Research Article

Comparative Influence of Different Concentrations of Indole Butyric Acid (IBA) on the Propagation Success of Two Olive Varieties

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Abstract | The application of various plant growth regulators hormones like auxins in form of Indole Butyric Acid (IBA) improve root development in asexual propagation of olive crop. In order to investigate the "Comparative effect of different doses of Indole Butyric Acid (IBA) on propagation success of two olive varieties", during the year 2021, an experiment was undertaken at PARC-National Tea and High Value Crops Research Institute Shinkiari, Mansehra, Pakistan. The trial was conducted using Randomized Complete Block Design (RCBD) with split plot arrangements with three replications. It was consisted of varieties i.e., Arbequina and Megaran which were allotted to the main plot and different concentrations of IBA i.e., IBA @ (0, 3000, 3500 and 4000 ppm) which was assigned to the sub plot. Significant variation among characters were noted for different treatemtns. In case of varieties, maximum sprouting percentage (4.95%), thickness of sprouted cutting (6.04 mm), shoots length (38.83 cm), number of secondary roots (8.58) was recorded from cuttings which were taken from variety Megaran. Highest number of shoots per cutting (2.13), root length (15.40 cm) was obtained from cuttings which were taken from variety Arbequina. In treatment IBA, more number of secondary roots (8.93), shoot length (51.94 cm) and thickness of sprouted cutting (7.27) was recorded from cutting which were treated with IBA @ 3000 ppm. Highest root length (19.42 cm), number of shoots per cutting (2.40) was recorded from cutting which were treated with IBA @ 3500 ppm. Maximum sprouting Percentage (5.95 %) was noted from cutting which were treated with IBA @ 4000 ppm. The present study reveals that IBA @ 3000 ppm in combination with variety Megaran gives promising results. For optimum outcomes, it is recommended that olive cuttings should be treated with IBA @ 3000 ppm.

Received | August 12, 2024; **Accepted** | December 23, 2024; **Published** | May13, 2025
***Correspondence** | Saeed Ur Rahman, Pakistan Oilseed Department, Ministry of National Food Security and Research, Islamabad, Pakistan; **Email:** saeedurrahman883@gmail.com
Citation | Rahman, S.U., B.H. Shah, S. Qamar, R. Alam, W. Akhtar, I. Ahmed, F. Ahmad, N.E. Jan, S. Khan, N. Ahmad, A. Rehman, U.B. Khalid, S. Kanwal and M. Iqbal. 2025. Comparative influence of different concentrations of indole butyric acid (IBA) on the propagation success of two olive varieties. *Sarhad Journal of Agriculture,* 41(2): 709-715.
DOI | https://dx.doi.org/10.17582/journal.sja/2025/41.2.709.715
Keywords | Olive, Inodole butyric acid, Sprouting, Root initiation, Cuttings, Variety

Introduction

Olive (*Olea europaea* L.) is an evergreen tree, locally called Kahu, Khuna or Zaitoon belongs to the family of Oleaceae. The olive was first domesticated in the Eastern Mediterranean region approximately 6500 years ago (Jan *et al*., 2015).

The largest olive plantation in the world exist in Mediterranean region around 945 million trees, it covers 9.3 million hectares and contains 960 million trees, accounting for almost 98 percent of the world's entire olive plantation (Salari *et al*., 2017) which produces more than 95% of the olive oil and 75% of the table olives (Fabbri *et al*., 2004). Around 80 million wild olive trees can be found in Pakistan, especially in Baluchistan, Gilgit Baltistan, Punjab's Pothwar belt, Khyber PakhtunKhwa, and Azad Jammu and Kashmir. The presence of such a large number of wild olive groves suggests that these locations' agro climatic conditions are appropriate for olive cultivation (Jan *et al*., 2014).

The consumption of an olive is as a fruit, leaves as a herbal tea and also uses its oil for various purposes. 20 to 30 percent oil extracts from the fresh weight of the fruit. Olive oil is particularly healthy since it contains a large amount of oleic acid, which has a medicinal effect (Ashrafi *et al*., 2008). Olive oil is commonly used for cooking purposes. Fatty acid present in olive oil controls blood pressure, cholesterol level, diabetes, cancer, migraine, heart disease and obesity (Shama *et al*., 2015).

Producing olives from seed is a lenghty process till maturity. Various techniques may be employed to propagate olive for early fruiting (Baloch, 1994). Cutting is one of the easiest and cheapest methods of propagation for producing maximum plants. The most important part used in vegetative propagation is shoot cuttings (Mohamed and Mohamed, 2018).

Low rooting capacity and poor root quality are limiting problems in olive cutting propagation (Wiesman and Lavee, 1994). IBA is a rooting harmone for olive cuttings which may or may not in response to olive cuttings (Wiesman and Lavee, 1995a, b; Aslmoshtaghi and Shahsavar, 2010). In nurseries, IBA has an important treatment that improves the roots of cuttings. Plant growth regulators (PGRs), particularly auxins like Indole Butyric Acid (IBA), are critical in improving rooting success in vegetative propagation. As olive is mostly vegetative propagated thus there is a dire need to conduct research non such issues. IBA has been widely studied and is known for its role in enhancing root initiation by stimulating cell division and differentiation at the basal end of cuttings (Da Silva *et al*., 2013). However, the effectiveness of IBA in promoting rooting can vary depending on the species, variety, and environmental conditions, necessitating further investigation into optimal concentrations (Khodadadi *et al*., 2016).

This study aims to investigate the comparative effects of different IBA concentrations on the rooting success of two olive varieties. By determining the optimal IBA concentration for propagation, this research will contribute to the development of more efficient and reliable techniques for olive production. The findings are expected to have practical implications for improving yield and ensuring sustainability in commercial olive cultivation.

Materials and Methods

Location

A field trial was undertaken at an Olive nursery at PARC-National Tea and High Value Crops Research Institute Shinkiari, Khyber Pakhtunkhwa, Pakistan in 2021 to investigate the comparative effect of different doses of IBA on propagation success of two Olive cultivars. NTHRI Shinkiari is located at 3258 fe*et al*titude, latitude 34.4588°N, and longitude 73.2685°E.

Experimental design

A field trial was conduted in three replications using Randomized Complete Block (RCB) Design with split plot arrangements. Experiment consisted of two factors in which varieties were assigned to the main plot whereas treatments were allotted to sub-plots.

Factor A: Varieties

a. Arbequina
b. Megaran

Factor B: IBA concentrations

a. Control
b. IBA @ 3000 ppm
c. IBA @ 3500 ppm
d. IBA @ 4000 ppm

Studied parameters

Sprouting %: it was recorded by using the following formula.

$$\text{Sprouting \%} = \frac{\text{Sprouted cuttings}}{\text{Total cutting planted}} \times 100$$

Thickness of sprouted cuttings (mm): Vernier's caliper was used to measure thickness of sprouted cuttings at one inch above the soil line in each experimental unit.

Shoots cuttings^{-1}: In each experimental unit sprouted cuttings were noted and means were computed.

Shoot length (cm): Measuring tape was used for measuring shoot length in each treatment and then their mean values were obtained.

Root length (cm): By using rular, the length of each root was taken from base to the tip of longest root in each experimental unit and average were obtained.

Number of primary roots: The total number of primary roots in sprouted cuttings was counted in each treatment and means were calculated.

Number of secondary roots: By counting seondry roots in each experimental unit through random selection and their means were noted.

Statistical analysis

The data was analysed statistically using the Statisticx 8.1 programme, and Least Significance Difference (LSD) test were used to compare means according to (Steel and Torrie, 1980).

Results and Discussion

Sprouting percentage

The percentage of sprouting had a substantial impact on the variety, IBA concentrations, and their interactions (Table 1). In terms of varietals, Megaran had the highest sprouting rate (4.95), whereas Arbequina had the lowest sprouting percentage (4.60). Cuttings treated with IBA @ 4000 ppm had the highest sprouting percentage (5.96), whereas cuttings treated with control had the lowest sprouting percentage (2.65). Those cuttings that were treated with 4000 ppm of IBA sprouted more. The ability of the growth regulator to encourage the development of adventitious roots may be directly connected to the percentage of cuttings that sprout after being treated with a high concentration of IBA. These roots absorbed minerals and nutrients from the soil, resulting in a higher percentage of sprouting.

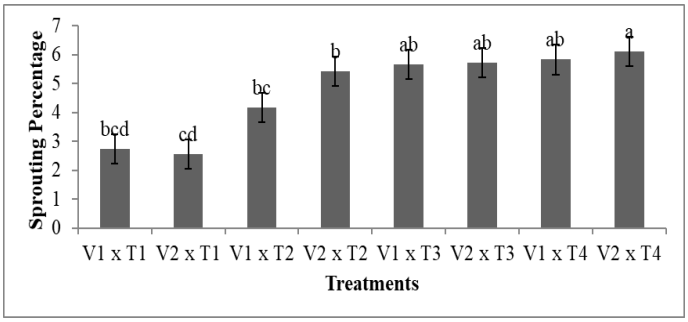

Figure 1: *Interactive effect of sprouting percentage as affected by IBA and olive varieties.*

Thickness of sprouted cuttings (mm)

Varieties, IBA concentrations and their interaction had significantly effect on thickness of sprouted cutting. In case of varieties maximum thickness of sprouted cutting (6.04) was noted in variety Megaran whereas the minimum thickness (5.31) was recorded in Arbequina. In case of IBA concentration maximum thickness (7.27) was noted at IBA @ 3000 ppm while minimum thickness (3.88) was noted from control. These findings are at par with (Siddiqui and Hussain, 2007) who reported that IBA enhance the thickness of olive cuttings. The interaction between two varieties and different concentration of IBA indicates that maximum thickness of sprouted cutting (8.22) was observed in variety Megaran with 3000 ppm concentration of IBA whereas the minimum thickness of sprouted cutting (3.73) was recorded in Arbequina from control.

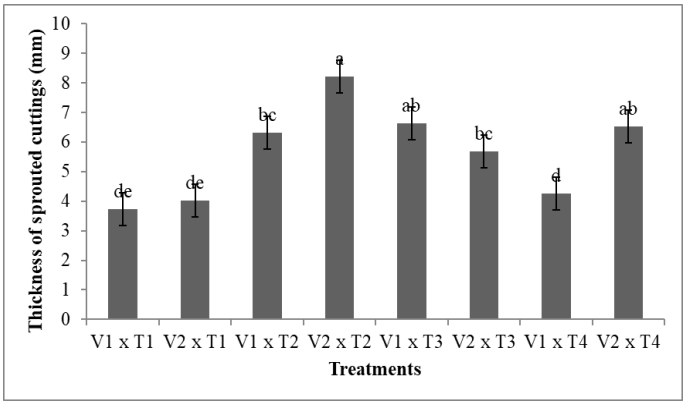

Figure 2: *Interactive effect of thickness of sprouted cuttings (mm) as affected by IBA and olive varieties.*

Shoots cutting^{-1}

Shoots cutting^{-1} was significantly affected by varieties,

IBA concentrations and their interaction. In case of varieties highest shoots cutting^{-1} (2.13) was noted in variety Arbequina whereas the lowest number of shoots per cutting (1.63) was recorded in variety Megaran. For IBA concentration maximum shoots cutting^{-1} (2.40) was recored from cuttings having IBA @ 3500 ppm while less shoots cutting^{-1} (1.15) was recorded as compared to control. These results are at par with the observation of (Siddiqui and Hussain, 2007) who found highest number of shoots from those cuttings which were treated with high concentration of IBA. IBA has significantly affected the number of branches per shoot (Yusnita *et al*., 2018; Stefancic *et al*., 2005). Number of shoots are increased in those cuttings which were treated with high concentration of IBA may be due to more number of roots, through roots, plants take minerals and essential nutrient from the soil. The interaction between two varieties and different concentration of IBA indicates that highest shoots cutting^{-1} (3.37) was noted in variety Arbequina with 3500 ppm concentration of IBA while lowest shoots cutting^{-1} (1.10) was noted in variety Arbequina from control.

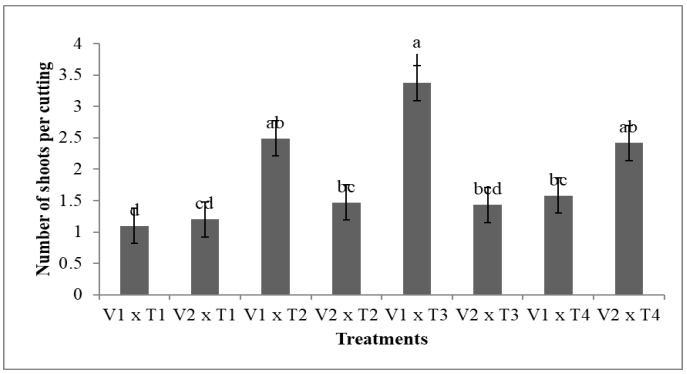

Figure 3: *Interactive effect of number of shoots cuttings^{-1} as affected by IBA and olive varieties.*

Shoots length (cm)

Varieties, IBA concentrations and their interaction had significantly effect on shoot length. In case of varieties maximum shoot length (38.83) was noted in variety Megaran whereas the minimum shoot length (32.20) was rexcorded in variety Arbequina. In case of IBA concentration largest shoot length (51.94) was observed from cuttings with IBA @ 3000 ppm while lowest shoot length (19.54) were noted from control. (Hegazi *et al*., 2010; Da Silva *et al*., 2013; Jan *et al*., 2015; Jana *et al*., 2015) they all observed that IBA enhanced shoot length of olive, citrus, apple and pear. IBA promotes cell division and cell enlargement, which results in early rooting leading towards maximum absorption of mineral and nutrient from soil and hence IBA increases the length of shoots. The interaction between two varieties and different concentration of IBA indicates that highest shoot length (54.43) was observed in variety Megaran with 3000 ppm concentration of IBA whereas the lowest shoot length (18.93) was recorded in variety Megaran from control.

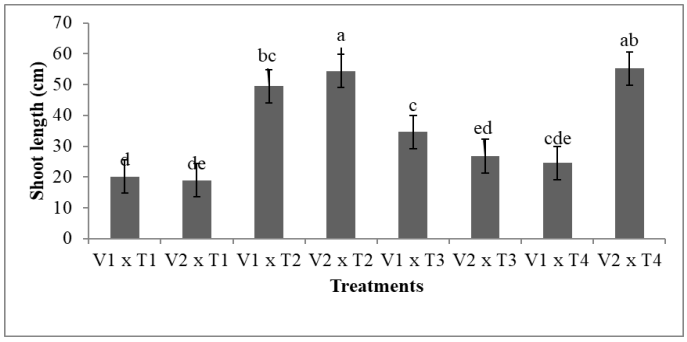

Figure 4: *Interactive effect of shoot length (cm) as affected by IBA and olive varieties.*

Root length (cm)

Root length was significantly affected on varieties, IBA concentrations and their interaction. In case of varieties longer root length (15.40) was noted in variety Arbequina and minimum (14.30) was recorded in variety Megaran. In case of IBA concentration longer root length (19.42) were noted for IBA @ 3500 ppm while shorter root length (8.24) were noted from control. These results are in contrast by (Porghorban *et al*., 2014; Hamooh, 2014; Jan *et al*., 2015; Lazaj *et al*., 2015) are in the opinion that application of IBA helps in increasing the length of root (Bhatt and Tomar, 2010) also found increase in root length with increasing IBA concentration in Citrus aurantifolia. Root length was also increase in those cuttings which are treated with high concentration of IBA. The interaction between two varieties and different concentration of IBA indicates that highest root length (23.43) was observed in variety Arbequina with 3500 ppm concentration of IBA while lowest root length (8.06) was noted in variety Megaran from control.

Primary roots plant^{-1}

IBA concentrations and their interaction had significantly effected on number of primary roots while varieties had non-significant effect on number of primary roots. In case of IBA concentration more primary roots (4.08) was noted at IBA @ 4000 ppm while lowest number of primary roots (1.98) was noted from control. These results are at par with (Hamooh, 2014; Porghorban *et al*., 2014; Jan *et al*., 2015; Lazaj *et al*., 2015; Mohamed, 2015) who observed that

application of IBA helps in increeasing roots in olive cuttings. IBA is a root promoting hormone which helped in root induction and root development. When IBA concentration increases, number of roots will be increased. The interaction between two varieties and different concentration of IBA indicates that more primary roots plant^{-1} (4.52) was noted in variety Arbequina at 4000 ppm concentration of IBA whereas the least primary roots (1.95) was observed in variety Megaran compared to control.

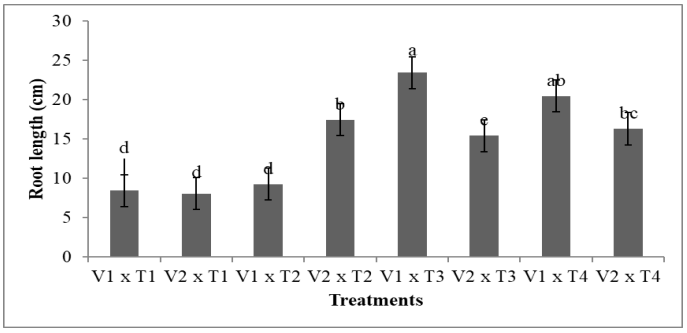

Figure 5: *Interactive effect of root length (cm) as affected by IBA and olive varieties.*

Secondary roots plant^{-1}

Secondary roots plant^{-1} was significantly affected for varieties, IBA concentrations and their interaction. In case of varieties more secondary roots (8.58) was noted in variety Megaran whereas the less secondary roots (8.19) was noted in Arbequina. In case of IBA concentration more secondry roots (8.93) was observed at IBA @ 3000 ppm while lower number of secondary roots (7.34) was noted from control. These findings are at par with (Jan *et al.*, 2015; Lazaj *et al.*, 2015) validated that number of roots increased with the use of IBA. IBA plays a crucial role in development of plant root, elongation of root hair and lateral root development. The interaction between two varieties and different concentration of IBA indicates that more secondary roots (9.35) was recorded in variety

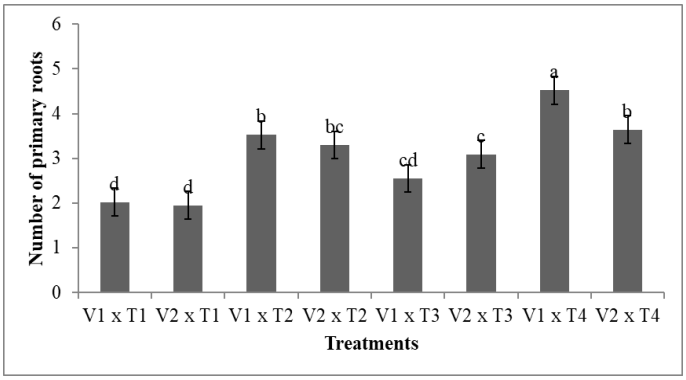

Figure 6: *Interactive effect of primary roots as affected by IBA and olive varieties.*

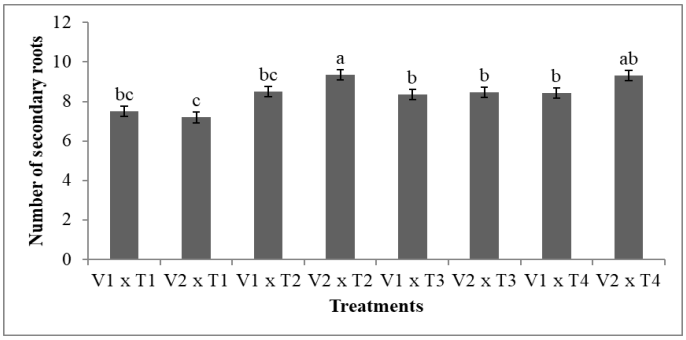

Figure 7: *Interactive effect of secondary roots as influenced by IBA and Olive varieties.*

Table 1: *Sprouting percentage, thickness of sprouted cuttings (mm), number of shoots cuttings^{-1}, shoot length (cm), root length (cm), primary roots plant^{-1} and secondary roots plant^{-1} as affected by different IBA concentration and varieties of olive.*

Treatments	Sprouting percentage	Thickness of sprouted cutting (mm)	Number of shoots per cutting	Shoot length (cm)	Root length (cm)	Number of primary roots	Number of secondary roots
Varieties							
Arbequina	4.60 B	5.31 B	2.13 A	32.20 B	15.40 A	3.15 A	8.19 B
Megaran	4.95 A	6.04 A	1.63 B	38.83 A	14.30 B	2.99 A	8.58 A
LSD	0.1293	0.1291	0.1731	1.1769	0.2231	NS	0.1868
IBA Concentration							
Control	2.65 C	3.88 D	1.15 C	19.54 D	8.24 D	1.98 D	7.34 C
3000 ppm	4.80 B	7.27 A	1.98 B	51.94 A	13.36 C	3.41 B	8.93 A
3500 ppm	5.70 A	6.16 B	2.40 A	30.70 C	19.42 A	2.82 C	8.41 B
4000 ppm	5.96 A	5.39 C	2.00 B	39.89 B	18.39 B	4.08 A	8.87 A
LSD	0.3694	0.1566	0.1686	1.1453	0.3135	0.2656	0.2077
Interaction							
VXI	Fig. 1	Fig. 2	Fig. 3	Fig. 4	Fig. 5	Fig. 6	Fig. 7

Means having different letters are significancant at P less then 0.05. NS: Non-significant.

Megaran with 3000 ppm concentration of IBA while lowest number of secondary roots (7.19) was noted in variety Megaran from control.

Conclusions and Recommendations

The experimental result indicates that IBA @ 3000 ppm with the variety Megaran gave superior results. The investigated results showed that thickness of sprouted cutting (mm), shoot length (cm) and number of secondary roots were significantly influenced due to the influence of IBA than control. So it is recommended that IBA @ 3000 ppm with Megaran Variety of Olive gave better results as compared to Arbequina variety.

Acknowledgements

The authors are thankful to Dr. Muhammad Tariq (NPD Olive, Federal Project Management Unit, NARC Islamabad), Dr. Azmat Ali (Dy. NPD Olive, Federal Project Management Unit, NARC Islamabad), Ms. Aasia Ramzan (SSO-Olive, Federal Project Management Unit, NARC Islamabad) and Mr. Sajid Siddique (SMS-Horticulture, AandE Department Mansehra) for their guidance and support.

Novelty Statement

This study introduce a novel combination of IBA concentrations and two olive varieties that significantly increase the sprouting percentage of olive cuttings, filling a critical knowledge gap in Olive cultivation.

Author's Contribution

Saeed Ur Rahman and Basharat Hussain Shah: Conceived and designed the experiment.
Saeed Ur Rahman and Basharat Hussain Shah: Performed the experiment.
Saeed Ur Rahman, Sheraz Qamar and Imtiaz Ahmad: Analyzed the data.
Riaz Alam, Waleed Akhtar, Fayaz Ahmad, Noor Elahi Jan, Sajjad Khan, Naveed Ahmad, Abdur Rehman, Usama Bin Khalid, Sabah Kanwal and Meryam Iqbal: Contributed reagents, materials, analysis tools.
Saeed Ur Rahman and Sheraz Qamar: Wrote the paper.

Conflict of interest
The authors have declared no conflict of interest.

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