering period on 7 April in 2022 season and ended on 13 April in the second season. Abstractly, the flowering periods of Aggizi Shame were being (15-16 days) in all treatments except free vase model which was (13-15 days) in the two seasons respectively, whereas in Manzanillo, it was (14-15 days in all pruning models) and (12-13 days) during 2022 and 2023 seasons respectively, in the free vase model.

Table (7). Effect of seasonal pruning models on flowering dates and flowering period of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons.

Pruning models	Start of flowering		Full bloom		End of flowering		Flowering period	
Treatments	2022	2023	2022	2023	2022	2023	2022	2023
Aggizi Shame								
Unpruned (control)	29 Mar.	24 Mar.	8 April	3 April	12 April	8 April	15 day	16 day
Spherical model	29 Mar.	24 Mar.	8 April	3 April	12 April	8 April	15 day	16 day
Free vase model	1 April	28 Mar.	10 April	8 April	13 April	11 April	13 day	15 day
Modified spherical model	29 Mar.	24 Mar.	8 April	3 April	12 April	8 April	15 day	16 day
Manzanillo								
Unpruned (control)	5 April	1 April	13 April	10 April	18 April	15 April	14 day	15 day
Spherical model	5 April	1 April	13 April	10 April	18 April	15 April	14 day	15 day
Free vase model	7 April	1 April	15 April	10 April	18 April	13 April	12 day	13 day
Modified spherical model	5 April	1 April	13 April	10 April	18 April	15 April	14 day	15 day

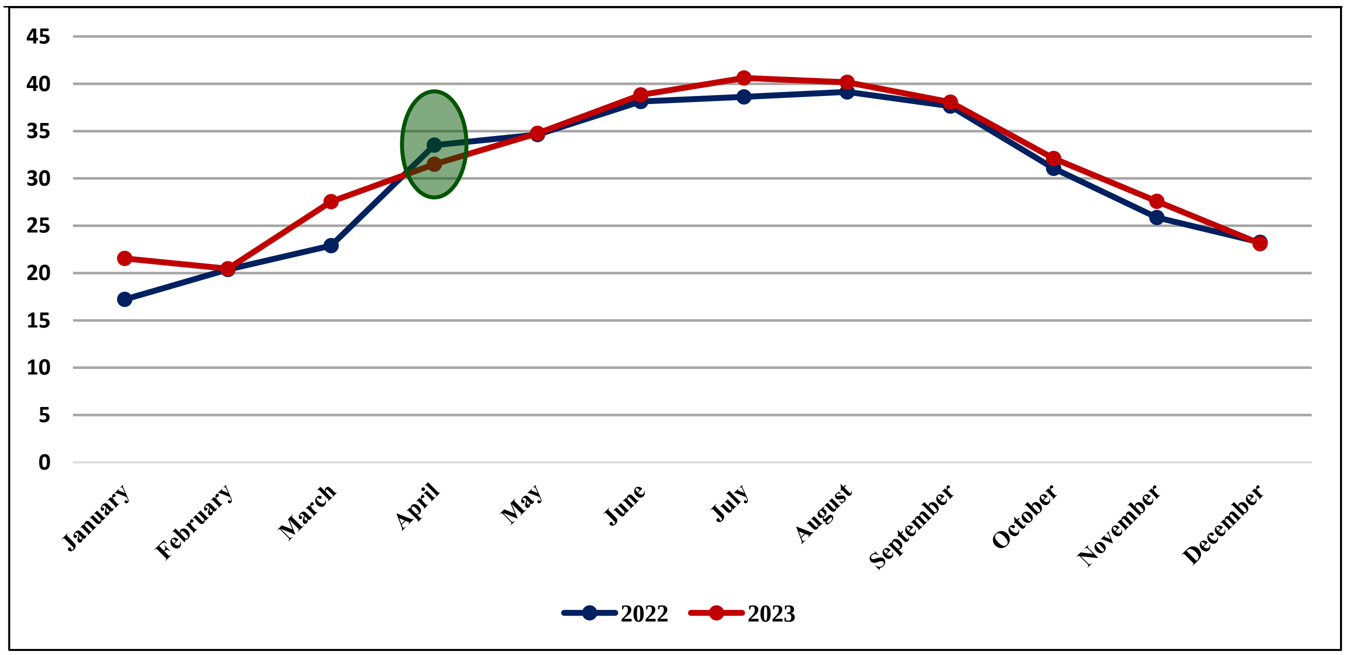


Fig. (1). Maximum temperature during the 2022 and 2023 seasons under Menia Region

Table (8). Flowering periods of the studied olive pruning models during 2022 and 2023 seasons.

Cultivar	Treatment	Season	Flowering periods																									
			March								April																	
			24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Aggizi Shame	Control	1st						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
		2nd	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
	SM	1st						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
		2nd	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
	FVM	1st									■	■	■	■	■	■	■	■	■	■	■	■	■					
		2nd					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
	MSM	1st						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
		2nd	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
Manzanillo	Control	1st													■	■	■	■	■	■	■	■	■	■	■	■	■	■
		2nd									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
	SM	1st													■	■	■	■	■	■	■	■	■	■	■	■	■	■
		2nd									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
	FVM	1st															■	■	■	■	■	■	■	■	■	■	■	■
		2nd									■	■	■	■	■	■	■	■	■	■	■	■	■					
	MSM	1st													■	■	■	■	■	■	■	■	■	■	■	■	■	■
		2nd									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			

Effect of seasonal pruning models on flowering characteristics:

There is a statistically significant difference between the studied pruning models in the studied flowering characteristics **(Table 9).** The modified spherical model produced the best significant results in terms of number of inflorescences per meter (61.86, 65.20 and 51.70, 55.46); inflorescence length (2.56, 3.09 and 2.77, 3.21 cm), number of flowers per inflorescence (13.86, 17.43 and 13.37, 15.77) and percentage of perfect flowers (77.90, 80.35 and 58.97, 61.68%) in both seasons for both cultivars Aggizi Shame and Manzanillo respectively. In contrast, the free vase model came in second rank in all the previous flowering characteristics. Ultimately, the spherical model was adopted, while unpruned olive trees produced the least significant values in both seasons of the study.

Table (9). Effect of seasonal pruning models on flowering characteristics of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons.

Pruning models Treatments	Flowering density		Inflorescence length (cm)		No. of total flowers/ inflorescence		Perfect flowers (%)	
	2022	2023	2022	2022	2022	2023	2022	2023
Aggizi Shame								
Unpruned (control)	46.86D	50.70D	2.11C	2.31C	9.24D	11.31D	63.96D	67.64D
Spherical model	50.73C	55.27C	2.15 C	2.33C	10.62C	13.35C	69.40C	74.47C
Free vase model	57.38B	62.60B	2.35B	2.58B	11.65B	15.92B	71.48B	77.01B
Modified spherical model	61.86A	65.20A	2.56A	3.09A	13.86A	17.43A	77.90A	80.35A
Manzanillo								
Unpruned (control)	29.26D	34.05D	2.10C	2.17C	9.20D	11.87C	51.10D	54.20D
Spherical model	37.12C	43.10C	2.31B	2.30BC	9.58C	11.45D	53.14C	56.92C
Free vase model	45.90B	49.72B	2.42B	2.47B	11.73B	13.60B	55.68B	59.06B
Modified spherical model	51.70A	55.46A	2.77A	3.21A	13.37A	15.77A	58.97A	61.68A

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

It may be said that, the modified spherical models have better flowering characteristics than the other pruning models during the two studied seasons, by causing slight shadowing, which in turn cooled and tempered the tree's micro-climate, the mechanical effect and the primary factor that allows trees to have a cooling effect are found in the canopy (Deng et al., 2019, Lin and Lin, 2010 and Cheung et al., 2021), which conceals the surface from direct sunlight. At the same time, the canopy's leaves are capable of transpiration and photosynthesis (Kántor et al., 2016 and Konarska et al., 2014). The three-dimensional properties of varied canopies cause variations in the trees' ability to cool. Speak et al. (2020) and Wang and Akbari, (2016) proposed that canopy form be included while studying the cooling effect of trees. Tree crown diameter (TCD) and tree height (TH) are two measures of tree size that have distinct implications on the thermal environment. At the same time, increasing the diameter of the crown will provide better cooling and humidification than raising the height of the trunk.

In addition, Albarracin et al. (2019) observed that alternate post-pruning management strategies may help improve the transition of new shoots from vegetative to reproductive phases when moderate or severe pruning is required to control canopy size. These results are fairly consistent with the results indicated above. Pruning generally improves light penetration into the crown and increases flowering. The impact of light on olive flower production was noted by Tombesi (1984), while Muñoz-Cobo and Guillén (1989) found that branches with adequate light have vigorous flowering.

Food elements and growth-promoting phytohormones called "gibberellins and cytokinins" move acropetally in response to wound healing, causing the formation of new vegetative buds (Bajguz and Piotrowska, 2023). Also, Bagchi et al. (2008) verified that branch bending and pruning induce molecular changes in guava, leading 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 plants that were pruned.

Effect of seasonal pruning models on initial fruit set (%), tree yield and fruit oil content (%):

The findings in **Table (10)** show that, in comparison to unpruned trees, pruning models significantly impacted both cultivars' fruit set and yield in the 2022 and 2023 seasons. The modified spherical model performed the best, scoring the highest significant values of fruit set (26.65, 30.89 - 24.76, 27.74%) and yield (26.83, 30.80 - 18.89, 21.73 kg/tree) with both olive cultivars Aggizi Shame and Manzanillo in both seasons, respectively. The free vase model and the spherical model came in second and third places, respectively. The worst results were obtained by unpruned trees. In addition, the modified spherical model produced the highest significant proportion of oil content in Aggizi Shame. No significant difference was observed between the rest of pruning treatments. Regarding Manzanillo olive cultivars in both seasons, the modified spherical model presented the highest significant oil content percentage, followed by both the spherical model and the control, with no significant difference between them. The lowest significant percentage of oil content was displayed by the free vase model.

These results are in harmony with those of Villalobos et al. (2006), who suggested that canopy size, density, and shape affect the fruiting potential of olive trees in the orchard. Taking into account that all the previous interpretations of flowering characteristics resulted in positive results of fruit setting and productivity. Most studies have confirmed that increasing the percentage of oil is in favor of more severe pruning, and this was confirmed by Fichte and Tapia (2006), where he mentioned that greater oil content per fruit as a result of pruning, when interpreting the obtained result, which is in favor of less severe pruning (globular and modified spherical), this may be due to the high temperatures during the oil accumulation period under the conditions of the Menia region, which strongly affected the cup shape (more severe pruning), while less severe pruning resulted in protection and partial shading of the fruits due to the larger green group, which led to a relative increase in oil in the spherical and modified spherical models). This interpretation is consistent with what was mentioned by Nissim et al. (2020) where he mentioned that high temperature environments are shown to negatively influence fruit development as well as oil accumulation and thereby reduce yield. It also came in agreement with Maestri et al. (2002) and Wilhelm et al. (1999), who reported that, oilseed crops are also negatively affected by heat stress, which has been shown to reduce starch, protein, and oil content.

Table (10). Effect of seasonal pruning models on initial fruit set and yield of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons.

Pruning models Treatments	Set fruit (%)		Yield (kg/tree)		Fruit oil (%)	
	2022	2023	2022	2023	2022	2023
Aggizi Shame						
Unpruned (control)	18.76D	22.35D	14.39D	16.24D	12.97B	13.54B
Spherical model	21.45C	24.86C	21.24C	24.30C	13.36B	13.58B
Free vase model	25.87B	28.77B	23.52B	27.48B	12.67B	13.28B
Modified spherical model	26.65A	30.89A	26.83A	30.80A	14.53A	14.81A
Manzanillo						
Unpruned (control)	17.32D	19.27D	6.4D	9.24D	29.52B	30.07B
Spherical model	20.19C	22.38C	11.52C	15.30C	30.19B	30.74B
Free vase model	21.12B	24.61B	15.70B	18.54B	27.21C	27.97C
Modified spherical model	24.76A	27.74A	18.89A	21.73A	31.47A	31.92A

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

Effect of seasonal pruning models on fruit and stone characteristics.

According to data in **Table (11),** pruning models had a substantial influence on quality characteristics of the fruit, such as fruit length, fruit width, flesh weight, and percentage of flesh/fruit in both seasons of Aggizi Shame and Manzanillo olive cultivars. The free vase model generated the highest values in all these parameters, followed by the modified spherical model, and finally the spherical model. Meanwhile the unpruned trees (control) have the lowest ones.

Table (12) shows how both olive cultivars responded to different pruning approaches in terms of stone length, width, weight, and stone/fruit percentage. In both seasons, unpruned and spherical-shaped trees produced the greatest length, width, and weight of Aggizi Shame stones, except for stone weight in the first season, where there was no significant difference among all treatments. The highest percentage of stone/fruit was obtained by unpruned trees. The lowest values for all parameters were registered by the free vase model. Regarding the Manzanillo olive cultivar, the highest stone dimensions (length and width) was recorded for control trees in both seasons. The stone weight did not show any significant change in the first and second seasons. While the highest percentage of stone/fruit was registered with both unpruned and spherical model and the lowest values were booked with a free vase model.

Table (11). Effect of seasonal pruning models on fruit characteristics of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons

Pruning models Treatments	Fruit length (cm)		Fruit width (cm)		Fruit weight (gm)		Flesh weight (g)		Flesh /fruit (%)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Aggizi Shame										
Unpruned (control)	2.62D	2.75D	2.25D	2.50D	6.41D	6.80D	5.43D	5.77D	84.71D	84.85D
Spherical model	2.85C	2.92C	2.50C	2.60C	7.22 C	7.56C	6.26C	6.51C	86.70C	86.11C
Free vase model	3.20A	3.30A	2.57A	2.81A	9.34A	9.85A	8.41A	8.88A	90.04A	90.15A
Modified spherical model	3.10B	3.25B	2.38B	2.71B	8.93 B	9.41B	7.98B	8.42B	89.36B	89.48B
Manzanillo										
Unpruned (control)	2.32C	2.47C	1.73D	1.86D	5.14D	5.40D	4.43D	4.60D	86.20C	86.50C
Spherical model	2.35C	2.53C	1.89C	2.11C	5.58C	5.83C	4.84C	5.09C	86.82C	87.30C
Free vase model	2.61A	2.75A	2.08A	2.19A	6.42A	6.82A	5.72A	6.11A	89.15A	89.65A
Modified spherical model	2.48B	2.62B	2.02B	2.13B	6.13B	6.41B	5.41B	5.67B	88.22B	88.52B

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

Table (12). Effect of seasonal pruning models on seed characteristics of Aggizi Shame and Manzanillo cvs. during the 2022 and 2023 seasons.

Pruning models Treatments	Stone length (cm)		stone width (cm)		stone weight (gm)		Stone/fruit (%)	
	2022	2023	2022	2023	2022	2023	2022	2023
Aggizi Shame								
Unpruned (control)	1.88A	1.90A	1.02A	1.02A	0.98A	1.03A	15.29A	15.15A
Spherical model	1.87A	1.89A	1.01A	1.02A	0.96A	1.05A	13.30B	13.89B
Free vase model	1.68C	1.70C	0.86C	0.84B	0.93A	0.97B	9.96D	9.85D
Modified spherical model	1.82B	1.75B	0.90B	0.88C	0.95A	0.99B	10.64C	10.52C
Manzanillo								
Unpruned (control)	1.67A	1.64A	0.92A	0.91A	0.71A	0.73A	13.80A	13.50A
Spherical model	1.58B	1.58B	0.90A	0.85B	0.74A	0.74A	13.18A	12.70A
Free vase model	1.43D	1.44C	0.83C	0.82C	0.70A	0.71A	10.85C	10.35C
Modified spherical model	1.49C	1.46C	0.87B	0.82C	0.72A	0.74A	11.78B	11.48B

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

One possible explanation for the increase in fruit size is that severe pruning produced fewer flower buds and fewer fruits, resulting in larger fruits. Similarly, the current results fully agree with findings reported by Castillo-Ruiz et al. (2015) and Villalobos et al. (2006), who mentioned that the pruning type and its intensity modify the tree crown to varying degrees, which notably affects the tree physiology and, consequently, the fruit quantity and quality. The current findings are consistent with research on peaches by Bussi et al. (2005) and Kumar et al. (2010), who found that fruit properties were improved by more severe pruning.

CONCLUSION

The majority of pruning models coincided in their beginning and end of flowering during the two studied seasons in Aggizi shame and Manzanillo cvs., except the free vase model, which was slightly later in Aggizi shame and Manzanillo and had the shortest flowering period. The free vase model produced the best values of the studied vegetative growth parameters and physical fruit characteristics, followed by the modified spherical model, which demonstrated superiority in the characteristics of fruit set, yield, and oil percentage, particularly in the Manzanillo cultivar, which was considered a dual-purpose cultivar.

Therefore, we can recommend the modified spherical model, which gave good fruit characteristics, the highest yield and oil percentage. Also, it saves available light for interior shoots and protects buds and flowers when temperatures increase, especially in olive-growing areas with very high temperatures.

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الملخص العربى

تأثير نماذج التقليم السنوى على التزهير والانتاجية وجودة الثمار فى أشجار الزيتون

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أُجريت هذه الدراسة خلال موسمين متتاليين (2022 ، 2023) على أشجار زيتون صنفى العجيزى الشامى والمنزانيللو عمر 5 سنوات، مزروعة على مسافات 6 × 5 م في تربة رملية بمزرعة خاصة بطريق أسيوط الغربي، محافظة المنيا، مصر. استهدفت الدراسة تأثير نماذج التقليم الموسمية (تقليم الاثمار) المختلفة على النمو الخضري وخصائص التزهير والمحصول والمواصفات الفيزيائية للثمار ونسبة الزيت في أشجار الزيتون. تزامنت معظم نماذج التقليم في فترات تزهيرها (بداية الازهار ونهايته) خلال موسمي الدراسة في صنفي العجيزي الشامي والمنزانيلو باستثناء النموذج الكأسى الحر الذي كان متأخرًا قليلاً في الصنفين، كما أنه أعطى أقصر فترة تزهير. كما سجل النموذج الكأسى الحر أيضاً أفضل القيم لصفات النمو الخضري والخصائص الفيزيائية للثمار، يليه النموذج الكروي المعدل الذي أظهر تفوقًا واضحاً في خصائص عقد الثمار، والإنتاجية، ونسبة الزيت، وخاصةً في صنف المنزانيلو. لذلك نوصي بالنموذج الكروي المعدل، الذي يجمع بين مزايا النموذجين الكأسى الحر من حيث توفر الضوء نسبيًا للبراعم الداخلية، والنموذج الكروي من حيث حماية البراعم والأزهار عند زيادة الحرارة ، وخاصةً في مناطق زراعة الزيتون التي تعاني من ارتفاع درجات الحرارة.