

Research Article



Effects of Different Concentrations of Naphthalene Acetic Acid on Rooting of Various Olive Varieties

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Abstract | To study the effect of various concentrations [0 ppm (control), 1000 ppm, 2000 ppm and 3000 ppm] of Naphthalene Acetic Acid (NAA) on rooting of various olive varieties (Hamdi, Nocellara and Sevallino) an experiment was conducted at Agricultural Research Institute (ARI) Tarnab, Peshawar during 2016. The trial was performed using two factorial RCBD. Cuttings were collected from mature olive orchard. The cuttings were treated for ten seconds in required concentration of NAA solutions. According to the experimental results, minimum days to root appearance (54.58), maximum root diameter (0.18 cm), maximum leaves shoot⁻¹ (15.67) were noted in Nocellara variety, lengthy root (4.30 cm) was found in Sevallino variety and maximum survival (47.6%) was observed in Hamdi variety, while minimum days to root appearance (46.33), number of days to bud sprout (34.89), maximum roots cutting⁻¹ (5.78), root length (5.36 cm), shoot length (16.66 cm), shoot diameter (0.30cm), number of leaves shoot⁻¹ (15.78), number of branches cutting⁻¹ (4.89) and plant survival percentage (50.36%) were noted in cuttings treated with 3000 ppm of NAA solution. Regarding interaction both varieties and NAA concentrations showed significant results for all variables except days to root appearance, length of shoot (cm), shoot diameter (cm), branches cutting⁻¹, and plant survival (%). It was concluded that the variety, Nocellara treated with 3000 ppm of NAA solution showed best results on growth variables.

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Introduction

Olive (*Olea europaea* L.) is a member of Oleaceae family (Green and Wickens, 1989), tree has slow growth and locally known as Zaitoon or Khuna that has a life span ranges from 900 to 1000 years. It is considered as a fruit tree of very early age and started domestically just about 6500 years ago which played a vital socioeconomic position in human

history (Loukas and Krimbas, 1983). It is one of the most ancient trees in Mediterranean, especially in the Middle East (Isfendiyaroglu and Ozeker, 2009). The rooting competency from leafy cuttings showed different results in various cultivars (Wiesman and Lavee, 1995). Rooting ability in many species increased with the external application of auxin (Avidan and Lavee, 1978; Hartman *et al.*, 2001). Olive trees population can be expanded by different

procedures such as hardwood and semi hardwood cuttings, suckers, budding or grafting. However, propagation by leafy cuttings under mist has become the most acceptable and best method throughout the world. Naphthalene acetic acid (NAA) was found to be more effective than IBA in some plants which respond unsatisfactory to IBA (Hartmann *et al.*, 2002). Olive can be propagated by hardwood and semi hardwood cuttings taken from 1-3 years old branches. Olive is hardy to root plant so treatment of cuttings with different levels of naphthalene acetic acid (NAA) is necessary for cuttings (Baloch, 1994).

Olive can grow well on variety of soil, but maximum yield can be obtained on calcareous silts (Munir, 2009). This type of soil provides sufficient aeration to the roots and has higher water holding capacity. Olive trees also perform well on light soil or on sandy loam soils with good drainage. Olive plants make excessive vegetative growth at the expense of fruiting on deep fertile land. The optimum soil pH for good olive production ranged between 6.5- 8.0 (Anon, 1985). Various olive cultivars are being grown in Pakistan include Coratina, Leccino, Pendolino, Manzallino, Arbequina, Uslu, Sevallino and Frantoio (Anon, 2010).

A little description of the selected varieties is mentioned below:

Hamdi: This cultivar originated in Syria and is moderately vigorous having spreading habit. Fruit is moderate-sized, round, has fruity flavors and is used almost exclusively for oil production.

Nocellara: The cultivar Nocellara is originated in Italy (Sicily). It is a vigorous tree and spreading in nature having large, lanceolate and green color leaves. The fruit with maximum weight of (5-7 grams) has a big base with rounded top. It is rich in oil (20%).

Sevallino: The cultivar Sevallino is originated in Spain. It can grow 25-30 feet tall, tolerant of winter cold and damp, but susceptible to drought conditions. The fruit is very large and is generally used as a table olive. Low oil content, therefore use for table purposes (Rafi, 2008).

Materials and Methods

During the experiment, selected mature trees of

three different olive varieties (Hamdi, Nocellara and Sevallino) were used as cutting sources. Different doses of NAA were applied to cuttings. The experiment was started during 3rd week of April. The trial was conducted using 2 factors RCB Design, with three replications. Total of 240 cuttings were used in each replication. Peat moss media was used and maintain media temperature at 22°C, while glass house temperature was 18°C with 85% humidity and the cuttings were irrigated with mist system. Rooting was checked after 45, 60, 90 and 120 days interval and 25% cuttings were observed for rooting.

Factor A: Varieties: V1: Hamdi; V2: Nocellara; V3: Sevallino.

Factor B: Naphthalene acetic acid (NAA) concentrations (ppm): T0: 0; T1: 1000; T2: 2000; T3: 3000.

Data were recorded on the subsequent parameters

- **Days to root appearance:** Days to root appearance was noted by adding the number of days from date of sowing till the roots appear.
- **Number of roots cuttings⁻¹:** Data was taken by counting numbers of roots appear cutting⁻¹ and average was then found out.
- **Length of root (cm):** Root length was calculated through measuring tap from stem bottom at the pointed tip of the main root.
- **Root diameter (cm):** Root width was observed through vernier caliper and then average was calculated.
- **Number of days to bud sprouting:** Data for this was noted from date of sowing till the bud sprout in the cutting.
- **Shoot length (cm):** Shoot length was measured by measuring tap calculated the mean value.
- **Shoot diameter (cm):** Vernier caliper was used for observing this data.
- **Number of leaves shoot⁻¹:** Data on number of leaves present shoot⁻¹ was taken by counting the total leaves on the shoot.
- **No of branches:** Data for this was taken by counting the branches present on the shoot in every treatment.
- **Plant survival percentage:** Survival percentage data was calculated as the plants survived in each treatment by the following formula:

$$\text{survial percentage} = \frac{\text{number of plants survived}}{\text{total number of plants}} \times 100$$

Statistical analysis of the data

The data recorded from all attributes was statistically analyzed through RCBD with two factors by using software (GenStat release 8.1). All the means recorded were compared at Least Significance Difference at 0.5 level of significance.

Results and Discussion

Days to root appearance

The averaged values for days to root appearance are showed in Table 1. Statistical analysis of the records displayed a highly expressive consequence of different applications of NAA and varieties for root appearance, as well as non-significant results for interaction. Maximum (60) days to root appearance were recorded in cuttings taken from variety Sevallino followed by days (58) in Hamdi, whereas minimum (55) days were recorded in cultivar Nocellera. Naphthalene acetic acid applied to olive cuttings significantly decreased the number of days (46) at 3000ppm NAA, while control treatment resulted in late root appearance. The results are in harmony with Murat and Elmas (2008). As naphthalene acetic acid increased vegetative level of the plant, as a response increases cell reproduction which results in early rooting. Results are in harmony with Ehsan et al. (2012), they found maximum number of roots in olive at 15cm cuttings length.

Table 1: Average values for root appearance, no of roots cutting⁻¹, Length of Root (cm), Root diameter (cm) and days to sprouting of bud different olive varieties on different NAA concentrations.

Olive varieties	Root appearance	No of roots cutting ⁻¹	Root length (cm)	Root diameter (cm)	No days to bud sprouting
Hamdi	58a	6	3.67b	0.15b	38
Nocellera	55b	4	3.68b	0.18a	38
Sevallino	61 a	5	4.30a	0.16a	39
LSD	3.22	NS	0.65	0.10	NS
NAA Conc.					
0 ppm	68a	4b	2.87c	0.09c	44 a
1000ppm	60b	5a	3.23c	0.16b	38 b
2000ppm	57b	5a	4.07b	0.20a	37 c
3000 ppm	46c	6a	5.36a	0.15b	35 c
LSD	3.72	1.21	0.56	2.47	1.72

Number of roots cutting⁻¹

The data in Table 1 revealed that roots number was significantly affected by NAA and olive varieties

x NAA interaction has meaningful result on roots number of roots per cutting, while varieties has no significant effect. According to the data maximum numbers of roots cuttings⁻¹ (6) were recorded when treated with 3000 ppm naphthalene acetic acid concentration, while control resulted in less (4) number of roots. The interactive effect showed that more roots cuttings⁻¹ (7) in variety Sevallino were produced at 3000 ppm NAA concentration than others. The results are in connection with those of Hamooh (2014) and Hassan et al. (2008) who reported positive response of naphthalene acetic acid on roots appearance. According to Marshall and Waring (1985) who reported that increasing photosynthate material may have shown its impact on length of shoots.

Root length (cm)

Results showed a significant effect of NAA, Varieties and their interaction on root length. It is revealed from Table 1 that lengthy roots (4.30 cm) were noted in Sevallino variety followed by Nocellara variety (3.68 cm) whereas smaller (3.67 cm) roots were produced in Hamdi variety cuttings. The reason might be genetic variation and internal physiology (carbohydrate level, mineral concentration and indigenous hormonal status) of cuttings of different varieties (Hassan et al., 2008). Data shows that highest root length (5.36cm) was recorded at 3000 ppm NAA as compared to (2.87 cm) was recorded in control. Treating the Sevallino cuttings with 3000 ppm NAA produced lengthy root, compared to (2.77 cm) in variety Nocellara with-out application of naphthalene acetic acid concentration. Olive cuttings demonstrated constructive result towards the increasing concentration of NAA concerning root length. The improvement of root length as a result of utmost number of branches shoot⁻¹ whose apical buds developed additional auxin that outcomes in root length and translocation of carbohydrates. Marshall and Waring (1985) also found enlarge in length of root with rising IBA concentration. Similarly, Ehsan et al. (2012), Hamooh (2014) and Hassan et al. (2008) also found that olive-cuttings expressed progressive reaction in the direction of the accumulative concentrations of NAA concerning increase in root length.

Root diameter (cm)

It is cleared from the mean Table 1 that both NAA and varieties and their interaction showed significant results for root diameter. Cutting of variety Nocellara

showed maximum (0.18cm) root diameter followed by Sevallino (0.16 cm), while minimum (0.15 cm) root diameter was recorded in Hamdi cuttings. Treating cutting with 2000 ppm NAA resulted in maximum root diameter (0.20 cm) as compared to (0.09 cm) in control. Treating the cutting of variety Nocellara with 2000 ppm NAA resulted in highest root diameter compared to rest of the treatments. Cuttings of olive displayed negative reaction regarding root diameter in the direction of increasing NAA concentration. [Murat and Elmas \(2008\)](#) reported same findings.

Number of days to bud sprouting

Analysis of variance displayed that there is significant effect of different naphthalene acetic acid concentrations, while varieties as well as their interactions were found non-significant. According to the data maximum number of days (39) to bud sprouting was recorded in variety Sevallino followed by Nocellara and variety Hamdi (38 days each). The mean data revealed that minimum number of days (35 days to bud sprouting) to bud sprouting was observed when the cutting were treated with 3000 ppm of naphthalene acetic acid, while maximum (44 days to bud sprouting) was recorded in control. It is observed from the results that naphthalene acetic acid concentration has positive effect on number of days to bud sprouting, alike results were reported by [Ehsan et al. \(2012\)](#).

Length of shoot (cm)

The data regarding length of shoot are reported in [Table 2](#). Statistical examination of the data demonstrates that there is considerable outcome of naphthalene acetic acid concentration on shoot length, whereas varieties and their interaction were found non-significant. Premier shoot length (16.66 cm) was recorded when cuttings were treated with 3000 ppm of naphthalene acetic acid concentration, while the minimum (8.40 cm) shoot length was recorded in control. Naphthalene acetic acid concentration has portrayed positive effect on shoot length. At high concentration more number of roots and leaves were observed, so the increasing cytokinin have shown its impact on length of shoot as reported by [Marshall and Waring \(1985\)](#). As NAA increased in a plant, it increases cell distribution, which result in untimely rooting which enable the plant to concentration of mineral nutrients besides to maximize length of shoot, related results were also revealed by [Ehsan et al. \(2012\)](#).

Table 2: Mean data for Length of shoot (cm), Shoot diameter (cm), Leaves and Branches No shoot⁻¹ and Plant survival percentage (%) different olive varieties on different NAA concentrations.

Olive varieties	Length of shoot (cm)	Shoot diameter (cm)	Number of leaves shoot ⁻¹	Number of branches shoot ⁻¹	Plant survival percentage (%)
Hamdi	13.70	0.22	12 b	4a	47.62a
Nocellera	13.24	0.23	16 a	3b	45.22a
Sevallino	13.92	0.21	14 b	4a	44.23b
LSD	NS	NS	1.65	0.84	2.49
NAA Conc.					
0 ppm	8.40c	0.19b	10 b	3b	43.29b
1000 ppm	14.32b	0.13b	15 a	3c	43.19b
2000 ppm	15.10b	0.26a	15 a	4b	45.92b
3000 ppm	16.66a	0.30a	16 a	5a	50.36a
LSD	0.84	0.15	4.39	0.97	2.88

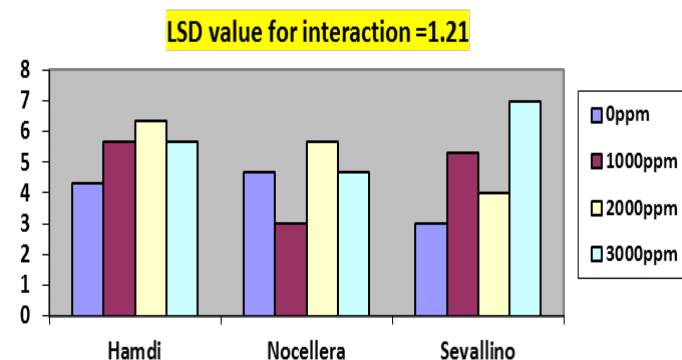


Figure 1: Interaction between varieties and NAA concentration for number of roots per cuttings.

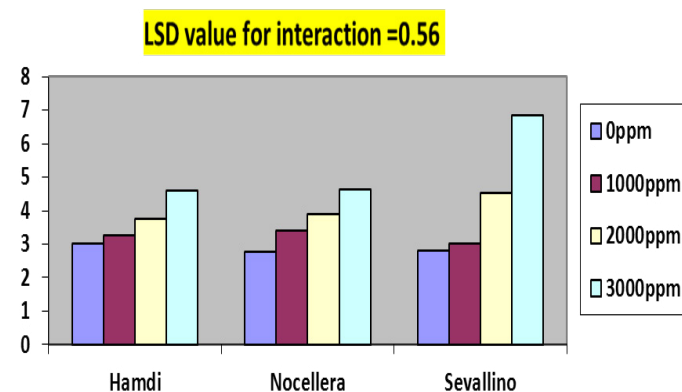


Figure 2: Interaction between varieties and NAA concentration for root length (cm).

Shoot diameter (cm)

The mean data concerning shoot diameter are specified in [Table 2](#). The statistical analysis of the data revealed that different naphthalene acetic acid concentration had significant effect on shoot diameter, while varieties and their interaction among

naphthalene acetic acid were found non-significant. Maximum (0.30cm) shoot diameter was observed in cuttings of different olive varieties treated with 3000 ppm naphthalene acetic acid concentration, while minimum (0.13 cm) shoot diameter was recorded in cuttings treated with 1000 ppm. Naphthalene acetic acid concentration has portrayed positive effect on shoot length and diameter. At high concentration of NAA more number of roots and leaves were observed, so the increasing cytokinin have shown its impact on length and diameter of shoot as reported by [Marshall and Waring \(1985\)](#).

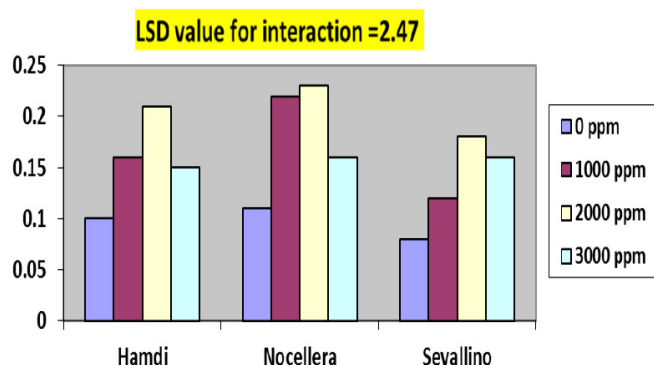


Figure 3: Interaction between varieties and NAA concentration for root diameter (cm).

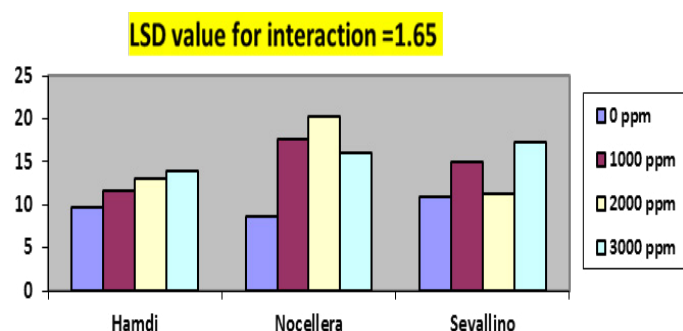


Figure 4: Interaction between varieties and NAA concentration for number of leaves per shoot.

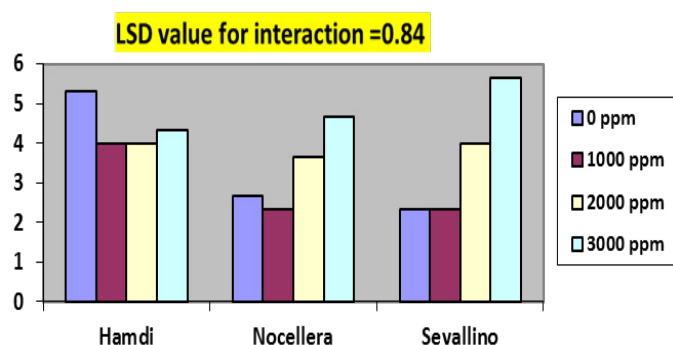


Figure 5: Interaction between varieties and NAA concentration for number of branches.

Number of leaves shoot⁻¹

The mean data regarding number of leaves shoot⁻¹ were given in [Table 2](#). It is evident from the statistical

analysis of the data that NAA, varieties and their interaction have significant effect on leaves counting. Olive variety Nocellera produced more leaves than other varieties. Treating the cutting in 3000 ppm NAA solution produced more leaves compared to control. Similarly dipping the cuttings of variety Nocellera in 2000 ppm NAA solution produced more leaves than other. NAA play a major role in boosting root development due to which shoot length increases and hence increase in number of leaves occurs in response of increase shoot length and thus balance top to root ratio for proper functioning. Rise in digits of root owing to NAA application may need the enlarged action of photo-synthesis, transpiration and inhalation in leaves and therefore may effects in the growth in number of leaves per cutting ([Muhammad, 1987](#)).

Number of branches shoot⁻¹

Statistical analysis of the data presented a significant effect of NAA, varieties and their interaction. Data in [Table 2](#) shows that the maximum (4) number of branches shoot⁻¹ were observed in variety Hamdi and variety Sevallino, while minimum (3) number of branches shoot⁻¹ were documented in cultivar Nocellera. Dipping the cuttings in 3000 ppm NAA solution resulted in more branches shoot⁻¹ (5) than (3) at 1000 ppm concentration. Dipping the cuttings of Variety Sevallino in 3000 ppm NAA produced more branches than other treatments. Naphthalene acetic acid concentration has shown substantial effect on number of branchesshoot⁻¹. It is a point that NAA straight affect number of root and root-growth and incidentally result shoot length which might result in high number of branches shoot⁻¹ ([Muhammad, 1987](#)).

Survival (%)

The analysis of the data represented a significant effect of both the treatments on plant survival, while there interaction has no significant effect. Maximum (47.62%) plant survival was found in cultivar Hamdi followed by (45.22%) plant survival in Nocellera variety whereas minimum (44.23%) plant survival was found in variety Sevallino. Plant survival was maximum at 3000 ppm NAA than control. Naphthalene acetic acid applied to different olive varieties cuttings significantly increased the survival percentage, the results of [Ehsan et al. \(2012\)](#) are similar to these findings. The survival of the sprouted cuttings may be directly associated with the compeers of adventitious roots in the cuttings. These roots fascinate mineral nutrient from soil which cause the

cuttings to survive.

Conclusions and Recommendations

Among the olive varieties, Nocellara variety showed good performance for all the variables, while treated with 3000 ppm of Naphthalene acetic acid solution. Regarding interaction, both olive varieties and naphthalene acetic acid have significant effect on all variables except days to root appearance, shoot length (cm), shoot diameter (cm), branches cutting⁻¹, and plant survival (%).

Novelty Statement

Rooting potential of olive cultivars in response to Naphthalene Acetic Acid (NAA) was investigated in the study. Results indicated that improves rooting and other growth variable of olive cultivars Nocellara at 3000 ppm.

Author's Contribution

Safiullah: Conducted the experiment.

Azmat Ali Awan: Design the study.

Mohammad Ilyas: Wrote the paper.

Fahim Ullah Khan: Statistical analyze and interpret the data.

Arshad Iqbal: Review and process the article.

Muhammad Adil and Asad Ullah: Collected the data.

Conflict of interest

The authors have declared no conflict of interest.

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