Effect of current severity and shock timing of cuttings on rooting of hard wood cuttings for two Olive (Olea europea) cultivars

By

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The Different Effects of the Dynamic Population on Agricultural Productivity as a Comparison among Less and More Developed Countries

Abstract:

The study was conducted in the plastic house of Horticulture Department – College of Agricultural engineering sciences. Duhok University - Iraq during spring season of 2020 to investigate the effect of electric current severity and shock timing of cuttings on the vegetative and rooting characters of two olive (Olea europea) cultivars. Three levels of electric current severity AC 2, 4, 8, Ampere and three timing of electric shock 1, 2, 4 minutes were tested on cuttings of two olive cultivars (Dogel and Basheqi). A special electric apparatus was designed for this purpose. The cuttings were soaked before treatment for 3hrs in a 1% NaCl solution, and then soaked in fresh water for the same period 3hrs before planting. The experiment was applied using randomized complete block design (RCBD) of three replications and the means comprised by Duncan's Multiple Ranges Test under 5%. Cuttings of Basheqi cv. which were exposed to medium current for a high period (T16) 4 A × 4 mins significantly increased rooting percentage 73.33%, roots number per cutting 36.25, fresh weight of roots 1.77 g, dry weight of roots 0.66 g, shoots number per cutting 4.25, leaves number 46.00, fresh weight of vegetative growth was 2.44 g and dry weight of vegetative growth was 1.15 g. While high current treatment (T8) 8 A × 2 mins of Dogel cultivar caused the superiority in obtaining the longest roots 17.17 cm and largest leaf area 3.77 cm².

Keywords: electric current, shock timing, olive cultivars
استعملت ثلاثة مستويات من شدة تيار مختلفة وهي (2, 4 و 8 أمبير) ولعدة زمنية مختلفة (1 و 2 و 4 دقائق) فضلا عن معاملة عدم (Basheqi و Dogel) الصعق (معاقمة المقارنة) على عقل صفوفين من الزيتون باستخدام جهاز خاص صمّم لهذا الغرض. عوّملت العقل بعد نقعها بمحلول ملح الطعام % 1 لمدة ثلاث ساعات، وزرعت بعد غسلها بالماء العادي لمدة ثلاث ساعات أيضا قبل الزراعة. استخدم تصميم القطاعات العشوائية الكاملة RCBD وبثلاث مكررات وقورنت الفروق المختلفة باعتبار ذلك مدخلا لعدة الدرجات تحت مستوى احتمال 0.05 لبيان الفروق الإحصائية بين المعاملات. أدى تعريض عقل (T16) لشدة تيار متوسطة ولعدة زمنية طويلة (4 أمبير × 4 دقيقة) إثارة زيادة معنوية في نسبة التجذير 73.33, عدد الجذور لكل عقلة 36.25, الوزن الرطب والجاف للجذور 1.77 و 0.66 غم على التوالي، عدد النوات الخضرية لكل عقلة 4 عدد الأوراق 44, الوزن الرطب والجاف للمجموع الخضري 2.44 و 1.15 غم على التوالي. بينما ادى المعاملة (T8) 8 أمبير × 2 دقائق إثارة زيادة معنوية في طول اطول الجذور 17.17 سم والمساحة الورقية 3.77 سم².

الكلمات المفتاحية: التيار الكهربائي, مدة الصعق, عقل, اصناف الزيتون

Introduction

Olive belongs to the botanical order, Ligustrales, family (Oleaceae), this family includes (30) genus including (Olea) which has (600) species. Olive is botanically called (Olea europaea L.). Commercial olives belong to the (Europaea) species, this species has two subspecies: oleaster and sativa (Bartolucci and Dhakal, 1999). europaea is one of about 20 species of Olea found in subtropical regions of the world. Only Olea europaea L. produces edible fruit. The Mediterranean region is native habitat (Sibbett et al., 2005).

Olive (Olea europaea L.) has been propagated mainly by cuttings, Stem cuttings are the important means of vegetative propagation in horticultural industry for mass production within a short time, but great differences in the rooting potential of cultivars and clones within a species were shown in many cultivars of olive (Dauod et al. 1989, Fernandes Serrano et al.
The biggest problem in vegetative propagation, in some olive cultivars, is the low ability of regeneration leading to low percentage of rooting (Rugini et al. 1990).

Increasing the rooting percentage of cuttings of many plant species that are difficult to root is important in plant propagation. Treatments are often applied on cuttings to increase the rooting percentage, including plant growth regulators, especially auxins, carbohydrates, other chemical substances, and plant-growth promoting rhizobacteria (Hartmann et al. 2002, Smart et al. 2002, Köse et al. 2003). The electric field was used in various applications of plant sciences and found that it can stimulate the growth of the plant and increase its production and improve its quality by exposing different parts of plants. The experimental study of the effect of electricity on plant growth began when Myrtus communis plants were subjected to a current output from stable electrical, which improved plant growth. Recent studies have reported on the effects of electric current on various physiological and biochemical responses of different plant species (Nakanishi et al. 1998, Kathiresan and Rajendran, 2000, Mishra et al. 2001, Filek et al. 2002). Studies have demonstrated that electric current had an effect on root elongation and root number of Rhizophora mucronata seedlings (Kathiresan and Rajendran, 2000), External electric current application can also influence polarization of dipoles in living cells (Moon and Chung, 2000). Shocking treatments of wheat and barley crops and obtained positive results (Al-Sahuki and Al- Sabahi, 2001a). The possibility of using electric current as an alternative method to traditional methods used in increasing the permeability of hard coats such as treatment with acids, hot water and dry hot water as they found a high increase in alfalfa seed germination when treated with electric current (Nelson et al., 1977). However, the mechanism of these actions...
is not yet well understood, and the feasibility of using electric current to control biological events occurring in plants is unclear. The effect of electric current on the rooting ability of plant cuttings has not been well documented, and there have been no studies on the effect of electric current on rooting of olive cuttings.

Therefore, the objective of this experiment was to stimulate vegetative growth and improve rooting by exposing cuttings of two olive cultivars to electric shock with different current severity for different periods of time.

**Materials and Methods**

An experiment on “electric current severity and shock timing of cuttings on rooting percent and vegetative growth characters of two olive cultivars” was conducted at the plastic house, Department of forestry, College of Agricultural Engineering Sciences, Duhok University, Duhok-Iraq, during spring season of 2020. The cuttings of two olive cultivars includes (Dogel and Basheqi) divided each cultivar in to 10 groups (20 groups for both cultivars), each group of them contain 30 cuttings with 3 replications, (10 cuttings for each replicate), All ten cuttings were bounded into a bundle and soaked in sodium chloride solution 1% for 3 hours to allow the solution to penetrate into the cutting tissue to increase the electrical conduction that was later imposed, then the cuttings transferred except cuttings of control treatment to a 10 liter glass basin through a device manufactured for this purpose consists of two poles of carbon connected to two wires connected to the electrical current into the basin to increase the contact area between the solution and carbon poles (Al-Sahoki, 1992). A clamber meter is used to measure voltages and amperes passing through the saline solution and to maintain the temperature of the
The Different Effects of saline solution by adding the ice cubes continuously during the shocking process (Fig. 1).

Figure (1). Electric shocking approaches

Table (1). Show treatments symbols used in the experiment.

| Treatment | Gladiolus cultivars | Electric current severity (Ampere) | Shock timing (minute) |
|-----------|---------------------|-----------------------------------|----------------------|
| T 0       | Dogel               | 0                                 | 0                    |
| T 1       | Dogel               | 2                                 | 1                    |
| T 2       | Dogel               | 2                                 | 2                    |
| T 3       | Dogel               | 2                                 | 4                    |
| T 4       | Dogel               | 4                                 | 1                    |
| T 5       | Dogel               | 4                                 | 2                    |
| T 6       | Dogel               | 4                                 | 4                    |
| T 7       | Dogel               | 8                                 | 1                    |
| T 8       | Dogel               | 8                                 | 2                    |
| T 9       | Dogel               | 8                                 | 4                    |
| T 10      | Basheqi             | 0                                 | 0                    |
| T 11      | Basheqi             | 2                                 | 1                    |
| T 12      | Basheqi             | 2                                 | 2                    |
| T 13      | Basheqi             | 2                                 | 4                    |
| T 14      | Basheqi             | 4                                 | 1                    |
| T 15      | Basheqi             | 4                                 | 2                    |
| T 16      | Basheqi             | 4                                 | 4                    |
| T 17      | Basheqi             | 8                                 | 1                    |
| T 18      | Basheqi             | 8                                 | 2                    |
| T 19      | Basheqi             | 8                                 | 4                    |
Cuttings were planted in pots with 25 cm diameter (10 cuttings/pot) filled with loam medium which was treated with fungicides, insecticides and nematodes before planting as recommended.

The studied measurements included:

A- Rooting characters
1- Rooting percentage (%).
2- Number of roots/cutting.
3- Length of longest roots (cm).
4- Fresh weight of roots (g).
5- Dry weight of roots (g).

B- Vegetative growth characters
1- Number of shoots/cutting.
2- Number of leaves/cutting.
3- Leaf area (cm²).
4- Fresh weight of vegetative growth (g).
5- Dry weight of vegetative growth (g).

The experiment was applied using randomized complete block design (RCBD) of three replications each replicate includes one pot cultured with 10 cuttings (30 cuttings for each experimental unit). The data has been analyzed by using the computer through the SAS program, and means comparison was done by Duncan's Multiple Ranges Test under 5% (SAS, 2009).

Results and Discussion

A- Rooting characters

The results showed that all tested parameters were significantly affected by both direct electric currents and durations of the treatment. The results in Table (2) showed significant differences in rooting percentage of olive cuttings when treated their cuttings with electric shock. T16 treatment for Basheqi cultivar was characterized by the high percent of rooting (73.33%) and had a significant difference in contrast to control
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treatment T0 for Dogel cultivars and control treatment T10 of Basheqi cultivar (40.00%).

Table (2) also showed significant differences in roots number per cutting, where T16 treatment of Basheqi cultivar was characterized by the highest number of roots (36.25 roots) which differ significantly compared with other treatment, while the lowest number of roots was (18.17 roots) for T10 treatment.

The treatment of olive cuttings by electric shock caused the superiority of T8 treatment for Dogel cultivar in obtaining the longest roots (17.17 cm), while T15 of Basheqi cultivar gave the shortest roots length (10.10 cm).

Exposure of cuttings to electrical current resulted in a significant increase in fresh weight of roots. Also T16 for Basheqi cultivar as in state of roots number gave the highest fresh weight of roots (1.77 g) compared to control treatments T0 for Dogel cultivar (1.26 g) and T10 of Basheqi cultivar which gave the lowest number of roots (1.18 g).

Also T16 for Basheqi cultivar was given the significant highest dry weight of roots (0.66 g) as compared with other treatments, where control treatments T0 for Dogel cultivar gives lowest dry weight of roots (0.36 g).

Table (2). Effect of electric current severity and shock timing of cuttings on the rooting characteristics of two olive (Olea europea) cultivars.

| Treatments | Rooting percentage (%) | Number of roots | Length of longest root (cm) | Roots fresh weight (g) | Roots dry weight (g) |
|------------|------------------------|----------------|-----------------------------|------------------------|----------------------|
| T0         | 40.00 b                | 24.78 b-d      | 11.10 d-e                   | 1.26 c-e               | 0.36 c               |
| T1         | 56.67 ab               | 25.33 b-d      | 13.31 b-f                   | 1.34 b-e               | 0.43 bc              |
| T2         | 43.33 b                | 28.00 b-d      | 12.38 b-f                   | 1.29 b-e               | 0.43 bc              |
| T3         | 43.33 b                | 23.67 b-e      | 14.32 a-e                   | 1.33 b-e               | 0.42 bc              |
| T4         | 63.33 ab               | 24.00 b-e      | 15.27 a-c                   | 1.36 b-e               | 0.46 a-c             |
| T5         | 43.33 b                | 26.17 b-d      | 13.25 b-f                   | 1.42 a-e               | 0.52 a-c             |
### Table

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| T6 | 56.67 ab | 22.83 b-e | 11.82 c-f | 1.23 ed | 0.42 bc |
| T7 | 60.00 ab | 21.44 ed | 12.00 b-f | 1.53 a-e | 0.47 a-c |
| T8 | 60.00 ab | 24.33 b-e | 17.17 a | 1.42 a-e | 0.47 a-c |
| T9 | 56.67 ab | 24.67 b-d | 12.87 b-f | 1.37 b-e | 0.38 bc |
| T10 | 40.00 b | 18.17 e | 12.12 b-f | 1.18 e | 0.35 bc |
| T11 | 56.67 ab | 26.78 b-d | 10.59 ef | 1.62 ab | 0.57 ab |
| T12 | 40.00 b | 23.33 b-e | 15.73 ab | 1.44 a-e | 0.47 a-c |
| T13 | 43.33 b | 29.17 b | 13.17 b-f | 1.52 a-e | 0.47 a-c |
| T14 | 36.67 b | 24.33 b-e | 12.65 b-f | 1.31 b-e | 0.40 bc |
| T15 | 53.33 ab | 21.67 c-e | 10.10 f | 1.60 a-c | 0.44 bc |
| T16 | 73.33 a | 36.25 a | 14.47 a-d | 1.77 a | 0.66 a |
| T17 | 56.67 ab | 24.11 b-e | 14.19 a-e | 1.58 a-d | 0.57 ab |
| T18 | 56.67 ab | 28.22 bc | 13.24 b-f | 1.40 b-e | 0.46 a-c |
| T19 | 43.33 b | 25.00 b-d | 11.75 c-f | 1.42 b-e | 0.43 bc |

Reason of significant differences among different treatments might be due to the differences between two olive cultivars in the genetic potentials (Tahir et al. 2011). Or this is explained by the fact that the electric current works to increase the permeability of cell membranes and helps in the speed of the transformation of food savings to a state that is easy to use by the cuttings and works to activate the carbon representation and increase the growth of roots (Waleed, 1993). And it may be effect of current electricity similar to ionizers is on auxins that produced in apical meristematic tissues (buds and small leaves) that alter the auxin balance in the plant. High doses increase the activity of the IAA-oxidase enzyme and reduce the content of auxin, which inhibits growth, while medium and low doses stimulate growth (Sherbash, 1996). Electric currents generally increased all parameters compared with the control, which can be explained by effects of direct current on plant metabolism such as hormonal and enzyme activities and on movements of endogenous solutes, particularly carbohydrates, plant-growth regulators, and enzymes. Recent research attests to the
complexity of adventitious root development, and factors include endogenous plant-growth regulators, carbohydrate storage, transport, and the presence and absence of dormant buds or emerged shoots (Smart et al. 2002). There is some evidence for electrical activity in plants as a mechanism for signal propagation and for regulation of various physiological and biochemical responses (Mishra et al. 2001). Nakanishi et al. (1998) found that electro stimulation of cells induced change in DNA synthesis, protein synthesis, membrane permeability, and cell growth, although the mechanism by which such changes occur is not yet well understood. Plants show an electrical polarity and negatively charged ions of indole-3-acetic acid, which stimulate adventitious root formation, move toward the positively charged base; that is, there is a parallel variation between the rate and polarity of basipetal movement of an electric wave and the rate and polarity of indole-3-acetic acid movement (Jacobs, 1979). There is also a relationship between ion accumulation and electric current loops in multicellular systems (Toko et al. 1989). It is not clear how applied current influences the physiological processes of plant tissues, but artificial direct current introduced to such tissues would probably reinforce or supplement transcellular natural currents (Rathore and Goldsworthy, 1985).

B- Vegetative growth characters

The number of shoots which formed on olive cuttings Table (3) was affected when treated their cuttings to electric shock, the significant largest number (4.25 shoots. cutting⁻¹) was for T16 treatment for Basheqi cultivar while the least number of shoots were in cuttings of T15 treatment of Dogel cultivar (2.53 shoots. cutting⁻¹).

The same Table referred that the number of leaves of olive cuttings also were affected significantly when treated their cuttings to electric shock, the significant largest number of
leaves (46.00 leaves /cutting) was for cuttings of T16 treatment for Basheqi cultivar, while the least number of leaves was on cuttings of T7 treatment of Dogel cultivar (15.67 leaves /cutting).

The leaf area of leaves were formed on olive cuttings also was affected; the significant largest leaf area (3.77 cm²) was when exposed to T8 treatment for Dogel cultivar, where the least leaf area (2.25 cm²) was in T2 for the same cultivar.

The highest fresh weight of vegetative growth was (2.44 g) for T16 of Basheqi cultivar which was significantly superior to most treatments, while the lowest dry weight for vegetative growth was for T10 of Dogel cultivars (1.46 g).

It is noted that the significant highest dry weight of vegetative growth was (1.15 g) for T16 of Basheqi cultivar which was significantly superior to most treatments, while the lowest dry weight for vegetative growth was for T10 of Dogel cultivars (0.52 g).

**Table (3).** Effect of electric current severity and shock timing of cuttings on the vegetative growth characteristics of two olive (*Olea europea*) cultivars.

| Treatments | Number of shoots/cutting | Number of leaves/cutting | Leaf area (cm²) | Fresh weight of vegetative growth (g) | dry weight of vegetative growth (g) |
|------------|--------------------------|--------------------------|-----------------|--------------------------------------|-------------------------------------|
| T0         | 2.75 b                   | 21.00 d-h                | 3.25 a-d        | 1.99 a-d                             | 0.70 b-f                            |
| T1         | 3.63 ab                  | 22.73 d-g                | 3.61 ab         | 1.80 b-d                             | 0.91 a-c                            |
| T2         | 3.25 ab                  | 23.25 d-f                | 2.25 d          | 1.58 b-d                             | 0.61 c-f                            |
| T3         | 3.50 ab                  | 20.00 d-h                | 3.13 a-d        | 2.02 a-d                             | 0.89 a-d                            |
| T4         | 3.00 b                   | 17.73 f-h                | 3.26 a-d        | 1.77 b-d                             | 0.74 b-f                            |
| T5         | 2.67 b                   | 21.00 d-h                | 2.85 a-d        | 2.10 a-c                             | 0.93 ab                             |
| T6         | 2.83 b                   | 18.00 f-h                | 2.53 b-d        | 1.50 cd                              | 0.55 ef                             |
| T7         | 2.90 b                   | 15.67 h                  | 3.36 a-d        | 1.61 b-d                             | 0.62 c-f                            |
| T8         | 3.40 ab                  | 21.57 d-h                | 3.77 a          | 1.91 a-d                             | 0.80 b-f                            |
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|   |   |   |   |   |
|---|---|---|---|---|
| T9 | 2.85 b | 17.00 gh | 3.17 a-d | 1.66 b-d | 0.59 d-f |
| T10 | 2.80 b | 23.43 d-f | 3.11 a-d | 1.46 d | 0.52 f |
| T11 | 2.67 b | 19.67 e-h | 2.49 cd | 1.49 d | 0.55 ef |
| T12 | 2.67 b | 26.00 cd | 3.15 a-d | 1.89 a-d | 0.73 b-f |
| T13 | 3.00 b | 23.23 d-f | 2.80 a-d | 1.80 b-d | 0.64 b-f |
| T14 | 2.67 b | 22.83 d-g | 2.43 cd | 1.53 b-d | 0.56 ef |
| T15 | 2.53 b | 24.47 de | 2.49 cd | 1.71 b-d | 0.57 ef |
| T16 | 4.25 a | 46.00 a | 3.06 a-d | 2.44 a | 1.15 a |
| T17 | 3.50 ab | 35.00 b | 3.08 a-d | 2.12 ab | 0.84 b-e |
| T18 | 3.43 ab | 30.23 bc | 3.52 a-c | 1.75 b-d | 0.67 b-f |
| T19 | 3.00 b | 30.10 bc | 2.61 b-d | 1.83 b-d | 0.71 b-f |

The reason of significant differences among different treatments might be due to the difference between two olive cultivars in the genetic potentials (Tahir et al., 2011).

It was found that the electricity treatments led to an increase all parameters of vegetative growth includes shoots number per cutting, leaves number, fresh and dry weight of vegetative growth when cutting subjected to medium doses of current electric for long period except leaf area which increased at high current treatment (Table 3). This may be due to the increase in the improvement of rooting characters of olive cuttings when subject this dose of current electric. Kathiresan and Rajendran (2000) reported that electric impulse generally improved growth characteristics of shoot and root of Rhizophora mucronata seedlings. And this may be due to the osmotic effort mechanism to transfer water and increase the absorption of mineral elements or as a result of a change in the activity of auxins and gibberellins in the plant (Frensom, 1965). Thus, electric shock contributes to increased vegetative growth and large their volume is reflected in the increase of carbon representation and the increase in amount of synthesis materials and thus increases the accumulation of dry matter. The results of correlation coefficient (Table 4) showed that there is a...
significant correlation with positive direction between the rooting percentage and number of shoots per cutting \( (r=0.373**) \), also between rooting percentage and leaf area \( (r=0.357**) \). Also demonstrated from same table that there are high significant correlation among number of roots and fresh and dry weight of roots \( (r=0.383** \) and \( r=0.493** \) respectively and on the other hand among number of roots with number of shoots \( (r=0.385**) \), number of leaves \( (r=0.540** \), fresh and dry weight of vegetative growth \( (r=0.498** \) and \( r=0.539** \) respectively.

**Conclusions**

The experimental results lead us to the conclusion that cuttings of Basheqi cv. which were exposed to medium current for a high period \( (T16) \) 4 A × 4 mins significantly increased rooting percentage, roots number per cutting, fresh and dry weight of roots, shoots number per cutting, leaves number, fresh and dry weight of vegetative growth. While high current treatment \( (T8) \) 8 A × 2 mins of Dogel cultivar caused the superiority in obtaining the longest roots and largest leaf area.
### Table (4): Correlation relation among all studied characters

| Characters studied | Root percentage | Root fresh weight | Root dry weight | number of roots / cutting | Length of longest root | number of shoot / cutting | number of leaves / cutting | Fresh weight of vegetative growth | Dry weight of vegetative growth |
|--------------------|-----------------|-------------------|-----------------|---------------------------|------------------------|--------------------------|-----------------------------|----------------------------------|---------------------------------|
| Root fresh weight  | 0.12777         |                   |                 |                           |                        |                          |                             |                                  |                                 |
| Root dry weight    | 0.09318         | 0.78279 **        |                 |                           |                        |                          |                             |                                  |                                 |
| number of roots / cutting | 0.08464 | 0.38308 **        | 0.49313 **      |                           |                        |                          |                             |                                  |                                 |
| Length of longest root | 0.24212 | 0.13789           | 0.32269 *       | 0.24460                   |                        |                          |                             |                                  |                                 |
| number of shoot / cutting | 0.7749 **     | 0.08140           | 0.28244 *       | 0.38455 **                | 0.39257 **            |                          |                             |                                  |                                 |
| number of leaves / cutting | 0.16551 **     | 0.31070 *         | 0.42720 **       | 0.54044 **                | 0.17239               | 0.51088 **             |                             |                                  |                                 |
| Fresh weight of vegetative growth | 0.36462 ** | 0.36503 **        | 0.49838 **      | 0.47285 **                | 0.49315 **            | 0.56863 **          |                             |                                  |                                 |
| Dry weight of vegetative growth | 0.27240 ** | 0.52223 **        | 0.53900 **      | 0.51620 **                | 0.57637 **            | 0.53783 **           | 0.92226 **                  |                                  |                                 |
| Leaf area          | 0.06007         | 0.12375           | 0.11410         | 0.42838 **                | 0.36887 **            | 0.09477               | 0.36748 **                  | 0.40314 **                      |                                 |
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