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The suitable planting distance for Koroneiki and Chemlali olives under Al-Nubaria district conditions

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Abstract: This study was carried out during two successive seasonson two years old Koroneiki and Chemlali olive seedlings, planted in the Experimental Station of National Research Centre, at Al-EmamMalek village, Al-Nubaria district, Al-Behaira Governorate, Egypt. Four planting distance (1.5X2.5 & 1.5X3.5 & 2.5X3.5 and 4X4m) were examined to conduct the most suitable one for cultivating both of the two cultivars under investigation in the orchard land. The obtained results show due to the increasing rate, that 1.5X2.5m apart as planting distance seems to be suitable for cultivating Koroneiki seedlings, since this space recorded the highest increment rate for stem thickness and number of leaves per branch, also largest leaf area, beside the leaf potassium percentage and chlorophyll (b) content.While, it could be concluded that the widest space (4X4m) is more suitable for planting Chemlali olive seedlings since it recorded the highest increment rate of plant height, stem thickness and number of branches per plant.
Key words: Olive - Koroneiki – Chemlali – Planting distances – Vegetative growth – Mineral content.

Introduction

The olive tree (*Oleaeuropaea* L.) has been cultivated for approximately 6000 years in Mediterranean region where about 95% olive resources are located (Esraa et al., [1]). Olive is one of the most important fruit crops grown in the newly reclaimed area in Egypt.

Determination of the optimum plant population density necessary for optimal yield is a major agronomic goal (Rasekh et al., [2]). Olive planting patterns is a hotly discussed topic. Optimal olive orchard designs involve planting trees to utilize space efficiently and maximize sun exposure. In olive-growing regions around the world, growers have their preferences, but as machine picking and super-high-density orchards become more common, trees must be spaced and pruned specifically for the machine, more than according to local preferences (Sibbettand Ferguson[3]).

There is no exact recipe for tree spacing. It depends on the variety, terrain, climate, proposed harvest method, tree training systems, fertility, irrigation management, and soil conditions. Spacing ranges from as close as 3ft by 12ft (0.9m by 3.7m) to 28ft by 28ft (8.5m by 8.5m), also referred to as 28ft on center and every combination in between (Sibbett and Ferguson [3]).

When the orchards planted at a high-density of about 200 to 350 trees per acre (494 to 865 per hectare),the more trees planted per acre, the faster the planting comes into bearing. Any variety can work in a high-density setting[3]. On the other hand, the super-high-density system has worked with three varieties: Arbequina, Arbosana, and Koroneiki. Any other variety closely spaced may have excellent results for the first

few years but, eventually, the trees grow too big for their allotted amount of space, grow too tall, and shade the lower portion of the trees. The super-high-density system never allows the trees to exceed a size of about 9 to 10ft tall by 6 to 7ft wide (2.7 to 3.0m by 1.8 to 2.1m) through annual renewal pruning. The trees are planted 5ft by 13ft (1.5m by 4.0m) apart in high vigor sites to 4ft by 12ft (1.2 by 3.6m) apart in low vigor sites (Sibbett and Ferguson [3]).

The highest values of fresh and dry weights of spray, total carbohydrates percentages in inflorescences, nitrogen, phosphorus, potassium content in inflorescences were obtained for planting distance of 40 cm when strawflower plant (HelichrysumbracteatumAndr.) was planted at 20, 30 and 40cm apart (Badawy et al.,[4]).

The effect of planting density on onion show that lower planting density significantly increased the number of leaves per plant and large bulbs weight. The medium planting density has significant effect only on weight of double bulbs. Higher planting density significantly increased leaf length, weight of small bulbsand weight of medium bulbs (Nasir et al., [5]).

The aim of this study is to detect the most suitable planting distance for cultivating both Koroneiki and Chemlali olive seedlings under sandy soil conditions.

Materials and Methods

This study was carried out during two successive seasons, 2014 and 2015 on two years old Koroneiki and Chemlali olive seedlings, planted under drip irrigation system in the experimental station of National Research Centre, at Al-EmamMalek village, Al-Nubaria district, Al-Behaira Governorate, Egypt. Four planting distance (1.5X2.5 & 1.5X3.5 & 2.5X3.5 and 4X4m) were examined to conduct the most suitable one for cultivating each of Koroneiki and Chemlali olive seedlings in the orchard. Treatments (planting distances) were arranged in randomized complete block design (RCBD) with four replicates for each treatment. The horticultural practices were the same for all plants under investigation.

The soil physical and chemical properties are showing in Table (1).

Table (1): Mechanical and chemical analysis of experimental soil Al-EmamMalek village, Al-Nubaria district, Al-Behaira Governorate.

Sand %	Silt %	Clay %	pH	Organic matter, %	$CaCO_3$ %	E.C. dS/m	Soluble N (ppm)	Available P (ppm)	Exchangeable K (ppm)
91.2	3.7	5.1	7.3	0.3	1.4	0.3	8.1	3.2	20

In both studied seasons the following physical and chemical properties were recorded for both cultivars:

First: Physical properties.

- Plant height (cm).
- Stem thickness (cm).
- Number of branches/plant.
- Number of leaves/branch.
- Leaf area (cm^2).
- Increasing rate for each of the previous parameters

Second: chemical properties.

Leaf samples were collected from each seedling to determine N, P and K contents according to the methods as described by Cottenie et al., [6].

Leaf Content of Chlorophylls: Forty leaves were collected then chlorophylls (a) and (b) were determined spectrophotometrically at 660, 640 mm wavelength for chlorophyll (a) and (b), respectively, against the blank methanol using the method as described by Beckett et al., [7].

Statistical analysis:

The data were subjected to analysis of variance and the method of Duncan's was used to differentiate means (Duncan[8]).

Results and discussion

Koroneiki

Results in Table (2) show that the planting distance had a significant effect on plant height, stem thickness, No of branches, No of leaves and leaf area of Koroneiki olive seedlings. In this concern, it's clear that the closest distances (1.5X2.5m) and (1.5X3.5m) had a constant effect in the two studied seasons since they increased the plant height, while the other distances show different effect through the two seasons. In respect to the increasing rate, the widest space recorded the highest increment for the plant height.

Regarding the stem thickness, results show that 1.5X3.5m apart significantly gave the highest value of stem thickness in the two seasons. While as, the increasing rate show that the closest space recorded the maximum percentage of increment for stem thickness.

Concerning number of branches, the highest number was recorded with 1.5X3.5m apart, while the lowest number of branches was obtained from the widest space (4X4). This was true in both studied seasons. The increasing rate was at the maximum due to 2.5X3.5m spacing which gave the highest value comparing with the other distances.

In respect to number of leaves per branch, results appear that there were no differences among planting distance in the first season, while in the second one the closest space recorded the maximum number of leaves and the widest space gave the lowest number. The increasing rate confirms the data in the second season since the widest space recorded the highest percentage.

As for leaf area, results show that the two wide spaces (4X4m) and (2.5X3.5m) gave larger leaf are in the first and second seasons, respectively. While, the smallest leaf area was obtained by the closest space (1.5X2.5m) in the first and second seasons of the study. On the contrary, the increasing rate was at the maximum value due to the closest space, while the widest space gave the minimum one.

Table (2): Physical properties of Koroneiki olive seedlings as affected by different planting distances.

Parameters / Treatments	Plant height (cm)		Increasing rate	Stem thickness (cm)		Increasing rate	No branches/ plant		Increasing rate	No leaves/ branch		Increasing rate	Leaf area (cm^2)		Increasing rate
	Season			Season			Season			Season			Season		
	1st	2nd		1st	2nd		1st	2nd		1st	2nd		1st	2nd	
1.5X2.5m	72.0a	111.7a	57.94 B	1.50c	2.93b	100.9 A	8.00ab	9.00a	13.06 B	34.67a	41.00a	18.95 A	3.60c	4.98c	38.58 A
1.5X3.5m	71.0a	112.0a	57.54 B	2.30a	3.77a	63.94 B	10.33a	11.0a	6.06B	36.00a	39.33ab	9.59 AB	4.15b	5.07b	22.25 B
2.5X3.5m	74.0a	95.33b	29.06 C	2.27a	2.77b	22.27 C	5.67bc	9.00a	61.11 A	36.67a	37.67ab	2.61B	4.08b	5.17a	26.83 B
4.0X4.0m	50.6b	113.3a	124.6 A	1.90b	2.10c	10.63 C	3.67c	5.00b	38.89 AB	31.33a	34.00b	8.66 AB	4.56a	5.02bc	10.15 C
Significance at 5% level	S	S	S	S	S	S	S	S	S	NS	S	S	S	S	S

As for nutrient content in the leaves, Table (3) show that nitrogen content was at the highest value when the seedlings planted at 2.5X3.5m apart, while the highest phosphorus content was recorded with 4X4m space. While as, the maximum value for potassium was obtained due to the closest space 1.5X2.5m. Regarding the chlorophyll content in the leaves, the highest value of chlorophyll (a) was recorded with 4X4m as planting distance followed by 1.5X2.5m then 1.5X3.5m. The highest value of chlorophyll (b) was obtained by 2.5X3.5m followed by 1.5X2.5m apart.

From the above results, it could be concluded that 1.5X2.5m apart as planting distance seems to be suitable for cultivating Koroneiki seedlings, since this space recorded the highest increment rate for stem thickness and number of leaves per branch, also largest leaf area, beside the leaf potassium percentage and chlorophyll (b) content that leadto increase storage of carbohydrate and nutrients in the stem which observed as the highest increment rate of the stem thickness.

Table (3): Mineral and chlorophyll content of Koroneiki olive leaves as affected by different planting distances.

Parameters / Treatments	Mineral content (%)			Chlorophyll content (mg/100 g FW)	
	N %	P %	K %	a	b
1.5X2.5m	1.23	0.14	1.13	55.00	12.67
1.5X3.5m	1.32	0.18	1.00	54.40	9.88
2.5X3.5m	1.39	0.15	0.93	46.88	22.79
4.0X4.0m	1.16	0.23	0.86	56.30	11.75

Chemlali

Results in table (4) show that the plant height was affected significantly by different planting distance. However, closer distances (1.5X2.5m) and (1.5X3.5m) recorded higher values of plant height in the studied seasons comparing with the other distances. On the contrary, the increasing rate of plant height was recorded with 4X4m spacing, while closer ones gave lower values.

As for stem thickness, it's observed that the obtained results were irregular in the two seasons, since when the thickest stem was recorded by the closest space in the first season, it was recorded in the second one due to the widest space. However, the highest value for the increasing rate of stem thickness was recorded by the widest space (4X4m).

Concerning number of branches per plant, the results show that 1.5X2.5m apart gave the highest number in both seasons followed in descending order by the wider distances. The increment rate of branches number was the highest with the widest space (4X4m).

Number of leaves was increased when the seedlings planted at wider distances except in the second season. In another word, the closet space gave the lowest number of leaves while 2.5X3.5m space gave the highest number followed by 4X4m. In respect to the increasing rate, 2.5X3.5m gave the highest number.

Regarding leaf area, it's clear that the intermediate distances recorded the highest values in the two seasons, since when 2.5X3.5m gave the highest value in the first season; 1.5X3.5m gave the highest one in the second season. Also 1.5X3.5m recorded the highest increment rate of leaf area.

Results in Table (5) show the effect of planting distance on leaf mineral content. In this concern, the closest space recorded the highest value of N and K in the leaves, while 2.5X3.5m recorded the highest value of P comparing with the other distances. In respect to chlorophyll (a) and (b) in the leaves, the obtained results show that the closest space (1.5X2.5m) gave the maximum value of chlorophyll (b), while the same space was the second for chlorophyll (a) followed to 1.5X3.5m apart.

From the above results, due to the increasing rate results, it could be concluded that the widest space (4X4m) is more suitable for planting Chemlali olive seedlings since it recorded the highest increment rate of plant height, stem thickness and number of branches per plant.

From the abovementioned results of the two cultivars under investigation, it could be concluded that each of the two cultivars are differed than the other in the suitable planting distance for cultivating in the orchard land, since although Koroneiki was grow better and gave the best results when planted at the closest distance (1.5X2.5m), Chemlali was grow better and recorded the best results with the widest distance (4X4m). These results may be due to the growing nature of each cultivar and the spacing needs to grow better, since when calculating the plant height/stem thickness ratio for Koroneiki, it was 0.574 for the closest distance (1.5X2.5m) and it was 11.63 for the widest distance (4X4m), this means that the closest distance was more effective than the widest one for Koroneiki cultivars especially when detected the results of increment rate of stem thickness, number of leaves per branch and leaf area, also K and chlorophyll content in the leaves. As for Chemlali the plant height/stem thickness ratio was 0.256 for the closest distance (1.5X2.5m) and it was 0.219 for the widest distance (4x4m) which means that the results is somewhat similar but the widest distance was more better than the closest one especially when detected the resultsof increment rate of plant height, stem thickness, number of branches per plant and chlorophyll content in the leaves.

The variations in the results among the different parameters of the two cultivars under investigation are in harmony and completely identical with those explained that the super-high-density system was not suitable for any olive cultivars, since three varieties worked best with the super-high-density system such asArbequina, Arbosana, and Koroneiki, while any other variety closely spaced may have excellent results for the first few years but, eventually, the trees grow too big for their allotted amount of space, grow too tall, and shade the lower portion of the trees[3]. The obtained results for Chemlali are in harmony with those obtained for strawflower plant since the widest planting space gave the best results**(**Badawy et al.,[4]).

So, it could be concluded that the closest distance (1.5X2.5m) is more suitable for planting Koroneiki seedlings in the orchard land, while the widest distance (4X4m) is more suitable for Chemlali seedlings.

Table (4): Physical properties of Chemlali olive leaves as affected by different planting distances.

Parameters / Treatments	Plant height (cm)		Increasing rate	Stem thickness (cm)		Increasing rate	No branches/ plant		Increasing rate	No leaves/ branch		Increasing rate	Leaf area (cm^2)		Increasing rate
	Season			Season			Season			Season			Season		
	1st	2nd		1st	2nd		1st	2nd		1st	2nd		1st	2nd	
1.5X2.5m	109.7a	134.7a	22.80 B	1.77a	3.30b	88.82 B	14.00a	14.67a	4.60B	33.00b	35.33c	7.62 AB	2.65b	3.70b	39.57 B
1.5X3.5m	111.7a	132.0a	18.23 B	1.30b	3.10b	139.4 B	10.00b	11.00b	10.07 B	43.67a	47.00b	7.72 AB	2.76ab	4.33a	56.81 A
2.5X3.5m	68.67b	85.00c	23.81 B	1.33b	2.80b	112.4 B	9.00b	9.67b	7.41 B	45.33a	51.67a	14.27 A	2.85a	3.08c	7.83 C
4.0X4.0m	57.33c	109.0b	91.53 A	1.20b	6.20a	416.7 A	5.00c	7.00c	40.00 A	47.00a	47.67b	1.42B	2.78ab	3.72b	34.29 B
Significance at 5% level	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Table (5): Mineral and chlorophyll content of Chemlali olive leaves as affected by different planting distances.

Parameters / Treatments	Mineral content (%)			Chlorophyll content (mg/100 g FW)	
	N %	P %	K %	a	b
1.5X2.5m	1.22	0.17	1.00	52.46	17.89
1.5X3.5m	1.14	0.15	0.93	52.94	11.85
2.5X3.5m	1.02	0.22	0.89	51.65	13.50
4.0X4.0m	1.11	0.10	0.93	51.35	11.54

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