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INFLUENCE OF SOIL BASED GROWING MEDIA ON VEGETATIVE PROPAGATION OF SELECTED CULTIVARS OF *OLEA EUROPAEA* L.

MUHAMMAD IBRAR AHMED[1], MUHAMMAD IRFAN ASHRAF[1*], SABEEQA USMAN MALIK[1] AND QAISER HUSSAIN[2, 3]

[1]Department of Forestry and Range Management, [2]Department of Soil Science & Soil Water Conservation, PMAS Arid Agriculture University Rawalpindi, 46300, Pakistan,
[3]Department of Soil Science, College of Food & Agricultural Sciences, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia.
**Corresponding author's e-mail: drirfancanada@gmail.com ; irfanashraf@uaar.edu.pk*

Abstract

Pothwar region of Pakistan is a natural habitat of *Olea* spp. There is a high demand of certified olive plants to establish olive orchids in the region, because native wild species are non-fruit bearing. Plants of certified fruit bearing olive (*Olea europaea* L.) cultivars are rarely available. Vegetative propagation of olive is highly responsive to texture of soil based growing media. This study examined the effect of growing media composition (soil texture and nutrients) on vegetative propagation of five cultivars of olive. The experiment was carried out in randomized complete block design (RCBD) with two factors factorial having 25 repeats of each four treatments. Plant growth and survival data were collected and analyzed for the influence of soil attributes. In sandy loam soil, cv. Bari-1 had 82% plant survival, highest number of roots per plant (3.5), and longest root length (13.01 cm). Highest number of shoots per plant (4.25) and maximum shoot length (15.64 cm) were also recorded for Bari-1 with sandy loam growing media. Silt loam soil is least suitable growing media for vegetative propagation of olive. In the silt loam soil, plants survival rate was 59% for cv. Gemlik, number of roots per plant was 1.5 for cv. Ottobrattica, minimum root length 5.65 cm, minimum number of shoots per plant one, and minimum shoot length 7.42 cm were recorded for cv. Pendolino with silt loam soil. Results suggested that sandy loam growing media is better than the others for vegetative propagation of olive. Cultivar Bari-1 performed better than the others examined in this study by indicating highest (1) survival percentage, (2) root and shoot length, and (3) number of roots and shoots produced within a specific period of time.

Key words: Cuttings, Nursery; Olive; *Olea*; Soil texture; Vegetative propagation.

Introduction

Olive (*Olea europaea* L.) belongs to the plant family *Oleaceae* that has 30 species (Luchetti, 2002). The only comestible species is *Olea europaea* L. having large and fleshy oil carrying fruit. It is an evergreen tree of subtropical climate that needs chilling for fruiting. Olive is a sign of opulence and peace around the world (Christakis *et al*., 1980).

Globally, area under olive cultivation is 9.15 million hectares with fruit yield of 14.04 million tonnes. Olive oil production is about 2.45 million tonnes in the world (Anon., 2003). Pakistan spends 216.4 billion rupees every year on import of 2.2 million tonnes edible oil to satisfy the needs of its population (Anon., 2013). Edible oil is the second largest import commodity after petroleum and leading in food commodities during recent years in Pakistan (Anon., 2013). Olive cultivation has a significant potential to reduce the burden of heavy import bill of Pakistan for edible oil. Natural area of olive cultivation across the globe lies between 30^o to 45^o on either side (north and south) of the equator. Pakistan is located between 23^o to 37^o north latitude and 61^o to 75^o east longitude. Olive is cultivated in sub-tropical as well as semi arid areas of Pakistan (Baloch, 1994). In Pakistan, wild olive trees (*Olea cuspidate* and *Olea ferrugenea*) are found in Pothwar region. The presence of wild olive indicates that the climatic conditions of this area are suitable for olive cultivation. During past years, exotic cultivars of *Olea europea* were introduced in Pothwar region. These new cultivars are successfully growing and bearing fruit. The interest of local farmers for olive farming has been increased due to successful olive cultivation in the region. There is a high demand for certified nursery plants of olive in the region (Jan *et al*., 2015). Currently, about ten percent of olive farmers have access to authentic and certified olive plants for cultivation while ~90 percent of farmers are growing uncertified plants. Healthy and certified plants produced from authentic mother plant source are required to bridge this huge gap.

There are many ways of olive propagation including vegetative and tissue culture. Vegetative propagation is a simple and fast method to produce plants from authentic mother source. Moreover, fruiting in vegetatively propagated plants starts earlier compared to plants that grown from seeds or tissue culture (Hartmann *et al*., 2002). Olive tree can be propagated by hard wood or semi hard wood cuttings (Fabbri *et al*., 2004). Various factors such as genotype, phenological stage, nutritional status and environmental conditions, control the rooting ability of stem cuttings (Loreti & Pisanni, 1982; Hartmann *et al*., 1990). Growing media is critical to vegetative propagation. Soil texture indicates firmness and the drainage capacity of the soil (Weismann, 2009). Rooting ability of plants greatly rely on growing media as well as micro climatic conditions. Studies related to vegetative propagation indicated about 80 % rooting in spring-summer whereas ~20 % in winter season (Mancuso, 1998).

The objective of this study was to analyze the influence of soil based growing on vegetative propagation of selected cultivars of *Olea europaea* L. The study was also aimed to find suitable olive cultivar for efficient propagation.

Material and Methods

Study area: This study was carried out at main campus of PMAS Arid Agriculture University Rawalpindi, in Punjab province of Pakistan. District Rawalpindi lies between 72° 38' to 73° 37' east longitudes and 33°4' to 34°01' north latitudes (Rabia & Sheikh, 2015). Climate of Rawalpindi is semi arid distinguished by mean annual temperature of 21.3°C. The average highest temperature of the district in summer is 38°C and lowest winter temperature is 8°C (Majid *et al.*, 2012).

Methods: The experiment was carried out in randomized complete block design (RCBD) with two factors factorial having 25 repeats of each four treatments as shown in Table 1. About one hundred hard wood cuttings of five olive cultivars were planted in polythene tubes (Table 2). Hard wood cuttings were used with two to four leaves left on the tip of each cutting. Polythene tubes were kept in beds of size 5x10 feet (width and length). Polythene tubes with adequate number of holes in the bottom half were filled with a prepared mixture for each treatment (Table 1). Soil filled polythene tubes were placed in a semi-controlled tunnel to be grown under favourable temperature, suitable humidity and reduced evapo-transpiration. Polythene tubes were irrigated by mist irrigation system. Thermo-hygrometer was used to monitor temperature and humidity on daily basis. Four treatments of soil based growing media were applied to five cultivars. Hardwood stem cuttings of cultivars: Bari-1, Leccino, Ottobrattica, Pendolino, Gemlik were obtained from Barani Agriculture Research Institute (BARI) Chakwal, Pakistan. Growth hormone (i.e., IBA: Indole-Butyric Acid) was applied before planting at the rate of 4000 ppm. Soil samples were collected randomly from filled polythene tubes of four treatments for the analysis of soil textural class, electrical conductivity (EC) pH, nitrogen, potassium, and phosphorus content using methods given by Page *et al*. (1982). The data regarding number of plants sprouted from each treatment in each repetition was recorded. Total plants survived after sprouting was counted and survival percentage was estimated using Eq. 1.

Table 1. Composition of soil based growing media used in this study.

Treatments	Percentage		
	Sand	Silt	Farm yard manure (decomposed)
T_1	50	25	25
T_2	33	33	33
T_3	50	0	50
T_4	0	50	50

Table 2. Cultivars of *Olea europaea* L. examined in this study.

S. No.	Name of cultivars	Origin
1.	Bari-1	Pakistan
2.	Leccino	Italy
3.	Ottobrattica	Italy
4.	Pendolino	Italy
5.	Gemlik	Turkey

$$\text{Plant survival (\%)} = \frac{\text{Total plants survived}}{\text{Total plants sprouted}} \times 100 \qquad \textit{Eq. 1}$$

Plants of each treatment were removed gently with their root system to estimate root and shoot growth**.** Root growth parameters were recorded by selecting five plants randomly from each treatment. The data regarding number of roots per plant was obtained by counting. Root length (cm) of the same plants was measured with scale from the base to end of the root. Their arithmetic mean was computed for all root parameters. Similarly, data regarding shoot growth was recorded by selecting five plants on random basis from each treatment. Measuring scale was used to record shoot length (cm) from base to tip of newly emerged shoots of each plant. Number of shoots per plant was obtained by counting. Finally growth indicators and soil attributes were analyzed for five cultivars.

Computer software (Statisticx 8.1 and MS Excel) was used for data analysis. Least significant difference test was applied to compare means of growth indicators ((LSD: Steel & Torrie, 1980; Geert *et al*., 1998).

Results and Discussion

Soil characteristics of treatments

Electrical conductivity (EC): Soil analysis results indicated that there was no substantial difference in EC among treatments (Table 3). The EC of loam soil (T_2) was slightly higher as compared to EC of sandy loam soil (T_1) and silt loam soil (T_4).

Organic matter (OM): Organic matter percentage of treatments ranged between 0.66-0.78 (Table 3). However, soil organic matter in silt loam soil (T_4) was slightly higher as compared to sandy soil (T_3).

Table 3. Soil texture and nutrient status of growing media.

Treatments	Texture	Soil characteristics						
		N mg Kg^{-1}	P mg Kg^{-1}	K mg Kg^{-1}	OM (%)	EC	pH	Saturation (%)
T_1	Sandy loam	0.92	5.5	100	0.73	1.95	7	32
T_2	Loam	0.90	4.8	90	0.70	2.10	7.2	30
T_3	Sandy	0.88	4.7	85	0.66	1.90	6.8	30
T_4	Silt loam	0.86	4.5	80	0.78	2.00	7.1	29

Available phosphorus: Soil nutrient analysis data is shown in Table 3. As shown, level of available phosphorus was higher (5.5 mg Kg^{-1}) in T_1 (sandy loam soil) compared to T_4 (silt loam soil: 4.5 mg Kg^{-1}). However, there was minor difference of available phosphorus among T_2 (loam soil) and T_3 (sandy soil).

Available potassium: The data showed that amount of available potassium was higher (100 mg Kg^{-1}) in sandy loam soil (T_1) compared to silt loam soil (T_4: 80 mg Kg^{-1}). There was no difference in available potassium (90 mg Kg^{-1}) between loam soil (T_2) and sandy soil (T_3: 85 mg Kg^{-1}) as shown in (Table 3).

pH: Soil analysis showed that there was slight difference in pH among treatments. Highest pH value: 7.2 was observed for T_2 and lowest 6.8 for T_3 (Table 3). Similar results were found by Hassan *et al*. (2013) showed an insignificant difference of pH among the sandy loam soil (T_1) loam soil (T_2).

Saturation percentage: Saturation percentage is known as moisture constituent of a soil that has promoted to saturation by adding up water. This value reflects water holding capacity related to soil texture (Wilcox, 1951). Data showed that there was only a slight difference of saturation percentage between silt loam soil (T_4: 29) and sandy loam soil (T_1: 32).

Available nitrogen: The data regarding available nitrogen showed that there was a little difference among the soil treatments. The highest nitrogen content was observed in T_1: 0.92 mg Kg^{-1} and lowest in T_4: 0.86 mg Kg^{-1}).

Plant growth characteristics: Data regarding plant survival is presented in Table 4. Statistical analysis revealed that there was a significant difference (82a and 59g) among plant survival percentage of cultivars within four applied soil treatments. The maximum plant survival percentage 82 was recorded in cv. Bari-1 with T_1 while the minimum plant survival percentage 59 in cv. Gemlik with T_4 as presented in Fig. 1.

Results regarding number of shoots per plant were presented in Table 4. Maximum numbers of shoot per plant were 4.25 for Bari-1 cultivar grown in T_1 (Fig. 2). Minimum number of shoots per plant was one in cv. Pendolino and cv. Ottobrattica with T_4 as presented in Fig. 2.

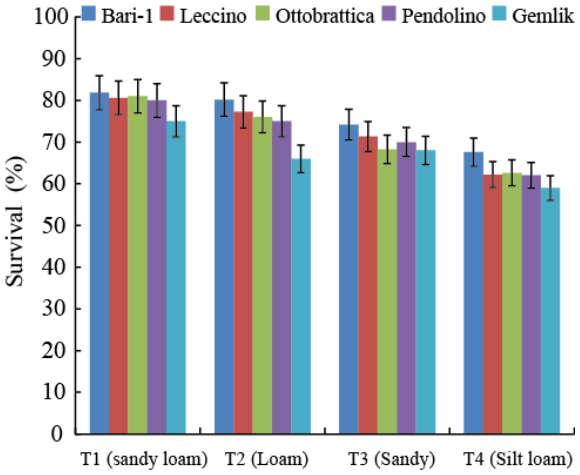
The observed data of shoot growth was presented in Table 4. Soil texture influence on shoot length was significant. Maximum shoot length 15.64 cm was recorded for cv. Bari-1 with T_1 and minimum shoot length 7.42 cm in cv. Pendolino with T_4 as shown in Fig. 3.

An insignificant difference was revealed among soil treatments and cultivars in terms of number of roots per plant (Table 4). A maximum number of roots were obtained 3.5 in variety Bari-1 with T_1 while; minimum number of roots was obtained 1.5 in Ottobrattica with T_4 as shown in Fig. 4.

The root length was significantly different among cultivars, treatments and also in the interaction between cultivars and impact of soil treatments on cultivars. Data collected on root length presented in Table 4 indicated that there is significant difference of root length among cultivars. Maximum root length 13.01 cm was observed in Bari- 1 with T_1, whereas minimum root length per plant 5.65 cm was noticed in Pendolino with T_4 as presented in Fig. 5.

Table 4. Effect of growing media treatments on plant growth indicators for olive cultivars.

Cultivars	Treatments	Plant survival (%)	Number of shoots	Shoot length (cm)	Number of roots	Root length (cm)
Bari-1	T_1	82 a*	4.25 a*	15.64 a*	3.5 a*	13.01 a*
	T2	80 abc	3.25 b	13.05 b	2.75 abc	10.94 b
	T3	74 cdef	2.5 c	12.22cd	2.75 abc	9.95 cd
	T4	67 fghi	1.75 de	9.96 ef	2.25 cde	8.93 ef
Leccino	T_1	80 abc	3.75 ab	12.6 bc	2.75 abc	10.78 bc
	T2	77 abcd	2.5 c	10.57efg	2.25 cde	8.45 efg
	T3	71 defg	1.75 de	9.25 gh	1.75 cde	7.55 gh
	T4	62 ij	1.25 ef	7.79 j	2.25 cde	6.05 j
Ottobrattica	T_1	81 ab	3.75 ab	12.97 b	2.75 abc	11.02 b
	T2	76 bcde	2 cd	11.3 de	2.25 cde	9.16 de
	T3	68 efghi	1.5 def	9.65 fg	1.75 de	8.2 fg
	T4	62 hij	1 f*	8.2 ij	1.5 e*	6.35 ij
Pendolino	T_1	80 abc	3.5 b	11.25 de	2.75 abc	9.2 de
	T2	75 bcdef	2 cd	10.05 fg	2.25 cde	8.17 fg
	T3	70 defgh	1.75 de	9 hi	2.25 cde	7 hi
	T4	61 ij	1 f*	7.42 j*	2 cde	5.65 j*
Gemlik	T_1	75cdef	4.25 a	12.35 bc	3.25 ab	10.36 bc
	T2	65 ghij	3.25 b	11.27 de	2.5 bcd	9.3 de
	T3	67 fghi	1.75 de	10.22 fg	2.25 cde	8.22 fg
	T4	59 g*	1.25 ef	7.92 j	2 cde	5.92 j



Error bars with percent

Fig. 1. Effect of soil texture on survival of olive cultivars after 120 days of sprouting.

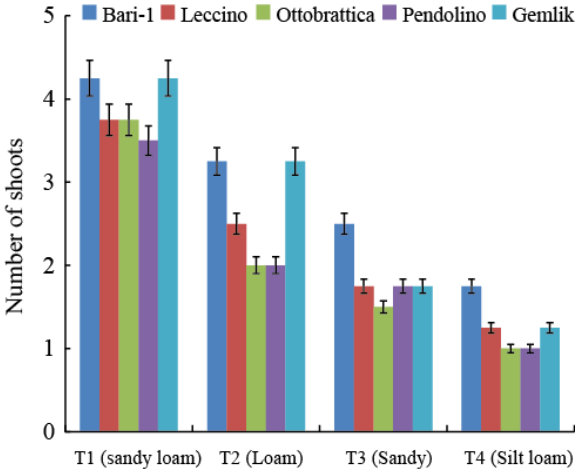


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Fig. 2. Effect soil texture on number of shoots of olive cultivars after 140 days of sprouting.

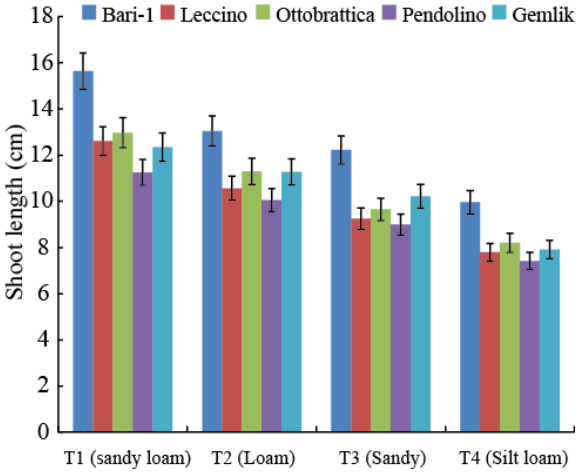

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Fig. 3. Effect of soil texture on shoot length of olive cultivars after 140 days of sprouting.

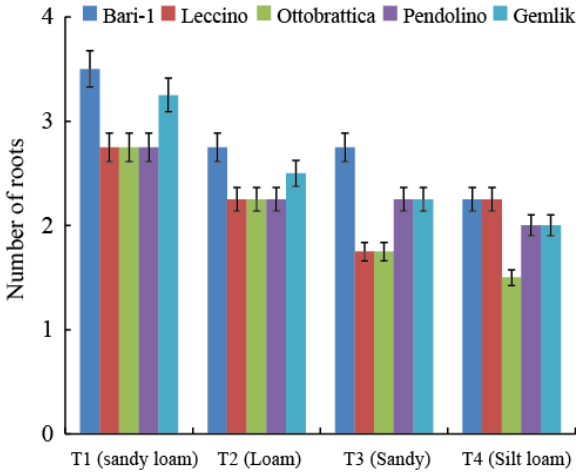

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Fig. 4. Effect of soil texture on number of roots of olive cultivars after 140 days of sprouting.

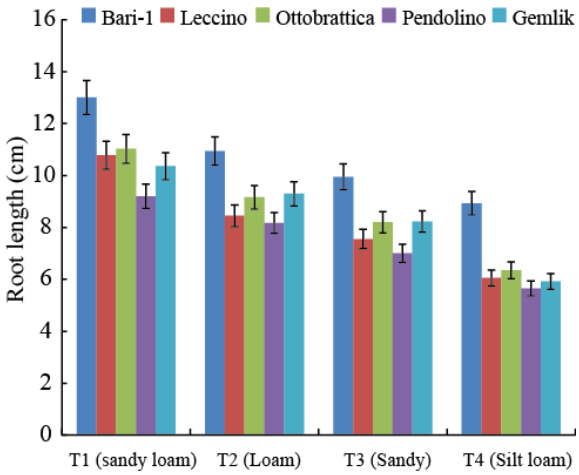

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Fig. 5. Effect of soil texture on root length of olive cultivars after 140 days of sprouting.

Conclusions

Vegetative propagation is quick and efficient method to produce plants from authentic mother source. Vegetative propagation of olive is highly influenced by the type of growing media (soil texture and nutrient). Among five studied cultivars of *Olea europaea* L., Bari-1 performed better on the basis of maximum survival percentage, root length, shoot length, number of roots and number of shoots. Sandy loam is the best soil mixture for vegetative propagation of olive. Silt loam soil indicated minimum survival percentage, little root and shoot development, and less number of roots and shoots. Maintenance of humidity and temperature in micro growing environment is critical to successful propagation. Decomposed farm yard manure improved the fertility and soil structure of the growing media. The use of growth hormone enhances the sprouting ratio of olive stem cuttings.

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