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Effect of chemical ions on oil palm midribs and leaves by direct electric voltage treatment

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ABSTRACT

The productivity of palm trees grown is generally measured in monthly and yearly periods, but on a shorter time scale, it is particularly measured by the plant maintenance of palm trees. Consideration of the general productivity in time is how to produce good fruit fertilizer (chemical aspect), healthy plants, fast growing and evolving (agricultural aspect), and genetic type of palm that grows (biological aspect). However, the growth and production on the physical aspect is still less attention. Through physical treatment, the growth of palm trees can be optimized to support aspects of the previous aspects, as it has been proven in advanced countries on the plant's aloe vera, avocado, and pine trees. In this paper, the methodology proposes a direct current voltage treatment to the palm tree that can accelerate the flow of ions to grow and develop nutrients. The palm tree samples are aged 1 to 5 years corresponding to the provision of 10, 16, 25, 35, and 50 V for each of the ages of the palm tree respectively. Identifying samples before and after treatment by electricity is based on the geometry of leaves, midribs, and ions effect. There have been reduced and increased levels of nutrients. This identification can optimize the productivity of palm trees.

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1. INTRODUCTION

The development of the economic potential of oil palm trees is increasingly rapid, both on a national and international scale. The production is not only fruit but almost all parts of the palm tree can be used, so market demand is increasingly high and availability is very necessary [1-3]. In line with this economic potential, handling and demands for advances in science and technology also help in the exploration and exploitation of production [4, 5], so that optimization of production results increases and competition no longer prioritizes palm oil but also various production derivatives as basic materials for synthetics, medicines, and household equipment [6-8].

Various chemical, biological, and engineering studies have been carried out [8, 9] and have begun to use electromagnetic approaches as a promising alternative to light, magnetism, and electricity to optimize production. One of the electrical components, electrodes, from tree identification to post-production, is starting to develop in research and technology [7, 9]. Palm tree production conditions are greatly influenced by internal factors such as seeds (genetic elements) and external factors such as soil, fertilizer, water, air, and sun [10-12]. Growth conditions are the availability of the tree's needs for chemical elements, easily, quickly, and smoothly with metabolic processes [13, 14]. The source of tree input and tree output is always considered while the metabolic processes of trees are always left to grow for months to years, as a result, production control is not optimal and tends to take a long time [15-17]. The productivity of oil palm trees is always measured in terms of months and years, but on a daily scale, the growth process to increase production is still not prioritized. General considerations are how fertilizer produces good fruit (chemistry), how plants grow and develop quickly (agriculture), and various types of palm oil (biology) [18-20]. However, growth and production in physical aspects are still not considered. Through the development of electrical technology, the growth process can be optimized [21, 22]. Developing electrical technology in plants is simple and has been tested in developed countries on aloe vera, avocado, and pine tree plants [6, 7, 16, 23-25]. Direct current (DC) voltage treatment on oil palm trees is intended to accelerate the flow of ions for optimal growth and development. This research aims to characterize the flow of ions from the soil to the midrib and leaves of palm oil using electrical potential differences, and ionic flow treatment patterns to understand the effects of conservative conditions that arise before and after treatment.

2. RESEARCH METHODS

Experimentally (see in Figure 1), samples were grouped based on planting age of 1, 2, 3, 4, and 5 years by applying varying voltages of 10, 16, 25, 35, and 50 V respectively, 8 hours per day, for one month. Voltage using electrodes is applied to the midribs and leaves of oil palm trees with variations in electrode poles. The general identification of oil palm tree nutrients is N, P, K, Mg, Ca, S, Cl, H_2O, B, Cu, Zn, Fe, and Mn.

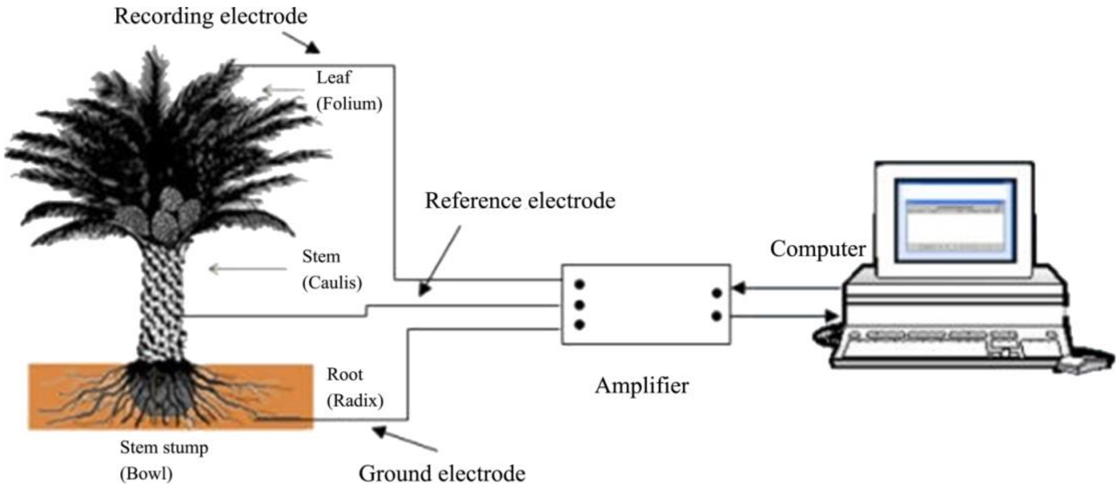

Figure 1. Electrical potential difference measurement circuit for oil palm plants.

Measurement of the electric potential difference with the distance from the root to the farthest leaf midrib, measured for 2 – 8 hours per day. The same treatment is also carried out but with the electrode poles reversed. Electrical calculations consist of electric current, resistivity, and the amount of chemical flow in the sample (stem and midrib). Calculations are obtained indirectly from the results of potential difference measurements. Nutrient identification process: the sample is dried, cut finely, and heated in an oven at 105°C for 1 hour, then the sample is desiccated for approximately 1 hour until the weight becomes constant, each constant sample is taken in hundreds of grams, then put into a glass flask. The next step is digestion by adding 10 mL of concentrated nitric acid (HNO_3) until all samples are completely dissolved. The sample was filtered using Whatman 42 filter paper, the filter results were dissolved in a volumetric flask to a volume of 100 mL. Sampek destruction is measured using atomic absorption spectroscopy at certain wavelengths. Some nutrients can be seen in Table 1.

The difference in electrical potential of oil palm trees is modeled using the Poisson equation. The conservative electric potential difference of electric current in Ohm's Law simplifies to:

$$J = \sigma E \tag{1}$$

$$\nabla P(z) + J_a + J_p = \sigma E \tag{2}$$

where, J, J_a, and J_p are the total current density, natural current density, and treatment current density respectively, z is the ion mass mechanical function parameter, σ is the electrical conductivity, and E is the electric field of the ionic fluid flow. For a conservative electric force where only one direction of change in motion occurs, the electric potential is simplified:

$$\nabla \times E = 0 \quad (3)$$

Then the potential gradient is $U = -\nabla V$. The symbol E is the electric field, U is electric potential energy and V is a potential difference. The V value is influenced by resistance R and electric current (I) in the form $\Delta V = R\Delta I$.

Table 1. Several chemical elements in oil palm plants.

Macro elements	Ion	Place found in trees	Deficiency	Good source of elements
Nitrogen (N)	$NO_3^- + 8H^+ + 8e^- \rightarrow 2H_2O + OH^-$ $NH_3 \leftrightarrow NH_3^+ + OH\text{-}NO_3^-$ $\cdot NH_4^+ \; N_2$	Leaf	2.3% in young plants	$(NH_4)_2SO_4$
Phosphorus (P)	H_3PO_4 $H_3PO_4 + H_2O \rightarrow PO_4^{3+}$	Root, Leaf	Occurs in plantations overgrown with reeds	Young plants: - Triple super phosphate - Diammonium phosphate Mature plant: -Rock phosphate
Potassium (K)	K^+ $K^+ + OH^- \rightarrow KOH$ $KOH + HCl$ $K^+ + Cl^-$	Empty bunch	-	KCl (Potassium chloride)
Magnesium (Mg)	Mg^{2+} $MgOH + H_2SO_4 \rightarrow MgSO_4 + H_2O$	Leaf	Occurs in light-textured, acidic soils and eroded topsoil	Kieserite (MgSO4·H2O)

3. RESULTS AND DISCUSSIONS

The result of electrical treatment is the difference between the natural electrical voltage and the treated electrical voltage on palm midribs and leaves. Figure 2 shows the differences in nutrient conditions in different ages and different compositions. Oil palm leaves aged 1, 2, 3, 4, and 5 years after being treated with Cl, S potential differences experienced a significant decrease in value. The elements P, Ca, and Fe have increased. Meanwhile, other elements such as N, Mg, K, Cu, Zn, and Fe have relatively normal increases and decreases in value. Electrical voltage in plants affects the movement of nutrients or chemical ions both within the plant tissue and on the surface of the plant with nutrients in the form of chemical ions that are positively, negatively, or uncharged. Treatment was given for 8 hours per day for 1 month.

Figures 2 and 3 are treated with the negative pole on the ground and the positive pole on the leaves and midrib. From the data on the elements Chloride, Sulfur, and Calcium there are large differences. It is not understood that the elements N, P, and K dominate the amount of increase. The flow of negative ions from the soil to the leaves and midribs will be accelerated, but the components that form N, P, and K are in the form of ions that are along the tree's vascular pathways as growth catalysts that react with several other elements and ions. Therefore, the fast movement of ions relative to normal conditions cannot be interpreted as a large flow and diffusion of ions towards the electrode point. It is understood that before the electrical potential difference is carried out, all ions are at the flow points of the midrib and leaf vessels and when treated, the flow of ions changes (during the first 8 hours) and returns to normal after the electrical treatment is stopped (2 × 8 hours). every day for up to a month. This means that when the potential difference is high, the flow of moving ions cannot always be provided in a certain place with relatively increasing or decreasing amounts, even though this condition is very possible between the two electrode poles. On the other hand, after being treated (the electric voltage is turned off), the ionic distribution of the plant adjusts again to create a natural formation to achieve balance in the movement and reaction of ions from their place. From the data obtained, it cannot be confirmed that the dominant natural elements accelerate the growth of leaves and midribs, but on the contrary, the movement of ions has been able to accelerate growth. The increase and decrease in nutrients is thought to be caused by electrical voltage around the roots which inhibits or stimulates the movement of ions which are then absorbed by plant tissue into the leaves and midribs.

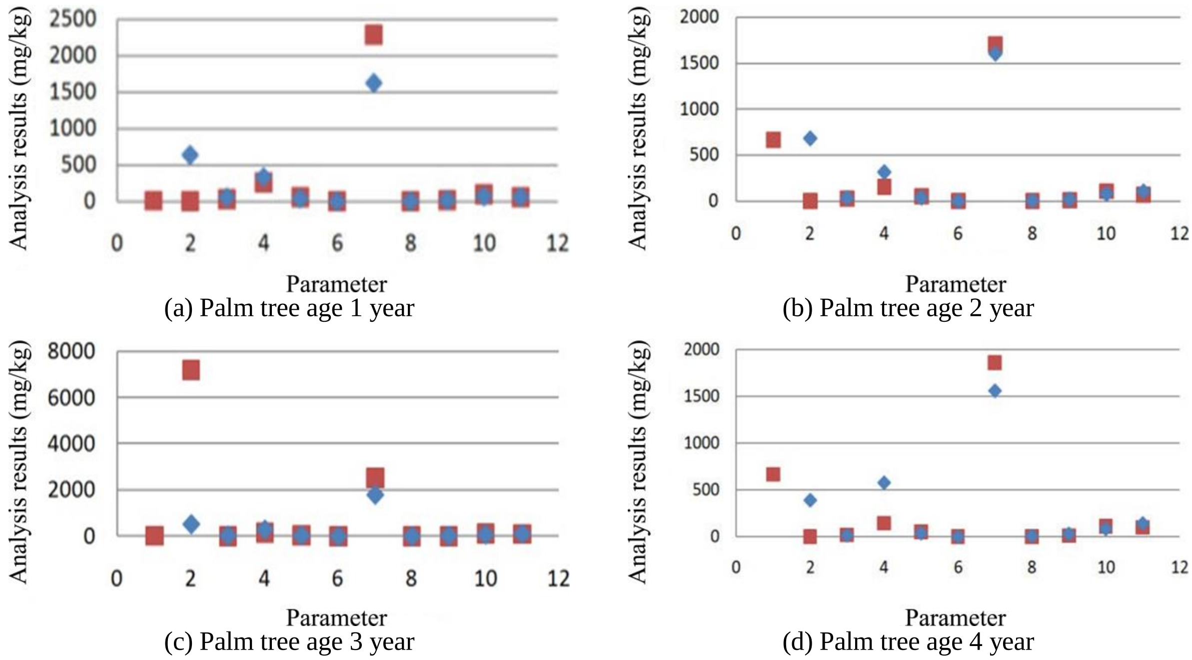

Figure 2. Nutrients in leaves, where the color is blue (before treatment) and red (after treatment). Nutrient element parameters are 1. Chloride (Cl), 2. Sulfate (SO_4), 3. Nitrate (NO_3), 4. Phosphorus (P), 5. Magnesium (Mg), 6. Potassium (K), 7.Calcium (Ca), 8. Copper (Cu), 9. Zinc (Zn), 10. Iron (Fe), and 11. Manganese (Mn).

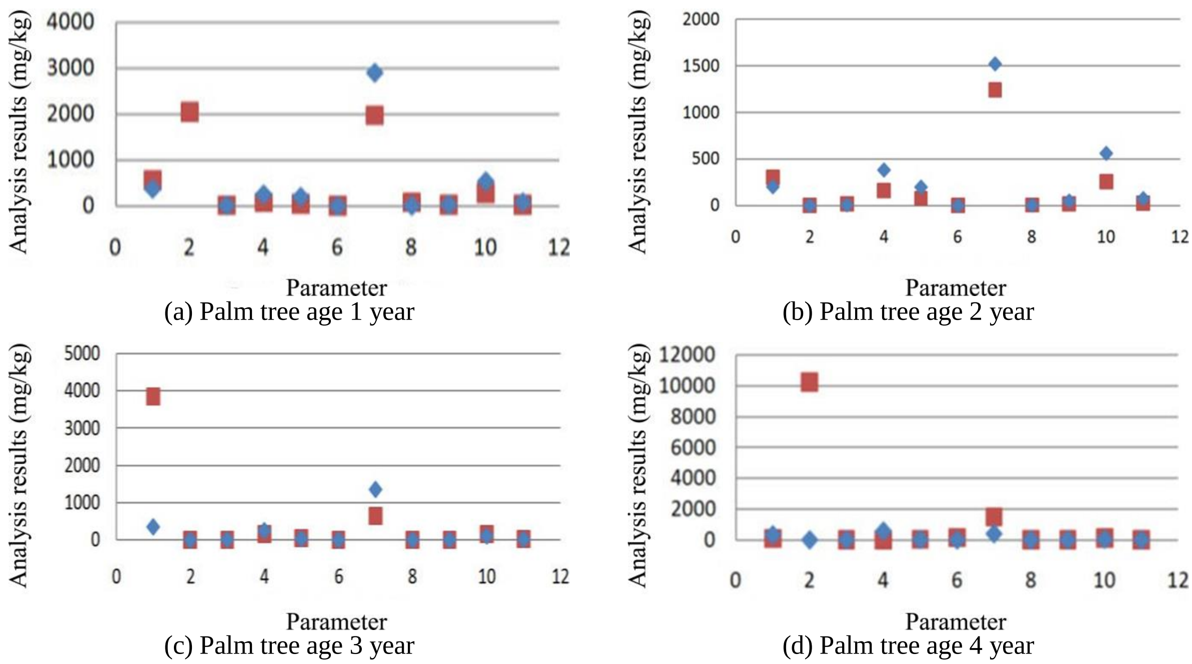

Figure 3. Nutrients in midribs, where the color is blue (before treatment) and red (after treatment). Nutrient element parameters are 1. Chloride (Cl), 2. Sulfate (SO_4), 3. Nitrate (NO_3), 4. Phosphorus (P), 5. Magnesium (Mg), 6. Potassium (K), 7.Calcium (Ca), 8. Copper (Cu), 9. Zinc (Zn), 10. Iron (Fe), and 11. Manganese (Mn).

The geometric differences in the size of the midrib and leaf are shown in Table 2 for electrode positions (-) (+), namely soil (-) and leaf/midrib (+), and electrode (+) (-), namely soil (+) and leaf/ midrib (-). Some treatments provide different voltage sources due to the plant's age, the electrode's location, and the resistance, causing some treatments to be made differently. However, this condition does not cause different behavior because electrically the electric current can be controlled well. In line with the growth of leaves and midribs, there is an increase in their geometric size after being electrified relative to the natural growth in length and width of leaves and midribs. Unidirectional and reverse electrode polarity in palm ion flow does not reduce the increase in length and width. The appearance of a fixed or reduced size causes an increase in size on the other side. This shows that there is an increase in small amounts. The factors that appear are the ions in the elements N, P, K, and S. The increase in electric current in palm oil treatment is the acceleration of the movement of positive and negative ions and the ions that occur are complex, therefore the development of midribs and leaves that occurs is caused by macro components of nutrients and from Table 2 growth acceleration cannot be ascertained from the age of the palm unless there is an increase in length and width. Quantitatively, in terms of age and the amount of electric current produced, fluctuations in the price of electric current and resistance are not the dominant problem. The most important thing from the calculation results is the difference before and after electrical treatment.

Table 2. Results of geometric measurements and electrical quantities of palm midribs and leaves.

Electrode treatment	Palm parts	Parameter	Year				
			1	2	3	4	5
Natural	Midribs	Length (mm)	900	1350	1500	1510	2300
		Width (mm)	15 – 29	15 – 30	18 – 48	17 – 50	23 – 65
	Leaves	Length (mm)	290	320	340	390	550
		Width (mm)	2 – 28	4 – 32	3 – 25	3 – 26	5 – 36
(+) (–)	Midribs	Length (mm)	1120	1340	1690	1700	2150
		Width (mm)	15 – 28	16 – 30	17 – 46	68	82
	Leaves	Length (mm)	297	325	310	340	560
		Width (mm)	3 – 28	4 – 30	3 – 26	3 – 27	5 – 36
(–) (+)	Midribs	Length (mm)	1100	1560	1820	1640	2360
		Width (mm)	29	32	63	65	69
	Leaves	Length (mm)	295	360	365	355	560
		Width (mm)	2 – 27	4 – 30	3 – 26	2 – 26	5 – 39

The distribution of electric potential in palm oil stems if a potential difference is applied at 2 points is modeled by the following Poisson equation:

$$\nabla^2 V + \frac{q}{s} = 0 \quad (4)$$

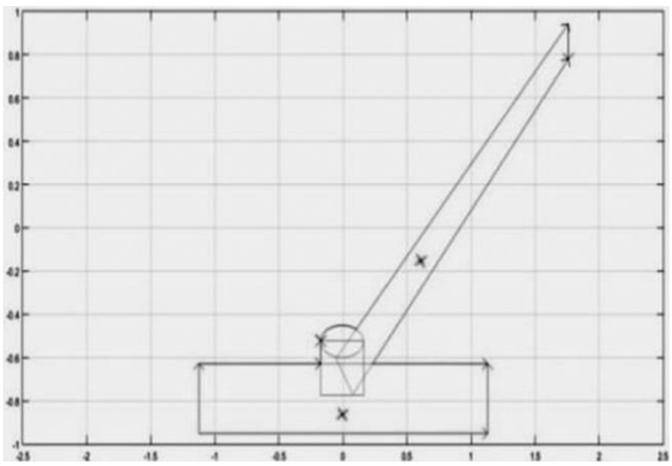

Figure 4. Design of boundary conditions.

The idealized model for the distribution of electrical potential in the oil palm stem illustration can be seen in Figure 4 to Figure 7. For the modeling solution, the boundary conditions used in Figure 4 are at distant points and the potential is taken to be equal to zero, $V = 0$ with Dirichlet boundary conditions. On plant walls, a potential gradient applies equally to zero where $\partial V/\partial n = 0$ (otherwise known as the Neumann boundary condition).

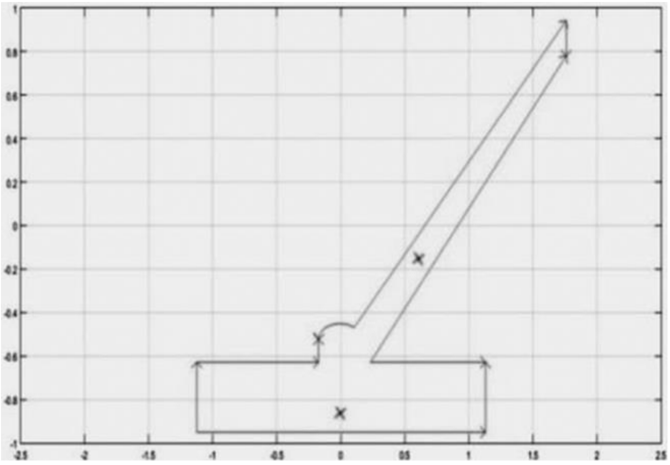

Figure 5. Determination of boundary condition points.

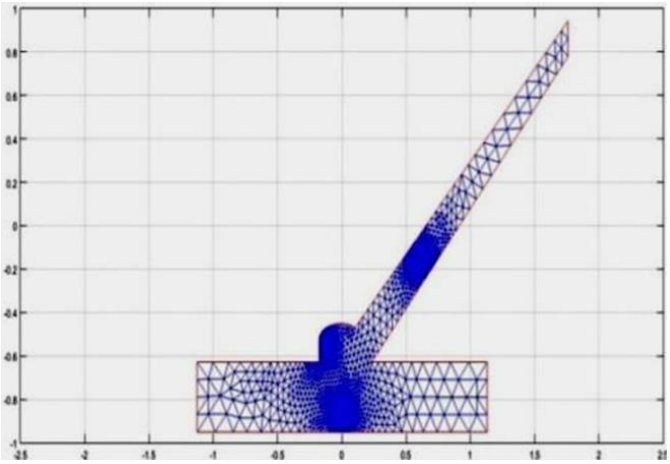

Figure 6. Electrical voltage distribution mesh.

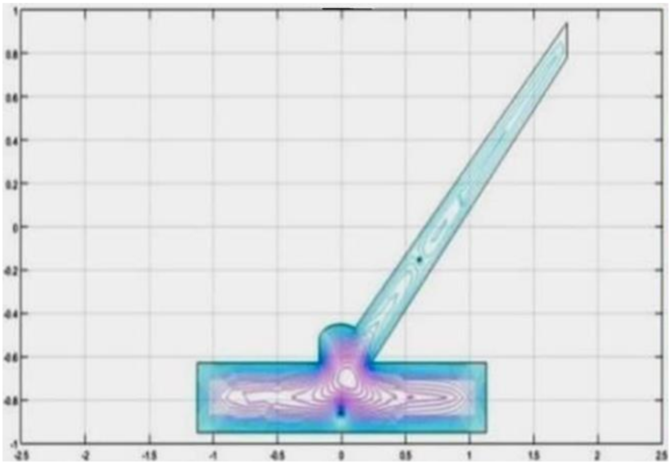

Figure 7. Electric voltage contour.

This electric potential distribution model is completed using the finite difference method, determining the boundary conditions on the network as in Figure 5, creating a mesh (network) in the model as in Figure 6, and determining the electric potential distribution in Figure 7. In Figure 6 the charge is distributed but more concentrated at certain points, while the contour with the same potential in Figure 7 shows the concentration in red. From these results, it turns out that palm tree ions are concentrated at certain points and result in some ions being unable to move freely. The condition of attracting ions results in the buildup of positive charges at one point and negative charges at other points so that the movement of the ions is no longer regular compared to the natural state of the oil palm tree. It is hoped that this modeling only explains the simulation conditions, but in the experiment the electrical potential that was treated was not designed for a long time so that when the electrical treatment was stopped there would be an increase in the movement of ions to reach equilibrium again, speeding up the metabolism of the ions that had already been formed.

4. CONCLUSION

The midribs and leaves of oil palm show several types of nutrients resulting in increases and decreases in quantity. The increase and decrease in nutrients are caused by differences in electric current, however, there are still several chemical element components for each part of the positive and negative ions which cannot be detected due to physical factors, ion flow pressure, cross-section, and the presence of ions when an electric voltage is applied, so that the distribution and the same number of ion charges differs in the amount of ion transport. Potential difference modeling in oil palm plants shows a distribution of charges that is concentrated around the electrodes which disrupts the natural flow.

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