Introduction

Olive tree (Olea europaea L.) consider one of the most important economic resources and diet for the Mediterranean region (Leone et al., 2015), which produce 98% of the olive oil production worldwide (IOC, 2019). Olive oil consumption and demand is increasing due to balanced fatty acid composition and antioxidant properties (IOC, 2019). Also, olive tree is a widely distributed in arid areas for ramified root system and special leaf structure (Tanasijevica et al., 2014).

High quality transplants are necessary to success in fruit production. Vegetative propagation of olive via rooting leafy cuttings is widely used (Hartmann et al., 2002 and Fabbri et al., 2004), which considered easy, inexpensive, fast and appropriate for mass plant propagation. The greatest effect on rooting achieved by Auxins (Eid et al., 2018). IBA (indole butyric acid) is the most auxin used for rooting of olive cuttings (Hussein et al., 2017 and Shiri et al., 2019), therefore, the results found vary a lot according to the dosage, the cultivar, the period of rooting, the substrate and the type of cutting among other factors.
Antioxidative substances like ascorbic acid (Patel et al., 2020) and citric acid (Moola & Kumari, 2020 and Soonthornkalump et al., 2020) are often reported in micropropagation, but it is still very rare in cuttings rooting. Ascorbic acid is an important component of antioxidant system in plants, which responsible for regulate many physiological activities such as H$_2$O$_2$ scavenging (Hasanuzzaman et al., 2020), cell elongation (Paciolla et al., 2019) and cell multiplication (Gallic, 2013, Lisko et al., 2014 and Ellya Kka, 2017). Also, citric acid acts as a chelating agent, acidulant and PPO activity inhibitor (Rojas-Graü et al., 2008, Hithamani et al., 2018 and Zhou et al., 2020). Ascorbic acid improved rooting percentage in Stewartia pseudocamellia cuttings before IBA (100mgL$^{-1}$) treatment (Struve and Lagrimini, 1999). More recently, El-Sharony et al. (2018) reported an increase in guava cuttings success after soaking in mixture of 5% citric acid + 5% ascorbic acid and treated with 3000ppm IBA compared to IBA treatment alone. Moreover, Radhi and Hussein (2020) revealed that Ascorbic acid alone induced rooting of Acacia leprosa when supplied individually rather than in combination with IBA.

Unfortunately, economically important olive cultivars that show intermediate or even easy rooting capacities and shoot growth had a low rooting success and shoot growth during winter nursery production (Fabbri et al., 2004). During cool seasons endogenous hormones rate was decreased due to the decrease in metabolic activities of the trees so, higher concentrations of hormones are required (Bartolini et al., 1986). In some Mediterranean country like Egypt, during cool season minimum temperature arranged from 19.1°C in September till 7°C in January (CDO, 2021) which unsuitable for olive growth. Propagation of olive cuttings under plastic tunnel is an ancient system, but nowadays for cold winter temperature, high price of electricity and irrigation water it was more suitable than fog irrigation system (mist). While, low cuttings rooting percent during winter cool season will increase propagation costs and decrease nursery production. So, the aim of this study was determine the rooting ability of between some olive cultivars in addition to improving olive cutting propagation procedure during cool season through supplementary application of IBA and antioxidants (Ascorbic and citric acid).

Materials and Methods

Experimental conditions
This study was carried out during two seasons 2018/19 and 2019/20 on three olive cultivars namely i.e., ‘Picual’, ‘Manzanillo’ and ‘Coratina’. Forty five cuttings of each cultivars were prepared in four nodes with 4 terminal leaves and 15cm length taken from one-year-old branches during September each year. All cuttings base dipped in IBA at 4000ppm for 20 seconds immediately before planting. After that, the cuttings treated with one of the following treatment i.e. treating the planted cuttings base through additional application of IBA at 100, 200 and 300ppm or mixture of antioxidant (1:1 of citric and ascorbic acid) at 100, 200 and 300ppm to the soil with approximately 300ml/solution for each treatment. The soil treated three times, each one every three days intervals started at planting day. The treatments added at night after mist stopped from 5.00 PM till 7.00 AM as modified and intermittent slow soaked treatments for 14 hours. The cuttings planted in sand : peat moss (4:1) under mist irrigation system which sprayed water 15 seconds every 15 minutes from 7.00am to 17.00pm for one month only. After that, the cuttings during cool season covered with polyethylene as a tunnel till the end of march and irrigated once a month. Cuttings rooting percent, roots number, roots length and new leaves number were recorded at the first of March.

Statistical analysis
This experiment was arranged in a randomized complete block design with two factors (olive cultivar X treatments) and subjected to variance analysis (Snedecor and Cochran, 1980). The means of the treatments were compared by least significant difference (Duncan, 1955) at 0.05 significance level. The treatments were factor A and the cultivars were factor B.

Results and Discussion

Cuttings rooting percent
Table 1 showed the effect of supplemental application of IBA and antioxidant on rooting percent of olive cuttings during cold season. It was cleared that, ‘Coratina’ olive cultivar recorded the highest significant rooting percent followed by ‘Picual’ while ‘Manzanillo’ cultivar recorded the significant lowest rooting percent. For the effect of supplementary application of IBA and antioxidant, it was cleared that, 300ppm followed by 200ppm antioxidant recorded the significant highest rooting percent. while the significant lowest rooting percent recorded by antioxidant at 100ppm and IBA at 300ppm. For the interaction effect, antioxidant at 300ppm...
gave the highest value with all olive cultivars. Moreover, the significant highest values were recorded by ‘Coratina’ olive cultivars under 300ppm antioxidant.

**Root number**

Table 2 showed the effect of supplementary application of IBA and antioxidant on rooting numbers of olive cuttings during cool season. It was cleared that, ‘Coratina’ olive cultivar recorded the significant highest root numbers compared to ‘Picual’ and ‘Manzanillo’ cultivars. For the effect of supplementary application of IBA and antioxidant, it was cleared that, 300ppm antioxidant followed by 100ppm IBA gave significant highest root numbers compared to the other treatments, while the lowest root numbers recorded by IBA at 300ppm and antioxidant at 100ppm. For the interaction effect, antioxidant at 300ppm gave the highest value with ‘Picual’ and ‘Manzanillo’ olive cultivars while 100ppm IBA gave the significant highest root numbers for ‘Coratina’ cultivar. The significant highest root number recorded by ‘Coratina’ olive cultivars treated with 300ppm antioxidant, while the lowest value recorded by ‘Manzanillo’ olive cultivar under 100ppm antioxidant.

**TABLE 1. Effect of supplementary application of IBA and antioxidant on rooting percent of three olive cultivars during cool season.**

| Treatments       | Cultivars | First season 2018 / 2019             | Mean     |
|------------------|-----------|-------------------------------------|----------|
|                  |           | Picual | Manzanillo | Coratina |          |
| 100ppm IBA       | 62.33 g   | 37.67 l | 83.33 c     | 61.11 D  |
| 200ppm IBA       | 52.00 i   | 31.00 m | 87.67 b     | 56.89 E  |
| 300ppm IBA       | 72.67 f   | 32.33 m | 57.00 h     | 54.00 F  |
| 100ppm Antioxidant| 61.33 g   | 23.00 m | 47.67 j     | 44.00 G  |
| 200ppm Antioxidant| 74.67 ef  | 44.67 k | 82.33 c     | 67.22 B  |
| 300ppm Antioxidant| 76.00 de | 52.67 i | 94.67 a     | 74.44 A  |
| Control          | 61.33 g   | 53.00 i | 78.33 d     | 64.22 C  |
| Mean             | 65.76 B   | 39.19 C | 75.86 A     |          |

Means followed by a different letters in the same column are significantly different at 0.05 level

**Root length**

Table 3 showed the effect of supplementary application of IBA and antioxidant on root length of olive cuttings during cool season. It was cleared that ‘Coratina’ and ‘Picual’ cultivar recorded the significant highest root length compared to ‘Manzanillo’ cultivars. For the effect of supplemental application of IBA and antioxidant, it was cleared that, 300ppm antioxidant gave the significant highest root length compared to the other treatments. For the interaction effect, antioxidant at 300ppm gave the significant highest value with ‘Coratina’ and ‘Manzanillo’ olive cultivars while 300ppm IBA gave the best results for ‘Picual’ cultivar. While, the lowest ones was recorded by ‘Coratina’ cultivar under 300ppm IBA.

**Leaves number**

Table 4 showed the effect of supplementary application of IBA and antioxidant on leaves number of olive cuttings during cool season. It was cleared that, ‘Manzanillo’ olive cultivar recorded the significant highest leaf number compared to ‘Coratina’ cultivar in both seasons. For the effect of supplemental application of IBA and oxidant, it was cleared that, 300 and 200ppm antioxidant
### TABLE 2. Effect of supplementary application of IBA and antioxidant on root number of three olive cultivars during cool season

| Treatments       | Cultivars          | Mean     |
|------------------|--------------------|----------|
|                  | First season 2018 / 2019 |          |
|                  | Picual             | Manzanillo | Coratina |
| 100ppm IBA       | 4.367 jk           | 6.200 efgh | 15.50 a   | 8.689 B |
| 200ppm IBA       | 5.433 ghij         | 6.900 de  | 6.833 de  | 6.389 D |
| 300ppm IBA       | 6.333 efg          | 4.467 jk  | 3.467 k   | 4.756 E |
| 100ppm Antioxidant| 4.833 ij           | 5.067 hij  | 4.833 ij  | 4.911 E |
| 200ppm Antioxidant| 8.667 c            | 7.833 cd  | 6.667 def | 7.722 C |
| 300ppm Antioxidant| 12.33 b             | 9.000 c   | 12.33 b   | 11.22 A |
| Control          | 5.533 fghi         | 6.000 efghi | 4.667 jk  | 5.400 E |
| Mean             | 6.786 B            | 6.495 B   | 7.757 A   |

| Treatments       | Mean     |
|------------------|----------|
| Second season 2019 / 2020 |          |
| 100ppm IBA       | 4.100 k  | 6.200 fgh | 16.80 a   | 9.033 B |
| 200ppm IBA       | 4.933 ijk| 6.833 def | 7.467 cde | 6.411 CD |
| 300ppm IBA       | 5.533 ghi| 4.600 jk  | 2.733 l   | 4.289 F |
| 100ppm Antioxidant| 5.267 ij | 7.267 cde | 2.867 l   | 5.133 E |
| 200ppm Antioxidant| 7.800 c  | 7.267 cde | 5.400 hij | 6.822 C |
| 300ppm Antioxidant| 11.03 b  | 7.667 cd  | 11.00 b   | 9.900 A |
| Control          | 6.667 ef | 5.000 ij  | 6.333 fg  | 6.000 D |
| Mean             | 6.476 B  | 6.405 B   | 7.514 A   |

Means followed by a different letters in the same column are significantly different at 0.05 level

### TABLE 3. Effect of supplementary application of IBA and antioxidant on root length of three olive cultivars during cool season

| Treatments       | Cultivars          | Mean     |
|------------------|--------------------|----------|
|                  | First season 2018 / 2019 |          |
|                  | Picual             | Manzanillo | Coratina |
| 100ppm IBA       | 7.100 def          | 6.333 fghi | 7.500 cde | 6.978 B |
| 200ppm IBA       | 6.000 ghij         | 5.233 j   | 7.000 defg | 6.078 C |
| 300ppm IBA       | 8.833 ab           | 5.833 hij | 5.500 ij  | 6.722 B |
| 100ppm Antioxidant| 6.667 efgh         | 5.100 j   | 6.500 efghi | 6.089 C |
| 200ppm Antioxidant| 6.967 defg         | 5.467 ij  | 7.833 bcd | 6.756 B |
| 300ppm Antioxidant| 8.167 bc           | 7.933 bcd | 9.500 a   | 8.533 A |
| Control          | 7.167 cdef         | 6.333 fghi | 6.667 efgh | 6.722 B |
| Mean             | 7.271 A            | 6.033 B   | 7.214 A   |

| Treatments       | Mean     |
|------------------|----------|
| Second season 2019 / 2020 |          |
| 100ppm IBA       | 6.867 bc  | 5.733 de  | 7.467 b   | 6.689 BC |
| 200ppm IBA       | 6.200 cd  | 5.600 de  | 7.633 b   | 6.478 BC |
| 300ppm IBA       | 8.833 a   | 5.100 de  | 4.933 e   | 6.289 C |
| 100ppm Antioxidant| 7.067 bc  | 5.467 de  | 7.100 bc  | 6.544 BC |
| 200ppm Antioxidant| 6.933 bc  | 6.200 cd  | 7.667 b   | 6.933 B |
| 300ppm Antioxidant| 7.500 b   | 7.667 b   | 9.333 a   | 8.167 A |
| Control          | 5.500 de  | 5.333 de  | 5.333 de  | 5.389 D |
| Mean             | 6.986 A  | 5.871 B   | 7.067 A   |

Means followed by a different letters in the same column are significantly different at 0.05 level

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beside 100ppm IBA gave significant highest leaves number, while the significant lowest roots number recorded by IBA at 300ppm and antioxidant at 100ppm. For the interaction effect, antioxidant at 300ppm gave the highest value with ‘Coratina’ and ‘Manzanillo’ olive cultivars, while 300ppm IBA gave the best results for ‘Picual’ cultivar, while the lowest ones was recorded by ‘Coratina’ cultivar under 100ppm antioxidant.

**Discussion**

The results indicated that, for the effect of cultivars, it is clear that under cool season ‘Coratina’ olive cultivar gave the highest rooting parameters, while ‘Manzanillo’ cultivar recorded the lowest values. In this regard Wiesman and Lavee, (1995a&b) found that, ‘Manzanillo’ and ‘Picual’ considered moderate to rooting cultivars. Concerning the effect of treatments, the results cleared that, antioxidant (Ascorbic and citric acid) have a great effect on rooting percent, root number, root length and leaves number of olive cuttings under this study, which improved rooting parameters under high concentration (300ppm) and decreased it under low concentration (100ppm). These results was agreement with Struve and Lagrimini, (1999) as they mentioned that ascorbic acid improved rooting of Stewartia pseudocamellia. Also, El-Sharony et al. (2018) as they observed an increase in guava cutting success which treated with mixture of 5% citric acid + 5% ascorbic acid compared to cuttings treated with 3000ppm IBA alone. This results may be due to that, ascorbic acid acts within the meristems as a necessary factor for cell division (Gallie, 2013, Lisko et al., 2014 and Ellya Kka, 2017) and cell elongation (Paciolla et al., 2019). Moreover, ascorbate stimulate dividing of quiescent cells similar to auxin activity which known as a rooting hormone in suitable concentration (Kaviani, 2014). Furthermore, Ascorbic acid possess some physiological activity related to rooting such as increasing mitotic index of root quiescent center and apical meristem, increasing cellular dimensions in cell elongation zone, increasing root mitotic divisions, increasing secondary roots production through pericycle cells stimulation and divisions (Kaviani, 2014). Potters et al. (2002) observed that ascorbic acid included in regulate passing cell through cell cycle. In addition, citric acid consider chelating agent, polyphenol oxides inhibitor, Cu-chelating agent (Jiang et al., 1999, Moline et al., 1999 and Rojas-Grau et al., 2008). More recently, Radhi and Hussein (2020) found

**TABLE 4. Effect of supplementary application of IBA and antioxidant on leaf number of three olive cultivars during cool season**

| Treatments       | Cultivars               | First season 2018 / 2019 | Mean  |
|------------------|-------------------------|--------------------------|-------|
|                  | Picual                  | Manzanillo               | Coratina |
| 100ppm IBA       | 8.333 hij               | 11.50 b                  | 13.17 a | 11.00 A       |
| 200ppm IBA       | 7.833 ij                | 10.83 bcd                | 10.83 bcd | 9.833 B      |
| 300ppm IBA       | 9.833 ef                | 5.833 k                  | 2.500 l | 6.056 D       |
| 100ppm Antioxidant | 7.500 j                | 13.27 a                  | 1.967 l | 7.578 C       |
| 200ppm Antioxidant | 12.83 a                | 9.500 efg                | 10.17 cde | 10.83 A      |
| 300ppm Antioxidant | 11.50 b                | 9.167 fgh                | 12.50 a | 11.06 A       |
| Control          | 11.00 bc                | 10.00 def                | 8.667 ghi | 9.889 B      |
| Mean             | 9.833 A                | 10.01 A                  | 8.543 B       |
|                  | Second season 2019 / 2020 |                          |       |
| 100ppm IBA       | 8.667 d                | 11.40 bc                 | 12.67 a | 10.91 A       |
| 200ppm IBA       | 6.867 e                | 10.60 c                  | 11.20 c | 9.556 B       |
| 300ppm IBA       | 11.20 c                | 5.533 f                  | 2.200 g | 6.311 E       |
| 100ppm Antioxidant | 6.600 e                | 12.53 a                  | 1.933 g | 7.022 D       |
| 200ppm Antioxidant | 12.40 a                | 9.333 d                  | 9.400 d | 10.38 A       |
| 300ppm Antioxidant | 11.33 c                | 8.633 d                  | 12.33 ab | 10.77 A      |
| Control          | 6.000 ef                | 6.667 e                  | 11.00 c | 7.889 C       |
| Mean             | 9.010 AB                | 9.243 A                  | 8.676 B       |

Means followed by a different letters in the same column are significantly different at 0.05 level

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that Ascorbic acid the electronic conjugation system and inducing rooting response by inhibiting IAA- oxidase or GH3 enzyme activity which increase IAA level. With respect to IBA treatments, the results cleared that, increasing IBA concentration decreased rooting parameters and leaves number of the studied olive cultivars. With regard to the effect of concentration of IBA, raising IBA concentration from 3000ppm to 5000ppm decreased significantly cutting rooting percent from 60% to 20% beside decreasing root length and number of Coratina olive cuttings (Kurd et al., 2010). The previous results were agreement with cornu (1973) who found that IBA had a broad ranges of root-estimulating activity, since 24.6 mM IBA was the best treatment compared to 98.6 mM IBA in Pseudotsuga menziesii. Also, little and too much auxin (IBA and NAA) decreased rooting (cornu, 1973). Moreover, the highest callus formation and rooting percent of black mulberry cuttings was in 3000 ppm dose application (68%) and the lowest one was in 4000 ppm dose application (17%) compared to the control (Kalyoncu et al., 2009). Furthermore, 500 ppm IBA treatment gave best results compare to 1000ppm in Tamarix aphylla L. cuttings (AI Makhmari, 2016). Similarly, Owais (2010) found that 9000ppm IBA gave the highest rooting percent and root length compared to 12000ppm IBA in pomegranate cuttings. More recently, Muller et al. (2005) found that the application of 0.1 and 1 mM IBA increased rooting percent, but rooting completely inhibited under rate of 100 mM IBA.

For the time of IBA treatment, treated olive cuttings from 17.00pm till 07.00am permitted 14 h three time (total 42 intermittent hour) were similar to long soaked period. These results were similar to Inocent et al. (2018) as they found that increasing soaked time from 1h to 8h gradually decreased rooting percent of ‘arbosana’ from 66.7 to 14.6% and ‘frantoio’ olive cultivar from 33.3 to 10.4%.

**Conclusion**

During cool winter ‘Coratina’ olive cultivar followed by ‘Picual’ is more suitable for cuttings propagation than ‘Manzanillo’ cultivar. Also, 300ppm antioxidant is more effective than IBA as supplementary treatments for increasing rooting percent of olive cuttings during cold season.

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**Conflict of interest**

The authors declare no conflict of interest or personal relationships that could have appeared to affect the work reported in current study.

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AN INTRODUCING TO EARTHQUAKE HAZARD ASSESSMENT METHOD FOR URBAN AREAS USING GIS TECHNIQUE

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The use of remote sensing and geographic information systems (GIS) in the assessment of earthquake hazards is widely recognized for its potential to provide comprehensive and comprehensive information on the spatial distribution and intensity of earthquakes. This study aims to develop a method for assessing earthquake hazards in urban areas using GIS techniques.

The study area includes the city of Cairo, which is one of the most densely populated cities in the world. The method involves the collection and analysis of various data sources, including satellite images, geologic maps, and geotechnical data, to identify potential earthquake hazards.

The results of the study indicate that certain areas within the city of Cairo are at higher risk of earthquake hazards due to the presence of specific geological and geotechnical conditions. The study also highlights the need for further research and development of more advanced GIS techniques to improve the accuracy and reliability of earthquake hazard assessments.

The findings of this study contribute to the ongoing efforts to enhance the safety and resilience of urban areas in the face of increasing earthquake hazards. The developed method can be applied to other urban areas to improve their earthquake preparedness and response capabilities.