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Beyond Electroculture: Modeling Possible Effect of Low Intensity Laser Pen to Improve Plant Growth

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Abstract
It is known that in many regions in this earth, there are growing concerns on rice and other crops supply stability, while the water supply for irrigation has become more scarce. Part of the problem is that farm lands have been reallocated to other purposes, including housing etc, and other reasons include the technology on farming was quite in stagnation for years. In this regard, studies have shown beneficial effects of laser technology to boost plant growth and especially during seed formation. In this small experiment, we take a look at modeling of such low intensity laser pen interacting with plant leaf, and then we tried to look at how low intensity laser pen actually can improve leaf textures, etc. Not necessarily increased leaf area is the only concern, as quality of leaf shall be more visible after low intensity laser pen treatment. It is our hope that this experiment can be useful in one or other ways especially in the spirit of Masanobu Fukuoka, the father of natural farming.

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INTRODUCTION

In a previous article in this journal, we discuss a type of farming which was mostly overlooked, i.e. *electroculture*. In our opinion, methods such as electroculture, magneticculture, and also laserculture can be an alternative way to move forward especially toward natural farming in the sense of *Gardening with Less water* (cf. for instance, Simeone, 2013; Bainbridge, 2015).

The so-called natural farming actually started with Masanobu Fukuoka, with his book *The One Straw Revolution* (Fukuoka, 2015).

The following is excerpt found in his book:

"Masanobu Fukuoka (1913–2008) was born and raised on the Japanese island of Shikoku. He was the oldest son of a rice farmer who was also the local mayor. Fukuoka studied plant pathology and worked for three years as a produce inspector in the customs office in Yokohama. But in 1938 he returned to his village home determined to put his ideas about natural farming into practice. During World War II, he worked for the Japanese government as a researcher on food production, managing to avoid military service until the final few months of the war. After the war, he returned to his birthplace to devote himself wholeheartedly to

farming. And in 1975, distressed by the effects of Japan's post-war modernization, Fukuoka wrote *The One-Straw Revolution*. In his later years, Fukuoka was involved with several projects to reduce *desertification* throughout the world." (Fukuoka, 1987; Fukuoka, 2015).

Figure 1: Masanobu Fukuoka

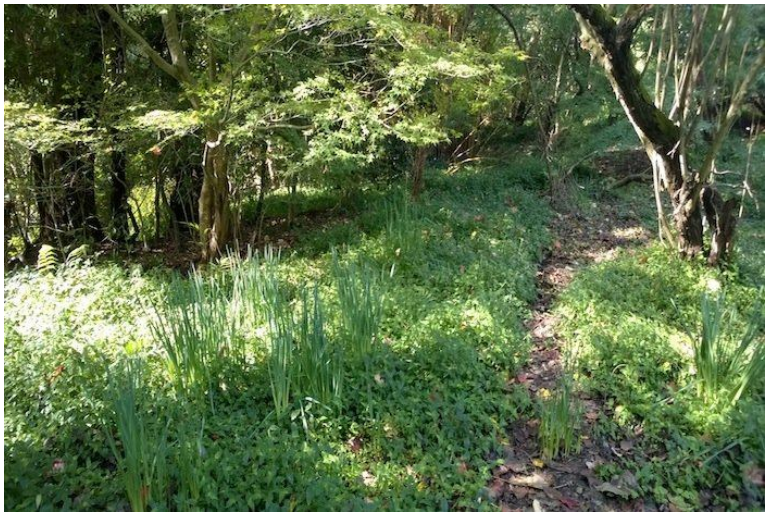

Figure 2: Fukuoka's forest

It is known that in many regions in this earth, there are growing concerns on rice and other crops supply stability, while the water supply for irrigation has become more scarce. Part of the problem is that farm lands have been reallocated to other purposes, including housing *etc*, and other reasons include the technology on farming was quite in stagnation for years. In this regards, studies have shown beneficial effects of (*low intensity*) laser technology to boost plant growth and especially during seed formation (Nadimi *et al.*, 2021; Okla *et al.*, 2021; Sevostyanova *et al.,* 2021).

In these series of small experiments, we take a look at modeling of such low intensity laser pen interacting with plant leaf, and then we tried to look at how low intensity laser pen actually can

improve leaf textures, *etc*. Not necessarily increased leaf area is the only concern, as quality of leaf shall be more visible after low intensity laser pen treatment.

In the following section we will discuss a series of small experiments to see what kind of actual impact during a day of experiment with leaf of plant.

Method of *Laserculture* (or Electroculture with low intensity Laser Pen)

Electroculture is a technique used to stimulate plant growth by exposing them to low-level electrical currents. The use of electroculture has been around for decades, and it has been shown to improve crop yields and *reduce the need for chemical fertilizers.* Recently, there has been interest in using laser pens as a form of electroculture to enhance plant growth. This essay will explore possible use of (low intensity) laser pens for electroculture treatment and specific procedures for implementing such a electroculture.

Laser pens are small, handheld devices that emit a highly concentrated beam of light. The beam of light is produced by a diode and amplified by a series of lenses. The most common type of laser pen is the red laser, which emits a wavelength of 650 nm. This wavelength is within the range of the red light spectrum, which is essential for plant growth.

The use of laser pens as electroculture works by stimulating the plant's photosynthesis process. Photosynthesis is the process by which plants convert light energy into chemical energy, which is stored in the plant's cells. The energy produced by photosynthesis is used for growth, reproduction, and metabolism. The use of laser pens can enhance the photosynthesis process by providing additional light energy to the plants.

The procedure for implementing electroculture using a laser pen is relatively straightforward. First, select a laser pen that emits a wavelength of 650 nm or within the red light spectrum. Next, choose the plant or crop that you want to stimulate. Place the laser pen approximately six inches away from the plant, and direct the laser beam towards the plant's leaves.

Actual Impact during a Day of Experiment with Leaves of Plant

Device and methods:
We utilize simple devices including timer, sound generator app, and low intensity laser device or known as “laser pen” for common presentation.

Method: Experiments were conducted during 1 and half day for duration of 5 minutes each, to 2 leaves, and with interval approximately 2 hours.

RESULTS

Results of our experiments are as shown below:

Table 1: Result of experiment with low intensity laser pen effect on leaf texture

Description	**Treatment #1 Laser stimulation (5 min.)**	**Treatment #2 Sound stimulation, 528 Hz(5min)**	**Treatment #3 Sound stimulation, 963 Hz(5min)**	**Treatment #4 Spoken words: “I love you.”(5 min)**
1. 21st April 2023, 19:00 - 19:10 - Leaf 1: - Leaf 2:	 v v			
2. 22ndApril 2023, 7:00 - 7:10				

- Leaf 1: - Leaf 2:	v v			
3. 22nd April 202, 9:00 : 9:10 - Leaf 1: - Leaf 2:	 v v			
4. 22nd April 2023, 11:00 - 11:10 - Leaf 1: - Leaf 2:	 v v			
5. 22nd April 2023, 13:00 - 13:15 - Leaf 1: - Leaf 2:	 v v	 v v	 v	 v v
6. 22nd April 2023, 15:10 - 15:25 - Leaf 1: - Leaf 2:	 v v	 v v	 v	 v v

Several photographs during experiment, 21st April 2023, 19:00 - 19:10 (phase 1)

Figure 3: Leaf 1

Figure 4: Leaf 2

Photographs during experiment, 22nd April 20233, 9:00 - 9:10 (phase 3)

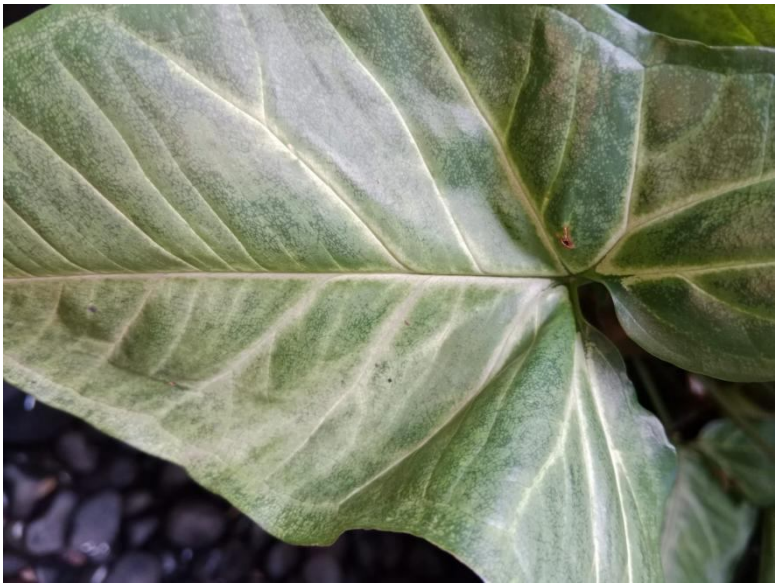

Figure 5: Leaf 1

Figure 6: Leaf 2

Photographs during experiment, 22nd April 2023, 15:10 -19:25 (phase 6)

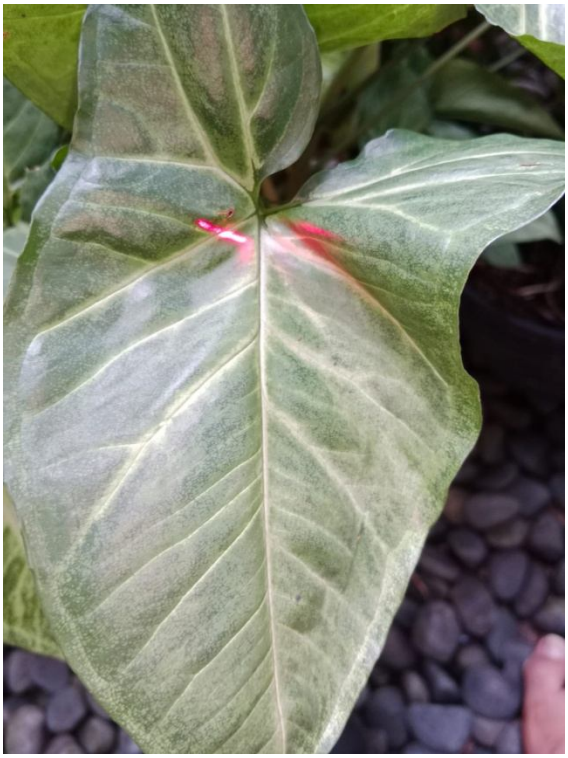

Figure 7: Leaf 1

Figure 8: Leaf 2

Modeling effect of low intensity laser pen to boost plant growth

While our experiments as shown in Table 1 above do not quite correspond to increase in leaf area caused by low intensity laser pen irradiation, let us suggest a simple model to predict such a growth effect.

An example of how to model the interaction of a low-level laser pen with a plant leaf and plot the results using Mathematica package. Please note that this is a simplified example and may not precisely represent the complex biology and physics involved in this process.

In this example, we assume a simplified model of a plant leaf growth with the interaction of a low-intensity laser pen. We consider a differential equation that describes the growth rate of the leaf area over time, with a given initial leaf area and a growth rate. We also include the effect of the laser, which is modeled as a constant laser power during the light exposure time, and zero otherwise.

Here's an example of Mathematica code that models the interaction of a low-level laser pen with a plant leaf and plots the results:

```
(* Set parameters *)
Initial Leaf Area = 1; (* Initial leaf area in square meters *)
Laser Power = 0.1; (* Laser power in Watts *)
Light Exposure Time = 10; (* Light exposure time in seconds *)
Growth Rate = 0.01; (* Growth rate of leaf area per second *)

(* Define differential equation for leaf growth *)
Leaf Growth [t_, A_]:= growth Rate*A;

(* Define laser effect on leaf growth *)
Laser Effect [t_]:= If [t <= light Exposure Time, laser Power, 0];
```

```
(* Solve differential equation with initial condition *)
Sol = ND Solve [{A'[t] == leaf Growth[t, A[t]] + laser Effect[t], A[0] == initial Leaf Area}, A, {t, 0, 10}];

(* Plot the leaf growth over time *)
Plot [Evaluate [A[t] /. sol], {t, 0, 10},
Plot Range -> All, Axes Label -> {"Time (s)", "Leaf Area (m^2)"},
Plot Label ->"Plant Growth with Low-Level Laser Pen"]
```

Code 1. Mathematica code

The differential equation is solved using the ND Solve function in Mathematica, with the initial condition of the leaf area at time zero. The solution is then plotted over time using the Plot function, with the time variable t ranging from 0 to 10 seconds. The plot shows the variation of the leaf area over time, which represents the potential effect of the low-level laser pen on plant growth.

Please note that this is a simplified example and the actual effect of a low-level laser pen on plant growth would involve more complex considerations, such as the specific biology and physiology of the plant, the properties of the laser, the duration and intensity of the light exposure, and other factors.

DISCUSSIONS & CONCLUDING REMARK

From photographs above (Figure 3 - Figure 8), this writer found *there is no noticeable effect* of low intensity laser pen irradiation with interval 2 hours to leaf #1. Perhaps that is because the intensity of laser pen used is too low, or duration of irradiation of 5 minutes each is not quite long to find noticeable effect.

Nonetheless, we notice few noticeable effects of low intensity laser pen irradiation to leaf #2, i.e. if we look at Photographs #4 to #6 and at the end to #8, the leaf in question turned gradually more into lighter green, compared to its initial colour. More than that, it seems that its dendritic pattern of its leaf becomes rather blurred.

We acknowledged that the devices in this series of experiments are very simple, however we present this result merely as an illustration how simple experiments may produce noticeable effects on plant leaves.

Last but not least, it is our hope that the experiments presented above can be useful for near future research on *Gardening with less water* / natural farming with electroculture (Simeone, 2013; Bainbridge, 2015).

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