

Effect of direct current electric field on the root growth of oil palm seedlings

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ABSTRACT

The acceleration of the growth in the rate of oil palm seed roots is a non-chemical solution in nursery needs. Utilizing the electricity sector as an increase in germination productivity. In this case, this study examines variations in the electric field direct current 50, 100, 200, 400, 800, and 1000 V/m and the exposure of time 15, 30, 45, and 60 minutes. The results showed exposure to an electric field direct current in voltage of 100 V/m increased germination at each exposure time by 17%, 21%, 20% and 26% with exposure times of 15, 30, 45, and 60 minutes to control. However, a maximum intensity of 1000 V/m inhibits the germination process for each time of 30, 45, and 60 minutes by 8%, 9%, and 12% in the control. Exposure to direct current in electric field intensity and exposure of time affect root metabolism in the germination process.

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1. INTRODUCTION

All living organisms, including humans, animals, and plants are exposed to atmospheric static electric fields. However, static sources also result from subway trains, direct current transmission lines, and cathode ray tubes. This exposure can affect the sources exposed such as metabolic activity, size, and physiology [1]. The biological effects of exposure to electromagnetic fields on plants have influenced the dormancy process, germination, flower pollen, plant weight, and plant movement patterns [2-4]. The relationship between changes in a pattern and changes in electricity in continuous plant growth will cause changes in electricity so that it can influence changes in plant electrical patterns [5-9].

The effect of electric fields on plant growth has been the subject of much research, especially those discussing plant physiology. Many studies have reviewed the use of DC electric fields to increase growth and germination as well as dormancy time [10-14]. High-voltage electric fields have significant effects on potato, cotton, and wheat cultivation [15-17]. In contrast, the negative effects of electricity and magnetic fields on ozel seed germination [18]. The effect of electric fields on rice growth and found that electric fields with intensities of 193 kV/m and 4 kV/m had a significant influence on the growth rate and height of rice plants [19]. Chlorophyll and carbohydrate contents of beans increased significantly at 6 kV/cm at 1, 3, and 5 days [20]. The electric field also increased the germination percentage in carrots, and radishes by 24 and 19% respectively [21].

An electric field of 2 kV/m on green beans and ciherang rice and a treatment time of 30-150 minutes showed an increase in the number of germinations of 70% for green beans and 17% for ciherang rice [10]. Several authors have shown that an electric field intensity of 25×10^3 V/m increases the growth of bean sprouts (greater shoot height and radicle elongation) [11]. The application of electric fields with various intensities of direct current (DC) in galvanostatic (50, 37.5, 25, and 12.5 mA) as well as on the growth of lettuce (*Lactuca sativa*) in hydroponic cultivation gave a response to an increase in leaf area of 65.3%. Current intensity 12.5 mA [12].

2. RESEARCH METHODS

Palm seeds that have emerged as the main root are chosen as the initial reference. Then, the seeds are placed in a plastic container containing nutrients with rock wool as a growing medium. The seeds are arranged in such a way in the cells so that the seeds only form a layer and do not accumulate. The orientation of seed root growth towards the direction of the applied electric field will be observed. Root size (length and diameter) will be measured using a caliper and micrometer screw. The application of the electric field will be varied according to the size of the electric field and the time of application. Variations in the electric field magnitude were carried out starting from 50, 100, 200, 400, 800, and 1000 V/m. Variations in application time start from 15, 30, 45, and 60 minutes for each variation in the amount of electric field applied. The electric field was applied during germination for 7 days. Arrangements of control seeds that are identical to the test seeds are placed in a separate place, and their growth and root size are monitored. The orientation of the seed arrangement will take into account the cardinal directions.

3. RESULTS AND DISCUSSIONS

Results of measuring root length growth of palm seeds during germination and germination presentation. Figure 1 (a) shows a graph of the growth of the average length of palm kernel roots as a function of days for exposure time. Varying electric field intensity generally increased root length growth for 15 minutes of exposure to an electric field of 100 V/m and 1000 V/m with an elongation of 1.7 cm and 1.52 cm for 7 days of treatment as well as a visible 17% germination presentation. in Figure 1 (b).

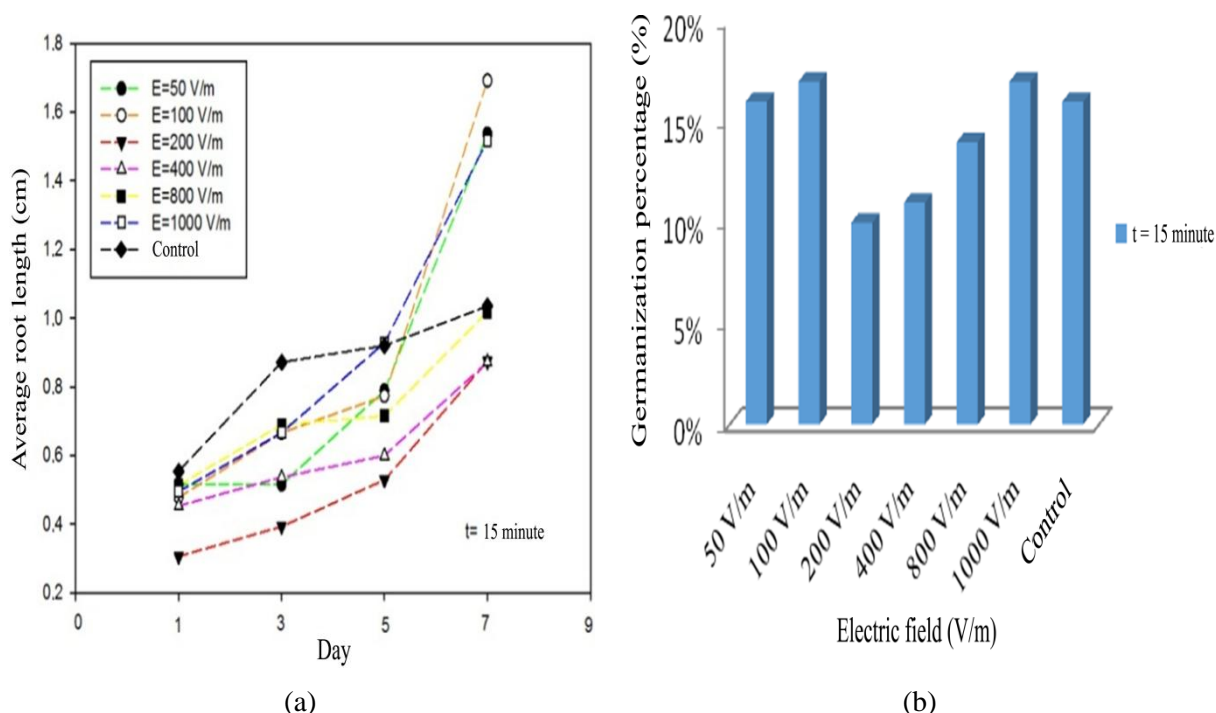


Figure 1. (a) Graph of the average root length of oil palm seed germination, a function of the electric field at 15 minutes of treatment time; (b) Graph of palm seed germination percentage, function of electric field at 15 minutes of treatment time

For an exposure time of 30 minutes shown in Figure 2 (a) with an increase in root length at an electric field intensity of 100 V/m of 1.74 cm with a germination presentation value of 21% and a slowing of growth at a field intensity of 1000 V/m of 0.7 cm with a germination presentation of 8% seen in Figure 2 (b).

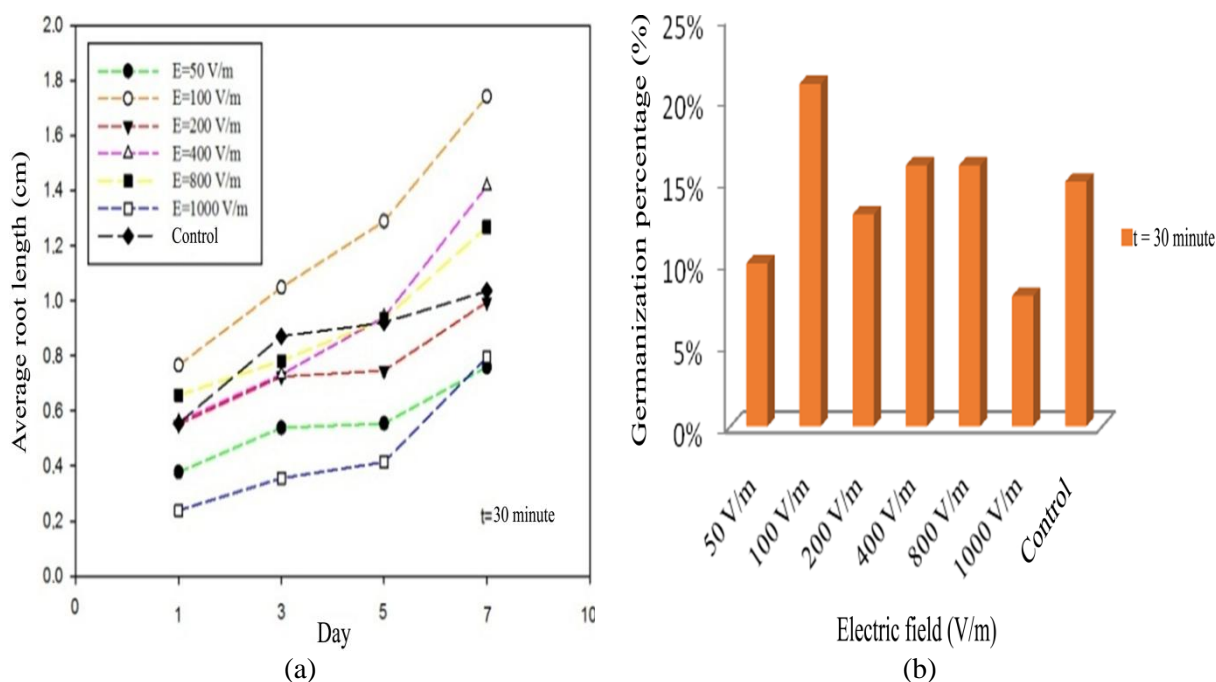


Figure 2. (a) Graph of the average root length of oil palm seed germination, a function of the electric field at 30 minutes of treatment time; (b) Graph of palm seed germination percentage, function of electric field at 30 minutes of treatment time

When the exposure time was increased to 45 minutes (Figure 3 (a)) good root length at an electric field of 100 V/m was 1.8 cm with a germination percentage of 20% (Figure 3 (b)) and root inhibition at an intensity of 1000 V/m of 8% (Figure 3 (b)) with a root length of 0.5 cm (Figure 3 (a)).

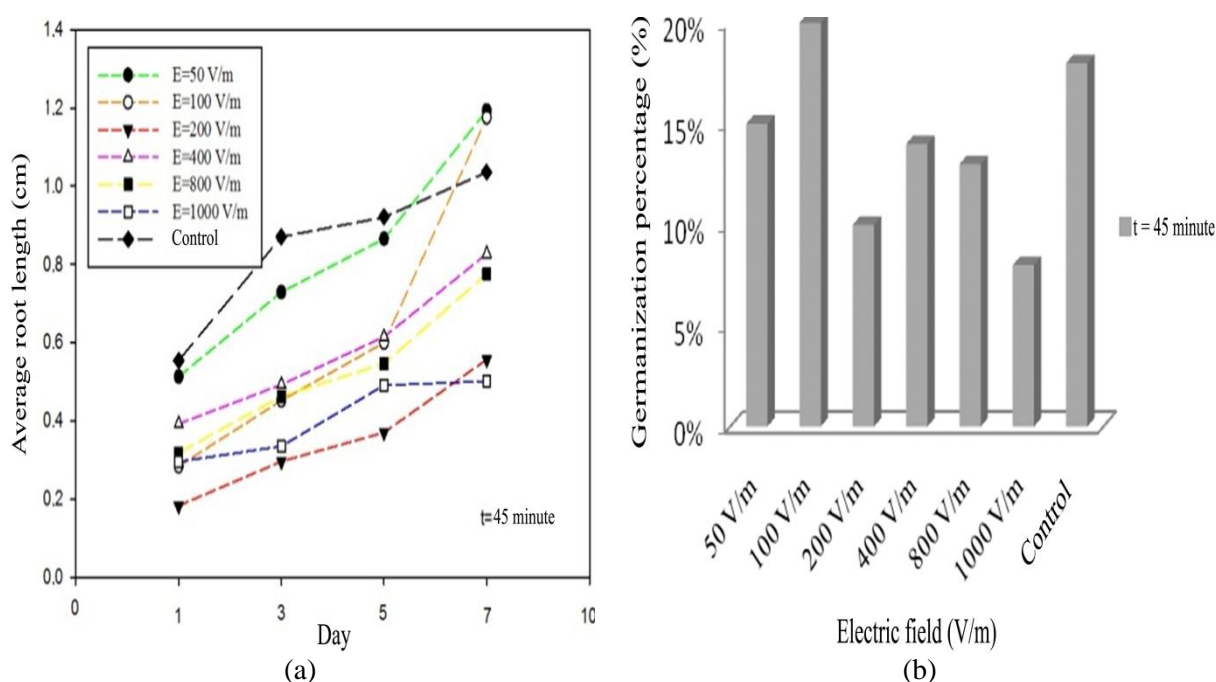


Figure 3. (a) Graph of the average root length of oil palm seed germination, a function of the electric field at 45 minutes of treatment time; (b) Graph of palm seed germination percentage, function of electric field at 45 minutes of treatment time

At 60 minutes treatment intensity of 100 V/m increased good growth by 1.42 cm (Figure 4 (a)) with presentation reaching 26% (Figure 4 (b)) and roots were inhibited at 1000 V/m by 0.4 cm (Figure 4 (a)) for length roots and 12% at germination presentation (Figure 4 (b)). From variations in time and different exposures, oil palm seed root growth is suitable at 100 V/m because exposure to electric fields at this intensity is tolerant to root growth.

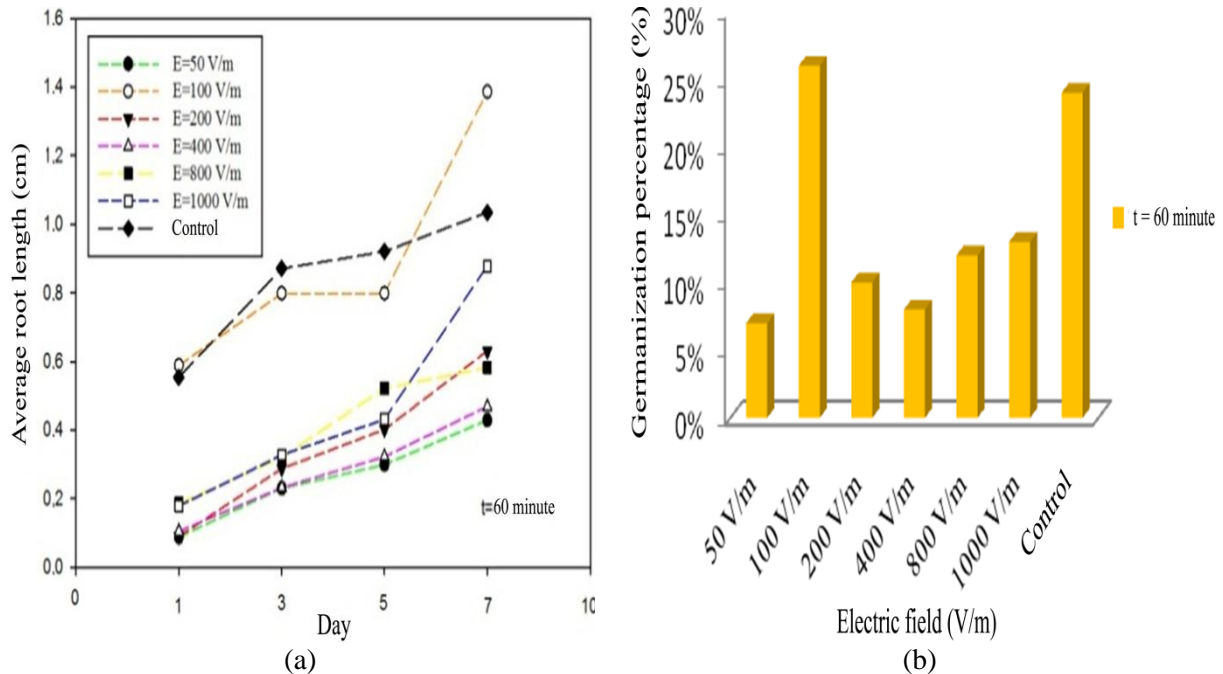


Figure 4. (a) Graph of the average root length of oil palm seed germination, a function of the electric field at 60 minutes of treatment time; (b) Graph of palm seed germination percentage, function of electric field at 60 minutes of treatment time

It can be seen that high-intensity DC voltage electric fields and long exposure times inhibit plant root growth. The electric field exposed around the plant roots has an influence on the ions in the plant root cell membrane which results in the permeability of the cell membrane. Apart from that, electrical changes in the roots cause positive ions in the roots to move freely [22], so that when an external electric field is exposed the ions in the cell membrane are polarized, and dipole-dipole formation occurs which accelerates the shift of the membrane in the roots. Higher membrane permeability will lead to increased ion uptake of available nutrients, resulting in ion accumulation in plant cells as demonstrated in garden lettuce sprouts [23]. Electric fields can influence plant growth in two ways: first, they affect the ions in the soil, and second, they can impact the overall activity of the plant related to electron and ion metabolism [24].

4. CONCLUSION

Exposure to an electric field of 100 V/m provides good growth rates for each variation in exposure time. The effect of long exposure to an electric field inhibits germination of palm seed root growth, namely at 1000 V/m with an exposure time span of 30 – 60 minutes. Exposure to electric fields and long exposure times have a threshold that can be tolerated by roots.

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