

Variation of Soil PH Using Circularly Polarized Light

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ABSTRACT

The use of a commercial circular polarizer to produce polarized light from a 85W conventional source and its influence on the pH of sandy loam soils is presented. The role of soil pH in the determination of plant nutrient requirements has made its monitoring important for plant growth and development. The study was designed to determine the effectiveness of using circularly polarized light to amend the level of soil acidity and alkalinity. Samples of acidic and alkaline sandy loam soils were exposed to a collimated beam of the circularly polarized and the pH and temperature measured at 1 - hour intervals for 8 hours in a dark room. The control was soil samples exposed to unpolarized light from another 85W conventional source. All the samples were replicated three times. The results show that circularly polarized light has the ability to significantly increase the pH of sandy loam acidic soil while it had no appreciable effect on the alkaline soil **.** This could provide an alternate non - chemical means of managing highly acidic sandy loam soils.

Key words: Soil pH, Circular Polarization

1. Introduction

Soil is an important resource that serves as a natural medium for the growth and development of land plants and provides a habitat for a wide range of organisms. Its acidity and alkalinity is measured by means of soil pH. Soil pH is a vital soil parameter that facilitates the determination of plant nutrient requirements as well as the selection of right mix of plants and allow the right treatment for soils (Halcomb & Fare 2011). It is not too often to find any one kind of plant grow equally well in both distinctly acid and distinctly alkaline soils (Halcomb & Fare 2011) so soils of either kind are modified in ways that make them more suitable for the intended use. Correcting acidic soils requires the application of a liming material, such as limestone containing both calcium and magnesium (Thien & Graveel 2003) while alkaline soils can be amended using gypsum ($CaSO_4 .2H_2O$) and sulfur (Troeh & Thompson 2005). These are highly successful time - tested chemical methods used widely by all manner of farmers the world over and it is to explore an alternative non - chemical approach using a polarizer that this study was conducted.

Light can be represented by oscillating electric and magnetic fields both of whose directions are perpendicular to the direction of the light beam and to each other. As customary with polarization of light, the specification of the direction of the displacement of the electric field vector is used to describe the state of polarization (Guenther 1990). When light wave is circularly polarized, then in any plane normal to its travelling direction, the tip of the electric field vector describes a circle once during each period of the wave (Young 2000). It is expected that when the circularly polarized light strikes the soil samples, the electrons and ion cores will oscillate in response to the light's electric field vector which is rotating (Giordano 2010) and this could enhance the polarizability of the ions leading to the overall effect on the pH of the soil samples.

In this paper, a circularly polarized beam of light from a 85 W conventional light source was exposed to acidic and alkaline sandy loam top soils and its effect on the pH and temperature of the soils monitored over a period of 8 hours is presented. The application of this method would rely on the polarization of the sunlight using polarizing sheets spread over the soil and will provide an alternate non - chemical means of amending soil pH. A sandy loam soil was used in the study since it is usually regarded as ideal for gardening as it promotes the growth of healthy plants.

2. Materials and methods

2.1 Location of the experiment

The experiment was carried out in a dark room at the laboratory of the Department of Science Education, College of Agriculture Education, University of Education, Winneba, Mampong - Ashanti, Ghana between 20:00 hr and 06:00hr during November, 2013.

2.2 Description of set up

The set up comprised essentially of two 85W low power light sources of conventional type fitted with a beam expander, a 67mm Pro - line circular polarizer fitted with a rotatable ring, randomly selected samples of loose acidic and alkaline sandy loam top soils with stones and clumps removed, a calibrated Eutech pH meter which measures pH by the electrometric method and a thermometer

2.3 Sample preparation

Using the procedure as described in Thien & Graveel 2003, 10g each of the acidic sandy loam soil samples were poured into 6 Petri dishes and 10ml of distilled water added to each. The mixtures were then stirred continuously for 10 minutes and left to stand for a further 30 minutes without agitation to allow the salts in the soil to dissolve in the distilled water. Three of the samples were used as the control. The same procedure was used for the alkaline soil samples

2.4 Procedure and Measurements

An expanded beam of light from the source, fitted with the circular polarizer and rotated for maximum effect, was exposed to three of the prepared acidic top soil samples. The remaining three samples were exposed to an expanded beam of light from the second source which was without the polarizer. This served as the control.

The initial pH and temperature of all the samples were taken and then again at 1 - hour intervals for 8 hours. The room temperature at the start and end of the experiment was also recorded. The same procedure and measurements were made for the alkaline soil samples. The schematic diagram of the experimental set up with the circular polarizer is as shown in Figure. 1

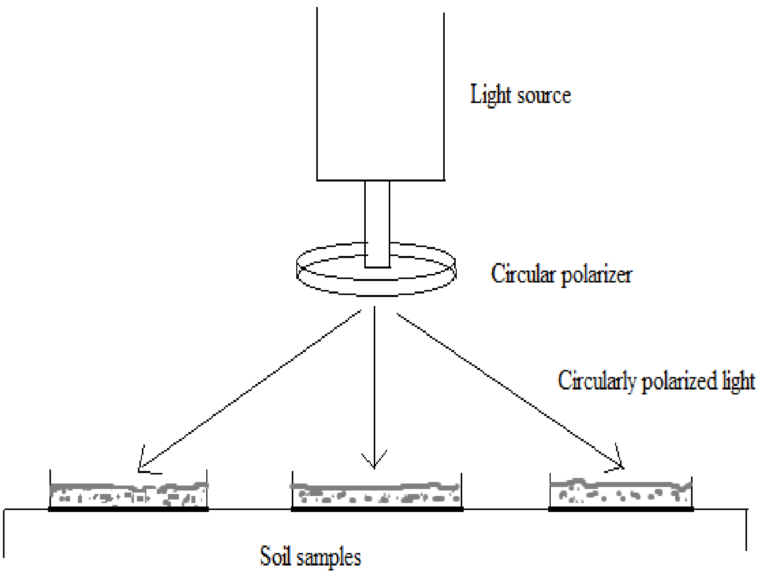

Figure 1. Schematic diagram of experimental set up

2.5 Data analysis

All data collected were subjected to analysis of variance (ANOVA) to compare mean values between treatment conditions at 5% significance level.

3. Results

3.1 Circularly polarized light on the pH of the soil samples

The results showed that the acidic soil samples exposed to circularly polarized light became significantly less acidic than the unpolarized samples. On the other hand, the circularly polarized light did not have any significant influence on the alkaline soil as shown in Table 1 below.

Table 1. Effect of circular polarization on the mean pH of the soil samples

Soil Sample	Mean pH of Acidic soil	Mean pH of Alkaline soil
Polarized soil	5.67	9.50
Unpolarized soil	5.60	9.46
LSD (0.05)	0.04	0.08
CV (%)	**1.20**	**1.6**

3.2 Effect of circularly polarized light on the temperature of the soil samples

As shown in Table 2, the results of the analysis indicate that both soil samples subjected to the circularly polarized light generated significantly higher mean temperatures than the unpolarized ones, with the warmer being the acidic. The temperature variations are also as shown in Figure 2 below.

Table 2. Effect of circular polarization on the mean temperature of the soil samples

Soil Sample	Mean temperature of Acidic soil/°C	Mean temperature of Alkaline soil/°C
Polarized soil	26.34	26.17
Unpolarized soil	26.07	25.77
LSD (0.05)	0.04	0.04
CV (%)	**0.3**	**0.3**

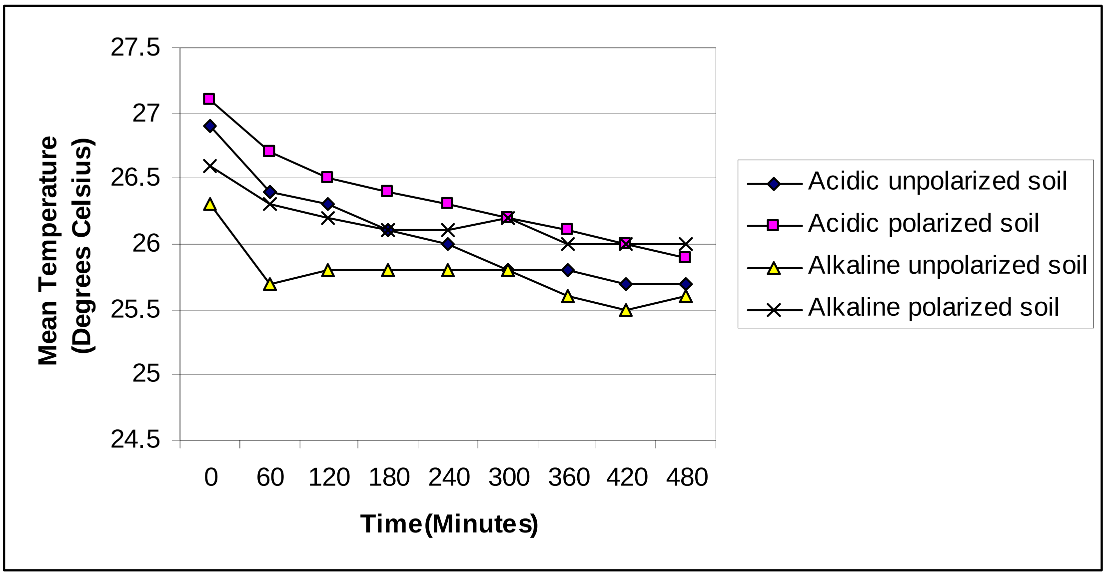

Figure 2. Variation of mean temperature with duration of exposure of polarized and unpolarized light

4. Discussion

The results have shown that circularly polarized light has the ability to significantly increase the pH of sandy loam acidic soil while it had no appreciable effect on the alkaline soil. The polarizability of the ions induced by the circularly polarized light (Giordano 2010) could have led to the displacement of the hydrogen ions from where they were causing soil acidity so that they now resided as part of the neutral water molecule (Thien & Graveel 2003). The net effect is the reduced soil acidity. This endothermic process is evidenced by the temperature of the polarized acidic soil sample remaining higher than the unpolarized as the ambient temperature decreased during the experiment.

In the case of the alkaline soil samples, circular polarization equally caused a higher temperature in the exposed than the unexposed but was unable to significantly reduce the pH.

5. Conclusion

The effect of circularly polarized light on acidic and alkaline sandy loam soil samples has been presented in this study. The results show that circularly polarized light can be used to increase soil pH but has no significant effect on alkaline soils.

6. Recommendation

Based on the findings of the study, it is recommended that field trials be conducted using circular polarizing sheets to determine the suitability of this material for controlling soil pH.

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