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Effect of planting dates and different growing media on seed germination and growth of pistachio seedlings

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Abstract

Background: Sowing time and suitable planting media are considered basic requirements to get the maximum yield and high profit for their direct and significant impact on seedlings quality and productivity of trees later. So this experiment has been carried out in a private nursery at Gharbiya Governorate, Egypt, during the seasons of 2016 and 2017 to study the effect of seven growing media (GM): sandy soil 100%; sandy soil:peat moss:vermiculite (2:1:1) by volume; sandy soil:peat moss:vermiculite (1:2:1); loamy soil:sandy soil:vermiculite (2:1:1); loamy soil:sandy soil:vermiculite (1:2:1); loamy soil:peat moss:vermiculite (2:1:1); and loamy soil:peat moss:vermiculite (1:2:1). Ashoury pistachio seeds were planted on three different dates viz, 1 February, 20 February, and 10 March and their interaction on seed germination and growth of the resulting seedlings.

Results: The results obtained from this study showed that the maximum germination percentage, number of leaves/seedling, stem diameter, root length, leaf fresh, and dry weight were recorded when the seed was planted on 10 March and seedlings growing in the loamy soil:sandy soil:vermiculite (2:1:1).

Conclusion: It could be concluded that planting seeds of "Ashoury" pistachio on 10 March in growing media contains loamy soil:sandy soil:vermiculite (2:1:1) for maximum germination and growth of subsequent seedlings.

Keywords: Pistachio, Planting dates, Growing media, Germination percentage, Seedlings

Background

Cultivation of pistachio trees *Pistacia vera* L. in Egypt is very limited. It is only grown in Saint Catherine, South Sinai Governorate where the chilling requirements are sufficient. It can be grown in a variety of non-fertile, saline, and alkaline soil and in environments exposed to varying periods of drought stress (Sheibani 1994). The increased consumption of pistachio nuts may be attributed to their high nutrient components, including sterols, vitamins, minerals, fatty acids, and phenolic compounds (Yang et al. 2009), and thus may be considered as "unique functional food" and recently classified among the top 50 food products highest in antioxidant potential (Halvorsen et al. 2006).

The convenient sowing time of each type of crop is considered basic requirements to yield. A number of

experiments have been conducted on sowing seeds and transplanting time, which showed that the total crop yield is significantly affected by sowing times (Snoek 1981). Moreover, the use of suitable growing media or substrates for sowing seeds directly affects the germination, development, and functional rooting system (Meena et al. 2017).

A good growing media provides adequate anchors or support to the plant, a reservoir for nutrients and water allows the release of oxygen to the roots and gas exchange between the roots and the atmosphere outside the roots substrate (Abad et al. 2002). The quality of seedlings is greatly affected by the growth media under nursery (Agbo and Omaliko 2006). The quality of the seedlings obtained from a nursery affects the re-establishment in the field and the final productivity of the orchard (Baiyeri and Mbah 2006).

Soil, peat moss, and vermiculite are generally used as a basic medium for sowing seeds in nurseries because it is cheap and easy to procure supplementing the soil to make media more porous and adequate source to the

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nutrients for the seedlings. Additionally, vermiculite has been used for years to amend professional potting soils made from peat moss (called “soilless” mixes or artificial soils because they literally contain no soil) (Meena et al. 2017). Essentially, vermiculite is used in the horticultural industry because it provides aeration and drainage, it can retain and hold a substantial amount of water and later release it as needed, it is necessary to find out proper planting date for sowing of Ashoury pistachio seeds in nursery as the farmers can obtain good earning by producing these seedlings. The present study was carried out to explore the most suitable date and growing media of sowing for Ashoury pistachio seeds in nursery.

Materials and methods

Mature seeds of *Pistacia vera* L. cv. ‘Ashoury’ were obtained from pistachio orchard in Saint Catherine, South Sinai, Egypt. The experiments were conducted in a private nursery at Gharbiya Governorate during two growth seasons (2016 and 2017) and data was represented as the average of two seasons. Seven growing media (GM): sandy soil 100% (GM1); sandy soil:peat moss:vermiculite (2:1:1) (GM2) by volume; sandy soil:peat moss:vermiculite (1:2:1) (GM3); loamy soil:sandy soil:vermiculite (2:1:1) (GM4); loamy soil: sandy soil: vermiculite (1:2:1) (GM5); loamy soil:peat moss:vermiculite (2:1:1) (GM6); and loamy soil:peat moss:vermiculite (1:2:1) (GM7). Physical and chemical properties of these growing media are shown (Table 1). Ashoury pistachio seeds were planted on three different dates viz, 1 February, 20 February, and 10 March at 20 days interval in polythene bags (60 × 25 cm) after soaking in water for 36 h (Abou Rayya et al. 2018). Each growth medium was represented by 10 polythene bags per replicate and replicated three times. One seed was sown per bag after disinfected by a fungicide and irrigation with water daily. In addition to this, all other cultural practices were completed according to the requirements of nursery. The experiment was ended on September 2016

Table 1 Physical and chemical properties of the growing media

Growing media	GM1	GM2	GM3	GM4	GM5	GM6	GM7
Sand g kg ⁻¹	893.1	890.63	830.7	130.7	300.63	130.2	150.82
Silt g kg ⁻¹	60.5	77.38	90.4	500.55	370.55	520.55	590.55
Clay g kg ⁻¹	46.4	31.99	38.8	308.82	320.82	310.6	258.33
Soil texture	Sandy		Sandy loam			Loamy	
Soil pH	7.17	7.82	7.33	8.02	8.01	8.00	8.01
EC: ds m ⁻¹	0.50	1.19	1.19	3.28	2.30	1.29	3.27
OM %	1.54	2.27	2.33	6.55	5.92	4.71	4.16
Nitrogen %	0.02	0.63	0.35	3.25	0.62	1.65	1.92
Phosphorus %	0.01	0.01	0.02	0.06	0.04	0.04	0.05
Potassium %	0.04	0.70	0.68	1.06	0.89	1.04	0.85

and 2017, germination percentage of pistachio seeds was measured as number of seeds that produced a seedling from each seeds group and expressed as percentage) according to (Al-Imama and Al-Jubury 2011), the stem length, number of leaves/seedling, leaf area, stem diameter of 5 cm above the soil surface, root length, leaf fresh weight, leaf dry weight, stem fresh weight, stem dry weight, root fresh weight, and root dry weight were measured for all plants. Data were statistically analyzed using completely randomized design with two factors with three replicates (10 seeds per replicate). Analysis of variance and Duncan’s multiple range tests were used (Roger and Hasted 2003).

Results

Germination seeds

The germination percentage of pistachio seeds was significantly affected by the planting date and medium (Table 2). The maximum germination (25.43%) was observed under sowing in 10 March. However, the minimum germination (22.57%) was recorded in 1 February sowing. Pistachio seeds were sowing in the (GM4) contained loamy soil: sandy soil: vermiculite (2:1:1) gave the highest germination percentage (26.33%). While the sowing in the (GM1) contained sandy soil 100% gave the lowest germination percentages (21.33%).

Seedling stem length

The maximum of seedling stem length (47.41 cm) was recorded with sowing on 20 February; however, the minimum of seedling stem length (38.87 cm) was noted when seeds were sown on 1 February. Growing media (GM4) loamy soil: sandy soil: vermiculite (1:2:1) was recorded the highest stem length (53.03 cm). The lowest stem length was (30.51 cm) in 100% sandy soil (Table 3).

Table 2 Effect of planting dates and different growing media and the interactions between them on seed germination percentage of pistachio seedlings

Treatment dates	Germination (%)			
	1 February	20 February	10 March	Mean
GM1	19.00i	22.00g	23.00f	21.33F
GM2	23.00f	25.00d	25.00d	24.33C
GM3	22.00g	24.00e	25.00d	23.67D
GM4	24.00e	27.00b	28.00a	26.33A
GM5	25.00d	25.00d	26.00c	25.33B
GM6	24.00e	25.00d	27.00b	25.33B
GM7	21.00h	23.00f	24.00e	22.67E
Mean	22.57C	24.43B	25.43A	

The same letter with row indicates that there is no significant difference (p < 0.05)

Table 3 Effect of planting dates and different growing media and the interactions between them on stem length and number of leaves/seedling of pistachio seedlings

Treatments Dates	Seedling stem length (cm)			
	1 February	20 February	10 March	Mean
GM1	26.93p	31.80o	32.80n	30.51F
GM2	36.90m	44.10g	41.73k	40.91E
GM3	37.07m	45.27f	43.80gh	42.04D
GM4	47.07e	59.50a	52.53d	53.03A
GM5	42.73ij	52.57d	45.27f	46.86C
GM6	43.37hi	55.27b	53.40c	50.68B
GM7	38.03l	43.37hi	42.17jk	41.19E
Mean	38.87C	47.41A	44.53B	
	No. of leaves/seedling			
GM1	13.67p	20.00n	21.00m	18.22F
GM2	19.67n	26.67i	27.33h	24.56D
GM3	22.00l	26.67i	29.67f	26.11C
GM4	26.67i	32.67c	33.33b	30.89A
GM5	21.67l	31.00d	30.33e	27.67B
GM6	25.33j	34.33a	32.67c	30.78A
GM7	16.67o	24.00k	28.00g	22.89E
Mean	20.81C	27.90B	28.90A	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

Number of leaves/seedling

The higher number of leaves/seedling (28.90) was noted when planted pistachio seeds on 10 March. The early planting (1 February) of pistachio seeds had lower number leaves/seedling (20.81). The greatest number of leaves/seedling (30.89) was found with loamy soil:sandy soil:vermiculite (1:2:1) and the least number of leaves/seedling (18.22) was found on 100% sandy soil (Table 3).

Leaf area

The maximum leaf area (7.17 cm²) was recorded in the seeds sown on 20 February. The minimum leaf area (6.71 cm²) was recorded in the seeds sown on 10 March (Table 4). The highest leaf area (7.75 cm²) was observed with planting in the loamy soil:sandy soil:vermiculite (1:2:1) and the lowest leaf area (6.20 cm²) with planted in 100% sandy soil.

Stem diameter

The greater stem diameter (4.19 mm) was recorded when planted on 10 March (Table 4). The early sowing (1 February) recorded a minimum stem diameter (3.23 mm). Growing media (GM6) loamy soil:peat moss:vermiculite (2:1:1) was recorded the highest stem diameter (4.58 mm). The lowest stem diameter was (2.93 mm) in 100% sandy soil (Table 5).

Table 4 Effect of planting dates and different growing media and the interactions between them on leaf area of pistachio seedlings

Treatment dates	Leaf area (cm ²)			
	1 February	20 February	10 March	Mean
GM1	6.31hi	6.32hi	5.97i	6.20C
GM2	6.75e-h	7.19c-f	6.48g-i	6.81B
GM3	6.62f-i	7.13c-g	6.58f-i	6.78B
GM4	7.91ab	7.79a-c	7.54a-d	7.75A
GM5	7.22c-f	6.90d-h	6.61f-i	6.91B
GM6	7.48b-d	8.16a	7.31b-e	7.65A
GM7	7.12c-g	6.72e-h	6.47g-i	6.77B
Mean	7.06A	7.17A	6.71B	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

Root length

The maximum root length (34.40 cm) was recorded with sowing on 10 March; however, the minimum root length (29.53 cm) was noted when seeds of pistachio were sown on 1 February (Table 4). The highest root length (39.58 cm) was found in seedlings growing in the (GM4) contained loamy soil:sandy soil:vermiculite (2:1:1) (Table 4). Whereas, the seedlings growing in the (GM1) contained

Table 5 Effect of planting dates and different growing media and the interactions between them on stem diameter and root length of pistachio seedlings

Treatment dates	Stem diameter (mm)			
	1 February	20 February	10 March	Mean
GM1	1.85i	3.25gh	3.70d-g	2.93D
GM2	2.97h	4.39a-c	4.19b-d	3.85C
GM3	3.19gh	3.89c-f	3.91c-f	3.66C
GM4	3.85c-f	3.99c-e	4.71ab	4.19B
GM5	3.40e-h	4.01c-e	3.78c-g	3.73C
GM6	4.05cd	4.84a	4.84a	4.58A
GM7	3.32f-h	4.07cd	4.23b-d	3.87C
Mean	3.23B	4.06A	4.19A	
	Root length (cm)			
GM1	20.93q	24.07o	23.14p	22.71G
GM2	26.27m	31.02j	37.22e	31.50E
GM3	33.03h	29.73k	34.63g	32.46D
GM4	38.72d	40.50b	39.51c	39.58A
GM5	29.65k	37.03e	35.34f	34.01C
GM6	32.43i	41.48a	40.08b	38.00B
GM7	25.66n	28.67l	30.91j	28.41F
Mean	29.53C	33.21B	34.40A	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

sandy soil 100% were recorded the lowest root length (22.71 cm) (Table 5).

Leaf fresh and dry weight

It is obvious from Table 6 that leaf fresh and dry weight of pistachio seedlings were significantly affected by the planting dates and different growing media. Sowing seeds on 10 March in (GM4) loamy soil:sandy soil:vermiculite (2:1:1) was recorded the highest values (15.70 and 17.63; and 6.24 and 6.98 gm), respectively. While the early sowing seeds on 1 February in sandy soil, 100% was recorded the lowest values (14.72 and 12.49; and 5.80 and 4.95 gm), respectively.

Stem fresh and dry weight

Results in Table 7 indicated that stem fresh and dry weight of Ashoury pistachio seedlings influenced significantly as a result of the planting dates and different growing media. The maximum stem fresh and dry weight were recorded with sowing on 20 February in (GM4) loamy soil:sandy soil:vermiculite (2:1:1) (10.79 and 13.22; and 3.29 and 3.93 gm); however, the minimum stem fresh and dry weight (8.58 and 5.84; and 2.68 and 1.65 gm) were noted when seeds were sown on 1 February in sandy soil 100%, respectively.

Table 6 Effect of planting dates and different growing media and the interactions between them on leaf fresh and dry weight of pistachio seedlings

Treatment dates	Leaf fresh weight (gm)			
	1 February	20 February	10 March	Mean
GM1	12.50jk	11.96k	13.01j	12.49G
GM2	14.33g-i	15.81de	14.76fg	14.97D
GM3	14.02hi	15.30ef	14.50gh	14.61E
GM4	16.29d	18.60a	18.01b	17.63A
GM5	15.66e	16.27d	17.02c	16.32C
GM6	16.40d	17.05c	17.95b	17.13B
GM7	13.81i	12.87j	14.62gh	13.77F
Mean	14.72C	15.41B	15.70A	
	Leaf dry weight (gm)			
GM1	4.83k	4.83k	5.20jk	4.95E
GM2	5.61ij	6.44d-f	5.88g-i	5.98C
GM3	5.22jk	6.14f-h	5.71hi	5.69D
GM4	6.40d-f	7.44a	7.11a-c	6.98A
GM5	6.26e-g	6.65c-e	6.80b-d	6.57B
GM6	6.72b-e	6.78b-d	7.20ab	6.90A
GM7	5.56ij	5.13jk	5.76hi	5.48D
Mean	5.80B	6.20A	6.24A	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

Table 7 Effect of planting dates and different growing media and the interactions between them on stem fresh and dry weight of pistachio seedlings

Treatments dates	Stem fresh weight (gm)			
	1 February	20 February	10 March	Mean
GM1	4.81p	6.77m	5.93o	5.84G
GM2	9.29i	10.53ef	8.27k	9.36D
GM3	8.57j	8.14k	9.44i	8.72E
GM4	10.33fg	15.60a	13.74c	13.22A
GM5	9.80h	12.01d	10.62e	10.81C
GM6	10.15g	14.36b	12.25d	12.25B
GM7	7.12l	8.11k	6.30n	7.18F
Mean	8.58C	10.79A	9.51B	
	Stem dry weight (gm)			
GM1	1.36f	1.86e	1.74e	1.65F
GM2	2.80d	3.71bc	2.53d	3.01C
GM3	2.65d	2.59d	2.86d	2.70D
GM4	3.58c	4.21a	4.01ab	3.93A
GM5	2.77d	3.98ab	3.62c	3.46B
GM6	3.62c	4.08a	3.89a-c	3.86A
GM7	2.01e	2.63d	1.91e	2.18E
Mean	2.68C	3.29A	2.94B	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

Root fresh and dry weight

Results in Table 8 show that root fresh and dry weight were significantly affected by the planting dates and different growing media. Sowing seeds on 20 February in (GM4) loamy soil:sandy soil:vermiculite (2:1:1) was recorded the highest values (7.82 and 10.60; and 3.37 and 4.41 gm), respectively. While the early sowing seeds on 1 February in sandy soil 100% was recorded the lowest values (7.06 and 5.28; and 2.84 and 1.70 gm), respectively.

Discussion

To determine the suitable planting date and agricultural soil for production of Ashoury pistachio seedlings in nursery, were compared between three planting dates: 1 February, 20 February, and 10 March with seven agricultural medias:sandy soil 100%; sandy soil:peat moss:vermiculite (2:1:1); sandy soil:peat moss:vermiculite (1:2:1); loamy soil:sandy soil:vermiculite (2:1:1); loamy soil:sandy soil:vermiculite (1:2:1); loamy soil:peat moss:vermiculite (2:1:1), and loamy soil:peat moss:vermiculite (1:2:1). The maximum germination percentage, number of leaves/seedling, stem diameter, root length, leaf fresh, and dry weight were recorded when the seed was planted on 10 March and seedlings growing in the (GM4) contained loamy soil:sandy soil:vermiculite (2:1:1). This increase in

Table 8 Effect of planting dates and different growing media and the interactions between them on root fresh and dry weight of pistachio seedlings

Treatment dates	Root fresh weight (gm)			
	1 February	20 February	10 March	Mean
GM1	4.11p	6.12k	5.60m	5.28F
GM2	5.83l	7.33h	6.92i	6.69C
GM3	4.54o	5.42n	6.37j	5.44E
GM4	9.06e	12.27a	10.47b	10.60A
GM5	7.70g	9.93d	9.01e	8.88B
GM6	8.23f	10.15c	8.22f	8.87B
GM7	9.92d	3.54q	3.26r	5.57D
Mean	7.06C	7.82A	7.12B	
	Root dry weight (gm)			
GM1	1.55m	1.76l	1.80l	1.70E
GM2	2.89gh	3.09f	2.68i	2.89C
GM3	2.36j	2.78g-i	2.70hi	2.61D
GM4	4.23b	4.97a	4.04cd	4.41A
GM5	3.17f	3.98cd	3.87d	3.67B
GM6	3.52e	4.09bc	3.66e	3.76B
GM7	2.17k	2.91g	2.72g-i	2.60D
Mean	2.84C	3.37A	3.07B	

The same letter with row indicates that there is no significant difference ($p < 0.05$)

germination percentage could be attributed to favorable soil temperature 15–18 °C and optimum moisture at the sowing time which caused an increase in germination percentage and contributes seedling production at the desired level. The optimum temperature is the basic requirement for germination (Hall 1975).

The increase in seedlings growth recorded in this investigation could be a reflection of the effect of the combination of high moisture retention and significant air space in agricultural media. The results are in agreement with those obtained by (Al-Imama and Al-Jubury 2011). In addition, growth media (GM4) contained adequate nutrients and the high water retention capacity necessary for germination and growth of pistachio seedlings. Results are in line with those published by (Okunomo et al. 2009).

These results are in conformity with the findings of (Lucas and Davis 1961) who observed that a pH close to neutral is suitable for most container-grown woody shrubs and trees to supply available nutrients in adequate quantities for cell turgidity and enlargement within plant tissues.

These results are also in agreement with observations of (Poole and Conover 1982; Hassan et al. 1994) that peat moss and loamy soil increased nutrient retention, promoted vegetative growth, and improved

growth overall through the activity of meristematic tissue (Kramer and Koziowski 1979). Comparing all agricultural media and planting dates.

Conclusion

Finally, it can be concluded that planting seeds of “Ashoury” pistachio on 10 March in growing media contains loamy soil:sandy soil:vermiculite (2:1:1) fulfillment maximum germination and enhance growth of subsequent seedlings.

Abbreviations

EC: Electrical conductivity; GM: Growing media; OM: Organic matter

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Authors' contributions

TSMM and ERA conducted the field experiments. TSMM wrote the manuscript and ERA performed the chemical analysis of the samples, coordinated the data collection and analysis. NEK designed this work and ARMS revised it. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are included in this published study.

Ethics approval and consent to participate

Not applicable

Consent for publication

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Competing interests

The authors declare that they have no competing interests.

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