Research Article

Impact of Different Seasonal Growth Conditions on the Rooting Behaviour of Olive Cuttings

Muhammad Jan[1*], Muhammad Ashraf Sumrah[2], Muhammad Azhar Iqbal[1], Inam-ul-Haq[1], Attiq Ur Rehman[1], Javeria Sherani[3], Muhammad Imran[3] and Rizwan Latif[4]

[1]Centre of Excellence for Olive Research and Training (CEFORT) BARI Chakwal; [2]Barani Agricultural Research Institute (BARI) Chakwal; [3]Ghazi University, Dera Ghazi Khan; [4]Soil and Water Testing Laboratory, Rawalpindi*

Abstract | The highest price and demand of olive oil and other value-added products enforcing the farmer of Potohar area to cultivate marginal land in Pakistan. Currently, more than 5.00 million olive plants had been planted over an area of 40450 hectares in the area of Balochistan, Khyber Pakhtunkhwa (KPK), Punjab, Azad Jammu Kashmir (AJK) and Gilgit Balistan (GB). This is only possible due to availability of certified olive plants in a bulk quantity. Center of Excellence for Olive Research and Training (CEFORT) is playing a pivot role in this regard as a source for availability of certified plants. To meet the increasing demand for the olive plants nursery production technologies should be optimized according to over local conditions. In this context, a study was designed at CEFORT BARI, Chakwal in order to find which season is suitable for maximum rooting. Five olive varieties from Germ Plasm Unit (GPU), of Barani Agricultural Research Institute (BARI), Chakwal were selected. Thousand cutting of each were planted during mid-August- mid October (S1) and mid-January- mid March (S2). All standard nursery protocol were followed to get maximum rooting and survival percentage. Results of study revealed that the rooting ability of oil purpose varieties is more as compare to table purpose olive varieties. Maximum rooting was observed in olive variety BARI Zaitoon-1 followed by Koroneiki, Arbosana, Arbiquina, and Monzanillo. In case of cutting plantation mid-August to mid-October (S1) was found most suitable time period in order to get maximum survival rate. Commercial nursery owners should use this time window to produce maximum number of plants.

Received | April 21, 2024; **Accepted** | July 19, 2024; **Published** | September 17, 2024

***Correspondence** | Muhammad Jan, Centre of Excellence for Olive Research and Training (CEFORT) BARI Chakwal; **Email:** mjanleghari@gmail.com

Citation | Muhammad Jan, Muhammad Ashraf Sumrah, Muhammad Azhar Iqbal, Inam-ul-Haq, Attiq Ur Rehman, Javeria Sherani, Muhammad Imran and Rizwan Latif. 2024. Impact of different seasonal growth conditions on the rooting behaviour of olive cuttings. *Sarhad Journal of Agriculture*, 40(3): 1065-1070.

DOI | https://dx.doi.org/10.17582/journal.sja/2024/40.3.1065.1070

Keywords | Olive cutting, Potohar, Survival, Summer, Winter

Introduction

The olive tree grows well in regions with a Mediterranean environment, which features rainy winter and humid summer (Ritter *et al.*, 2021; Martins *et al.*, 2022). The average yearly temperature in places where olive trees are grown for commercial purposes must be between 60 and 68 °F (15 and 20 °C) (Mohammed, 2023; Chakir *et al.*, 2021; López-Bernal *et al.*, 2020). Pakistan's temperate cli-

mate varies as much as the topography of the area; it is often dry and hot at the coast and along the Indus River's lowland plains and gradually gets cooler in the northern uplands and Himalayas. Olive trees thrive in climates with long, hot summers and short, cool winters (Yousaf *et al*., 2022; Hussain *et al*., 2020). They require a two-month period of cool weather during which they must dormancy, with optimal temperatures falling between 40˚ F and 50˚ F. A tree that is not covered, however, can be harmed or even killed by severe winter temperatures (below 20˚ F) (Carlson, 2020). Many areas are appropriate for olive growth, which needs a warm and temperate environment, and its sunny winters. The climate in the Pothohar region is ideal because its temperature 2.00 ^{0}C (in winter) to 39 ^{0}C (in summer) and rainfall range from 250-850 mm. The strictly asexual mode of propagation (using suckers or cuttings) and later the procedure of grafting seedlings are the conventional techniques utilised for olive multiplication since antiquity. The two major methods of commercially successful olive plant multiplication nowadays are grafting and rooting cuttings (Haq *et al*., 2021; Ahmad *et al*., 2021).

The length of the olive tree's growing season varies based on the region and climate in which it is grown. Typically, new growth on olive trees starts in the spring, around March or April, when the temperature rises (Siakou *et al*., 2021). The tree will grow new shoots, blooms, and leaves during this period. The techniques which are useful for propagation are cutting, grafting and using olive tree seeds (Schicchi, 2021). While cutting propagated olive trees will develop more quickly and more closely resemble the parent tree terms of size, growth habit, and fruit output, both methods (cutting and grafting) will produce trees that can be planted within a year (Yilmaz *et al*., 2019; Neri *et al*., 2020; Sezer, 2023). Olive in Pakistan is a new crop because till this one cultivation started in the Potohar districts (Chakwal, Khushab, Jhelum, Mianwali and Rawalpindi) of Punjab, Balochistan, KPK and Gilgit Baltistan. The adoptability trials also started in different districts of South Punjab. The existing gaps are suitable variety cultivation in suitable area (varietal identification according to its fruiting behaviour), less production and more demand for olive oil and other value-added products, proper packing and gap between farmer and marketing at profitable price (Akhtar *et al*., 2021).

The optimum growth for olive trees is achieved with softwood and semi-hardwood cuttings. The healthy branch that is about the width of a pencil, under a year old, and in good condition. Cut an olive branch with a 1/4-inch-diameter stem into an 8-inch semi-hardwood length. Just below a leaf node, trim it off by 1/8 of an inch. Trim the bottom four to six leaves before wrapping the branch's tip in a wet paper towel. Along the bottom of the cutting, remove each leaf. Then, dip the leafless end of the olive cutting into rooting talc containing 0.2% IBA. To get rid of any extra powder, tap the stem. Spray the cuttings every day and place them in a bright spot out of the direct sun (Hussain, 2020; Saee, 2021; Ferreira *et al*., 2022; Margossian, 2022).

The current study was planned to find out the best season and best olive variety for maximum rooting of olive cuttings under Pothwar climate.

Materials and Methods

Olive cuttings of variety Arbequina, Arbosana, Koroneiki, BARI Zaitoon-1 and Monzanillo having pencil size or 9 inches were collected from diseased free branches during mid-January to mid-March and mid-August to mid-October of year 2022. The cuttings were dipped 0.2 cm for five seconds into Indole Butyric Solution (IBA) having concentration of 3000 ppm and sown during morning time into sand and silt mixed bed for further propagation. The beds were covered with polythene sheet under tunnel structure into lower tunnel. The beds were irrigated to maintain humidity upto 80-90 %, temperature range upto 30-35 ^{0}C and covered with green net to maintain light flux upto 2000 lux. For the maintenance of temperature and humidity mists were installed in upper and lower tunnels. After four months, The cuttings were sprayed with Isabian (to promote root initiation) @ 2ml/L of water and chlorpyrifos @ 2ml/L of water to prevent termite attack. The cuttings were kept under controlled environment upto duration of nine months. After callus and root development the rooted cuttings were shifted into polythene bags for further growth. The root related data was collected in the term of cutting rooted percentage, number of roots /cutting, root length and survival percentage.

Statistical design

The data mean was recorded and difference were calculated by calculating analysis of variance (ANOVA). Experimental design CRD factorial was used for data

collection by using Statistix 8.1® software.

Results

Rooting percentage

The rooting percentage in two season i-e. Mid-August- mid October (S_1) and Mid-January-mid March (S_2) significantly (P<0.05) affected. Generally, the rooting ability was higher in summer than in winter (Table 1). The rooting success percentage ranged from 43.56 to 62.77% in winter-2021 and 43.56 to 78.40% in summer-2022 for different varieties.

Table 1: *Seasonal variations in the rooting percentage of olive cuttings for different varieties.*

Variety	Mid-August to mid October (S_1)	Mid-January to mid March (S_2)
Arbequina	49.67±0.37 d	43.70±0.32 e
Arbosana	65.32±0.57 b	58.34±0.48 b
Koroneiki	57.16±0.51 c	55.90±0.50 bc
BARI Zaitoon-1	78.40±0.70 a	62.77±0.53 b
Monzanillo	43.56±0.27 e	38.96±0.27 f

Seasonal variation can have a significant impact on the survival and growth of olive cuttings. Olive tree are well adapted to Mediterranean climate but their response to different season can affect their propagation success. Olive trees are sensitive to cold temperatures, and cuttings are more likely to survive and root successfully during warmer seasons such as spring and early summer. In colder seasons, the growth of cuttings may slow down or even cease, leading to decreased survival rates. Similar fundings were also reported by Saee (2021) and Mohammed (2023) as they studied the effect of cultivars, planting date, IBA concentration and their interaction on rooting of semi-hardwood olive cutting of olive and role of cold storage in rooting of stem cutting respectively.

Number of roots per cutting

Number of roots per cuttings recorded in two seasons of all five olive varieties. The highest root cuttings in mid-August- mid October (S_1) and mid-January-mid March (S_2), were 8.1 and 9.7 respectively, in "BARI- Zaitoon-1". While the lowest number of roots 5.7 in winter-2021 and 5.96 in summer-2022 were observed in Monzanillo olive variety (Table 2).

Actually, olive trees have specific growth cycles, including periods of dormancy. Propagating olive cuttings during the active growth phases, such as spring and early summer, increases the chances of success. During these times, the plant's energy is focused on growth and root development, making it more receptive to rooting hormones and environmental factors. These results are also in line with the findings of different researchers Ritter *et al.* (2021) and Martin *et al.* (2022) as they studied the effects of anatomical structures and phenolic compound deposition on the rooting of olive cuttings and micro bio-stimulants study in olive cuttings.

Table 2: *Seasonal variations in number of roots for different varieties.*

Variety	Mid-August to mid October (S1)	Mid-January to mid-March (S_1)
Arbequina	6.20±0.32 e	5.95±0.43 e
Arbosana	8.60±0.54 b	7.80±0.48 d
Koroneiki	7.30±0.43 c	6.95±0.22 e
BARI Zaitoon-1	9.70±0.81 a	8.10±0.35 bc
Monzanillo	5.96±0.12 e	5.70±0.20 e

Root length

Comparatively, longer roots were recorded from the cuttings planted during summer than during winter, however, maximum root length observed in BARI – Zaitoon-1 i-e. 7.10 and 9.90 in winter-2021 and summer-2022, respectively while minimum 5.12 and 6.10 in Monzonilla olive variety during winter-2021 and summer-2022, respectively (Table 3).

Table 3: *Seasonal variations in root length of olive with respect to different varieties.*

Variety	Mid-August to mid October (S_1)	Mid-January to mid March (S_2)
Arbequina	6.45±0.20 c	5.30±0.05 f
Arbosana	8.56±0.12 b	6.83±0.11 d
Koroneiki	7.80±0.43 c	6.15±0.09 e
BARI Zaitoon-1	9.90±0.27 a	7.10±0.12 bc
Monzanillo	6.10±0.18 d	5.12±0.30 g

Olive trees are usually propagated through hardwood cuttings during winter and softwood cutting during winter actually late winter and early spring. During late winter or early spring, the tree allocates more resources to root development which can lead to stronger and longer roots. During dormant time certain hormones may be more active in promoting root growth which contributes towards root development. Some other Researchers i-e. Rosa *et al.* 2018

observed the similar findings as they studied the rooting of semi hardwood cuttings of olive: in response of indolbutyric acid, calcium and *Azospirillum brasilense*. Denaxa *et al*. (2020) also reported this reasoning as a role of the endogenous phenolic compounds on adventitious root formation of olive stem cuttings.

Survival percentage of cuttings

The data on root survival percentage showed significantly higher plant survival percentage (55% in Mid-January-mid March (S_2) and 76% in Mid-August- mid October (S_1) were observed in the BARI Zaitoon-1 than rest of the olive varieties. However, the lowest plant survival percentage (35% in winter and 46% in summer) was observed in Monzonilla variety (Table 4).

Table 4: *Survival percentage of olive varieties in two seasons*

Variety	Mid-August to mid October (S_1)	Mid-January to-mid March (S_2)
Arbequina	52.00±1.40 d	37.00±0.20 f
Arbosana	64.00 ±1.12 c	47.00 ±0.31e
Koroneiki	60.00 ±1.31 bc	42.00 ±0.40 de
BARI Zaitoon-1	76.00 ±1.40 a	55.00 ±0.48 d

Olive propagation through cutting is mostly dependent on local climate, technique to be used and specific olive variety. In literature mostly it was reported that in Mediterranean region, winter season is most successful for cutting plantation compared to mid-January to mid-March or spring season but in the current experiment the cuttings were planted during mid-August- mid October, at that season cell sap was more in the softwood cutting which ultimately increased the rooting percentage beside of this cutting's growth established well before June and July and not affected much due to high temperature. Simialr findings were also reported by Casrian *et al*. (2018) as they studied the effects of culture medium and plant hormones in organogenesis in olive (CV. Kroneiki). Fazeli-Nasab *et al*. (2021) also reported similar findings when they conducted the study rooting of olive mini cuttings at different seasons grown in clonal mini garden.

Conclusions and Recommendations

The results of current study revealed that maximum rooting was observed in olive variety BARI Zaitoon-1 (dual purpose) followed by Arbosana, Koroneiki, Arbiquina (oil purpose) and Monzanillo (table purpose) olive variety. Cutting plantation during mid-August to mid-October (S_1) was found most suitable time period in order to get maximum survival rate. So, it will be a good signal for private sector nursery holders to produce maximum olive plants of above-mentioned olive varieties for maximum earning and strengthening olive nursery sector in Pakistan.

Acknowledgements

We are thankful to Govt of Punjab for providing funds under Annual Development Project "Establishment of Centre of Excellence for Olive Research and Training (CEFORT)" at BARI Chakwal.

Novelty Statement

Olive is a hardy plant so its root initiation and survival percentage is a main issue. The seasonal variation has a key role for its root initiation and plants production under nursery condition. The present study was conducted to find out the best season and best olive variety to produce maximum olive plants under Pothwar climate.

Author's Contribution

Muhammad Jan: Conceived the ideas of research and conducted experiment.
Muhammad Ashraf Sumrah: Helped in management of article.
Muhammad Azhar Iqbal: Worked for language improvement of manuscript.
Inam-ul-Haq: Prepared first draft.
Attiq Ur Rehman: Thoroughly review the article and improved the article time to time.
Javeria Sherani: Provided technical input
Muhammad Imran: Helped for manuscript improvement.
Rizwan Latif: Reviewed and corrected the final draft.

Conflicts of Interest

The authors have declared no conflict of interest.

References

Ahmad, S., N. Bostan., M. Munir., F. Rabi. and J. Rehman. 2021. 01. Effect of different sizes of olive cutting on growth capacity. Pure Appl. Biol. (PAB), 3(3): 92-94. https://doi.

org/10.19045/bspab.2014.33001

Carlson, A.R., J.S. Sibold. and J.F. Negrón. 2020. Canopy structure and below-canopy temperatures interact to shape seedling response to disturbance in a ROCKY MOUNTAIN SUBALPINE FOREST. For. Ecol. Manage, 472: 118-234. https://doi.org/10.1016/j.foreco.2020.118234

Casarin, J.V., A. Ramm., C.G. Raasch., C.R.F. Timm. and M.W. Schuch. 2018. Rooting of olive minicuttings at different seasons grown in clonal minigarden. Comun. Sci., 9(1): 41-49. https://doi.org/10.14295/cs.v9i1.2525

Chakir, S., A. Bekraoui., H. Majdoubi., A. Senhaji. and M. Mouqallid. 2021. Numerical simulation and measurement of air temperature and relative humidity in an olive cuttings tunnel greenhouse. Open J. Model. Simul., 10(1): 32-47. https://doi.org/10.4236/ojmsi.2022.101002

Denaxa, N.K., P.A. Roussos. and S.N. Vemmos. 2020. Assigning a role to the endogenous phenolic compounds on adventitious root formation of olive stem cuttings. J. Plant. Growth. Regul., 39, 411-421. https://doi.org/10.1007/s00344-019-09991-0

Fazeli-Nasab, B., H. Khajeh. and A.F. Rahmani. 2021. Effects of culture medium and plant hormones in organogenesis in olive (CV. Kroneiki). J. Plant. Bioinform. Biotech., 1(1): 1-13.

Hamooh, B.T. 2014. The Effects of cutting collection time, auxin types and auxin concentrations on rooting of olive (*Olea europaea* L.) cuttings under arid land conditions. Int. J. Eng. Res. and Technol. (IJERT), 3 (1): 1389 – 1395.

Haq, I.U., H. Umar., N. Akhtar., M.A. Iqbal. and M. Ijaz. 2021. Techniques for Micropropagation of Olive (*Olea europaea* L.): A Systematic Review. Pak. J. Agri. Res., 34(1). https://doi.org/10.17582/journal.pjar/2021/34.1.184.192

Hussain, K., R. Qadri., M.T. Akram., N. Nisar. and A. Iqbal. 2020. Clonal propagation of olive (aa) through semi hardwood cuttings using IBA under shaded polyethylene tunnels (SPTS). Feb Fresenius Environ. Bull., 8131-8137.

Jan, I., M. Sajid., A. Rab., A. Iqbal., O. Khan., Y. Jamal and S.T. Shah. 2015. Effect of various concentrations of Indole butyric acid (IBA) on olive cuttings. Mitteilungen Klosterneuburg, 64:127-136

Lazaj, A., P. Rama and H. Vrapi. 2015. The interaction with season collection of cuttings, Indol butyric acid (IBA) and juvenility factors on root induction in *Olea europaea* L. (Cultivar "Kalinjot"). Int. Ref. J. Eng. Sci. (IRJES), 4(3): PP.32-38.

López-Bernal, Á., O. García-Tejera., L. Testi. and F.J. Villalobos. 2020. Genotypic variability in radial resistance to water flow in olive roots and its response to temperature variations. Tree Physiol., 40(4): 445-453. https://doi.org/10.1093/treephys/tpaa010

Margossian, R.L. 2022. Evaluation of SpermTracker paper and spray for the visualization of seminal stains (Doctoral dissertation, Boston University).

Martins, M., A.F.G. Gomes., É.M. da Silva., D.F. da Silva., P.M. Peche., T.A. Magalhães. and R. Pio. 2022. Effects of anatomical structures and phenolic compound deposition on the rooting of olive cuttings. Rhizosphere, 23 100557. https://doi.org/10.1016/j.rhisph.2022.100557

Mayer, N. A., L. Picolotto., P.V. Bastos., B. Ueno. and L.E.C. Antunes. 2014. Herbaceous cutting propagation of peach rootstocks in late summer. Semina: CiênciasAgrárias, 35(4): 1761-1772. https://doi.org/10.5433/1679-0359.2014v35n4p1761

Mohamed, Y.I. 2015. Evaluation the effect of rooting media and hormonal concentrations (IBA) in three olive cultivars growing in Siwa Oesis-Egypt. Int. J. Agric. Sci., 5 (3): 500-503. https://doi.org/10.9734/ajaar/2023/v21i3416

Mohammed, A. 2023. Role of cold storage in rooting of stem cuttings: A review. Asian J. Adv. Agric. Res., 21(3): 1-6.

Porghorban, M., E.G. Moghadam and A. Asgharzadeh. 2014. Effect of media and indole butyric acid (IBA) concentrations on rooting of Russian olive (*Elaeagnus angustifolia* L.) Semi-hard wood cuttings. Indian J. Fundam. Appl. Life Sci., 4 (3):517-522.

Ritter, G., F. Villa., D.F. da Silva., O. Alberton., F.J. Menegusso., T. Eberling. and J. Dória. 2021. Microbiological bio-stimulant promotes rooting of olive cuttings. Int. J. Agric. Biol. Eng., 14(6), 207-212. https://doi.org/10.25165/j.ijabe.20211406.5880

Rosa, D., F. Villa., D.F. da Silva. and F. Corbari. 2018. Rooting of semihardwood cuttings of olive: indol butyric acid, calcium and *Azospirillum brasilense*. Comun. Sci., 9(1): 34-

40. https://doi.org/10.14295/cs.v9i1.977

Schicchi, R., C. Speciale., F. Amato., G. Bazan., G. Di Noto., P. Marino. and A. Geraci. 2021. The monumental olive trees as biocultural heritage of Mediterranean landscapes: The case study of Sicily. Sustainability, 13(12): 6767. https://doi.org/10.3390/su13126767

Siakou, M., A. Bruggeman., M. Eliades., C. Zoumides., H. Djuma., M.C. Kyriacou. and A. Moriana. 2021. Effects of deficit irrigation on 'Koroneiki'olive tree growth, physiology and olive oil quality at different harvest dates. Agric. Water Manag., 258: 107200. https://doi.org/10.1016/j.agwat.2021.107200

Soni, N., S.K. Pandey., S.S. Singh., S.R.K. Singh., A. Mishra., S.S. Baghel and P.K. Kaurav. 2016. Propagation of guava through cutting under net house condition at Jabalpur, Madhya Pradesh, India. Flora and Fauna, 22 (1): 36-40.

Ferreira, G.M., M. Pasqual., R. Melloni., J.M.Q. Luz. and J.D.R. Sores. 2022. Microbial biostimulants as alternatives for the rooting of olive tree cuttings. Biosci. J., 38(e38091): 1981-3163. https://doi.org/10.14393/BJ-v38n0a2022-53570

Neri, D., T. Cioccolanti., G. Zuccherelli., O. Navacchi., V. Giorgi. and E.M. Lodolini. 2020. Micropropagation effects on juvenile traits, flower differentiation, and tree architecture in young olive trees. Agronomy, 10(11): 1742. https://doi.org/10.3390/agronomy10111742

Saee, G.M. 2021. Effect of cultivars, date, IBA and their interaction on rooting of semi-hardwood olive cutting Cvs. Shami and Qaisi. J. Duhok Univ., 24(2): 19-27. https://doi.org/10.26682/ajuod.2021.24.2.3

Akhtar, S., M.A. Sumrah., M. Faisal., M. Jan., M.R. Anser., M.A. Iqbala. and M. Rafiquea. 2021. J. Econ. Impact., *3*(3): 202-208. https://doi.org/10.52223/jei3032110

Sezer, F. 2023. Identification and gene expression analysis of TIR1 in easy and hard to root olive (*Olea europaea* L.) Cultivars. Int. J. Innov. Appr. Sci. Res., Vol. 7 (1): 1-8. https://doi.org/10.29329/ijiasr.2023.524.1

Yılmaz, N., T. Mahmutoğlu. and D. Ozkök. 2019. Effects of the season on the rooting performance on the local olive types of Northern Cyprus. Turk. J. Agric. -Food Sci. Technol., 7(10), 1705-1709. https://doi.org/10.24925/turjaf.v7i10.1705-1709.2842

Yousif Ali, Abdulrehman, and S.M. Abdulqader. 2022. Effect of current intensity and shock timing of cuttings on rooting of hard wood cuttings for two olive tree (*Olea europea* L.) cultivars. ProEnviron. Promediu, 15(50).