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VOLTAGE DEPENDENCE OF ROCK MEAL BASED FOLIAR FERTILIZERS WITH ISR PROPERTIES, WATER SOLUTIONS

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Abstract

The electrical conductivity of several rock meal based fertilizers with expressed ISR activity, measured as voltage dropping when their distilled water solution was affected with low – voltage electric currents of 5 volts (DC and AC) was examined. For comparison, hard and soft tap water (with 196 and 65 ppm CaCO3 hardness), 1% distilled water solutions of NaCL and CuSO4.5H2O solution and 0.1% solution of organosilicone surfactant were also tested in the conducted trials. The result shows that hard water, solutions of NaCL and CuSO4.5H2O and solutions of fertilizers with fulvic acids content can cause drops in the voltage of electric currents. The same results were received for the fertilizer on the basis of K2O, SiO2, Cu, although other products with similar content do not cause a voltage decrease. There were no differences in the conducted tests between the DC and AC electric currents.

Keywords: fertilizers, ISR, electricity, voltage, water hardness

INTRODUCTION

The electricity properties of the agrochemical solutions are not well studied although they play an important role in their action and effectiveness, especially when water with high hardness values is used for the preparation of treatment solutions. Electrical currents were used to enhance ex-situ bioremediation of soils - the effect of different applied voltages (0.33 – 1.0 V/cm) as well as the effect of inorganic (NPK) fertilizer on the electrokinetic bioremediation of soil was evaluated. The results demonstrated that by the application of 0.33, 0.67 and 1.0 V/cm voltage, electricity biostimulation can be very effective (Agarry, 2017). The balanced nutrition level for a plant is provided by managing the pH and the electrical conductivity level of the fertilizer solution according to the soil pH and electrical conductivity (Kaur & Kumar, 2013). The promising direction for the intensification of the animal waste processing is in the creation of a specially formed pulsed high-voltage electric discharge inside the liquid volume under the influence of which the microbial flora – bacteria and fungi - intensively dies (Spiridonov et al., 2022). By using a specific electric fertilization apparatus, the mechanism of the electric field on the physical-chemical characteristics of the soil was studied. The preliminary conclusion is that the amount of chemical fertilizer may be saved under the effect of electricity (Yaqin et al., 1993), and chloride-free potash fertilizers can be made by electrodialysis metathesis (Han et al., 2018). Hard water causes many problems in domestic and industrial usage including in the area of agrochemicals, causing changes in the effectiveness of fertilizers, pesticides and ISR promoters. (Imai et al., 1997; Roskamp, 2012; Tharp & Sigler, 2013; Devkota & Johnson, 2016). The electrical potential of 6, 12, and 24 V can be used for removing water hardness instead of chemical treatments (Malakootian et al., 2010) and also for water hardness detection (Bhattacharjee et al., 2013). Hard water can also affect agrochemical adjuvants such as wettable agents and strikers (Hudson, 1934; DeBoer & Larson , 1961; Osorio et al., 2005), while the hardness of the water can be detected via various physical and chemical methods and devices (Capitán-Vallvey et al., 2003; Bhattacharjee et al., 2014; Bouhoun et al., 2021). It could be difficult to determine the sensitiveness of the agrochemical products, especially for complex natural based products additionally enhanced with various spray adjuvants.

In the present study, a simple method for this problem was examined by using a standard electronic (digital) multimeter widely available as a device and affordable with numerous applications in the field of electronics and electricity and many other scientific areas, including medicine and agriculture (Gonulol et al., 2008; Chen & Wang, 2018; Shadrin et al., 2019; Zhu et al., 2021).

MATERIALS AND METHODS

In the current research, several inorganic / organic rock meal based fertilizers with ISR activity were tested:

- Panamin Agro – with the following content of inorganic chemicals: SiO_2 – 29.29%; P_2O_5 – 0.05%; K_2O – 0.65%; MgO – 3.23%; $MgCO_3$ – 6.76%; CaO – 30.5%; $CaCO_3$ – 54.54%; Cu – 0.0008%; Zn – 0.0015% and Fe – 0.152%. pH = 8.8
- Panamin Suspension – with the following content of inorganic chemicals: CaO – 30.5% and MgO – 3.23%. pH = 8.8
- Panatop Immuno Active - with the following content of inorganic chemicals: CaO – 16.5% and MgO – 10.2%. pH = 6.8
- Panatop Immuno Active + with the following content of inorganic chemicals: CaO – 13%, MgO – 8% and Cu – 5.5%. pH = 6.8
- Panatop Immuno Safe - with the following content of inorganic chemicals: K_2O – 9.5%; SiO_2 – 20.5% and Cu – 0.3%. pH = 10.5
- Panatop Fulvic Max - with the following content of inorganic and organic chemicals: potassium fulvate – 23%; fulvic acids – 11.5%; humic acids – 9.2%; K_2O – 2.3%; amino acids – 3.5% and algae extract – 5.8%. pH = 7.5
- Panatop Alga Max - with the following content of inorganic and organic chemicals: seaweed extract – 50%, amino acids – 10%, organic carbon – 2.1%. Microelements: Fe – 0.12%; Mn – 0.06%; B – 0.04%; Zn – 0.04%, Cu – 0.02% and Mo – 0.004%. pH = 4.8
- Panatop Fulvic Start - with the following content of inorganic and organic chemicals: fulvic and humic acids – 20%, P_2O_5 – 5% and l-amino acids – 5%. Microelements: Zn – 0.5%, Mn – 0.5%, Cu – 0.2% and Mo – 0.05%. pH = 6.5

Electricity currents (alternated (AC) and direct current (DC)) of 6 volts AC and 5 volts DC were used in the conducted trials. For an alternated current (AC), an electrical transformer 220 Ṽ 50 Hz input power monophase Transformer AC EI41 Ferrite Corefrom to 6 AC Ṽ 50 Hz output was used – Figure.1

For a direct current, 220-230 AC Ṽ 50 Hz input to 5 V DC output converter was used – Figure.2

Two copper wires (2 mm diameter) dipped into the tested solutions were used to conduct AC / DC current into the tested solutions. The rlectronic multimeter UT131C was used for measuring AC / DC voltage on the electrodes. In a AC mode: resolution 0,1 V; accuracy +/- (1,2% + 3). In a DC mode: resolution 0, 01 V; accuracy +/- (0, 7% + 3). As control variants in the conducted tests, distilled water, 1% NaCl and $CuSO_4.5H_2O$ distilled water solutions were used. All test solutions were also prepared with distilled water at registered concentrations.

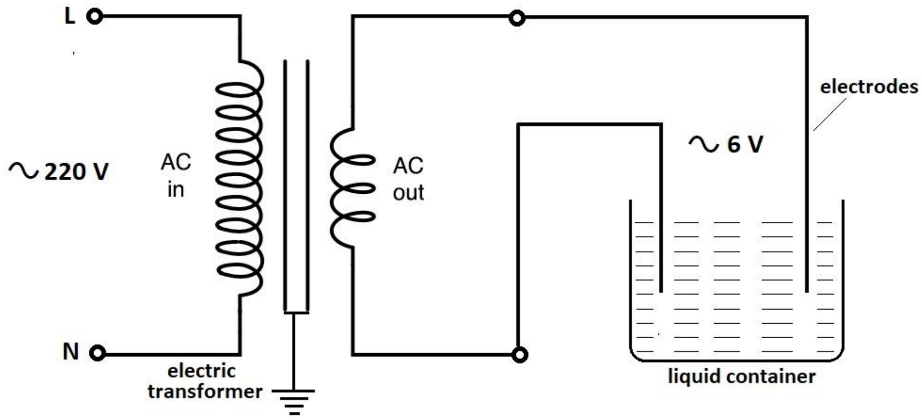

Figure. 1 AC 220 Ṽ 50 Hz input to AC 6 Ṽ 50 Hz output

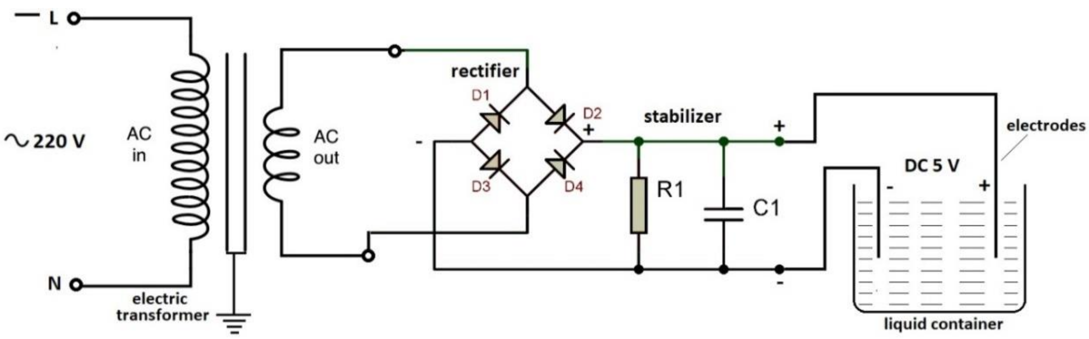

Figure. 2 AC 220 Ṽ 50 Hz input to DC 5 V output

Percent variation towards distilled water was calculated on the basis of the formula:

Percent variation towards distilled water = ((Voltage of test solution / Voltage of distilled water)*100) – 100

Hardness of the water was measured via a standard color tester Sumpeme –T-WH in ppm CaCO3 units.

RESULTS AND DISCUSSION

The first conducted tests were done with distilled water, hard tap water (with 196 ppm CaCO3 hardness), soft tap water (with 65 ppm CaCO3 hardness) and organosilicone surfactant Silwet L-77 at a registered 0.1% concentration. The water solution of the tested surfactant was made with distilled water. 1% distilled water solutions of NaCL and CuSO4.5H2O were also tested. The results are presented in the figure below (Figure.3)

The measured electric voltage when the electrodes were dipped into distilled water was 5 volts for DC and 6 volts for AC. There was no differences in the voltage when the electrodes were not dipped into the solution. However, from the figure above, it can be seen that when the electrodes were dipped into hard water, the voltage dropped by 1% caused by the hardness of water. In soft tap water, a decrease in the voltage was only by 0.4-0.5%. When the electrodes were dipped into a solution of typical electrolytes such as NaCL and CuSO4.5H2O, the dropping of the voltage was significant (4.6-4.7% for NaCL and 3.6- 3.7% for CuSO4.5H2O). In the presented figure, it is obvious that the oranosilicone surfactant does not cause any voltage dropping, just like with distilled water, which means that such products are not sensitive to water hardness. There are no differences in the conducted test between the two eclectic currents types DC and AC.

In the next Figure 4 the results received from the tests conducted with the tested fertilizers are presented.

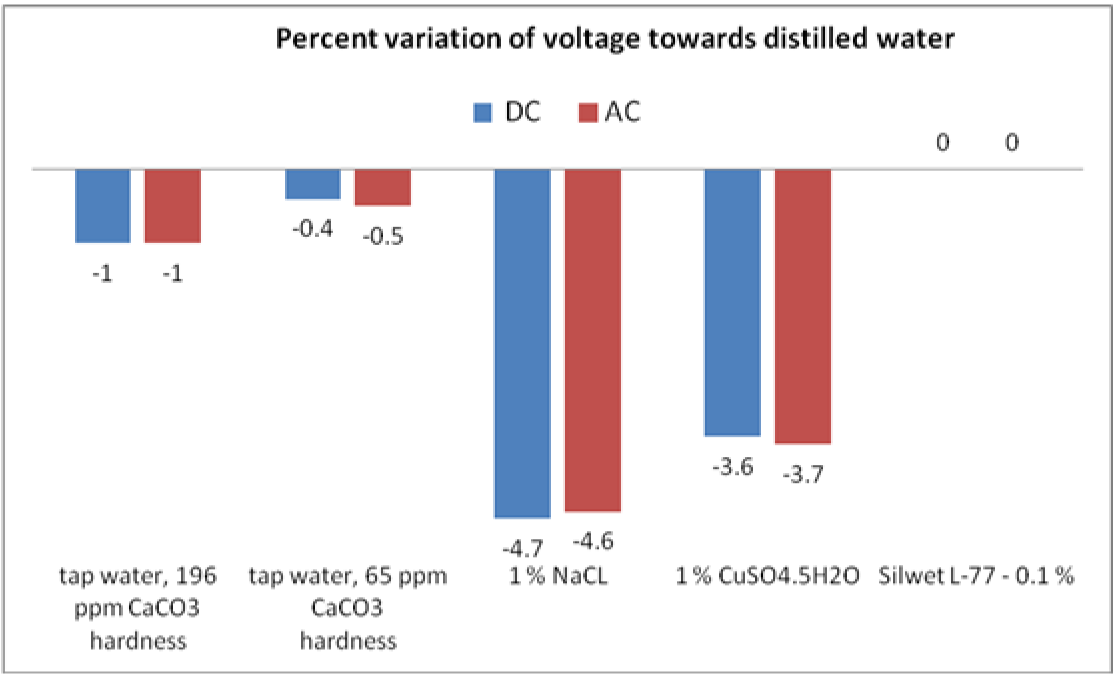

Figure 3. Percent variation of voltage towards distilled water

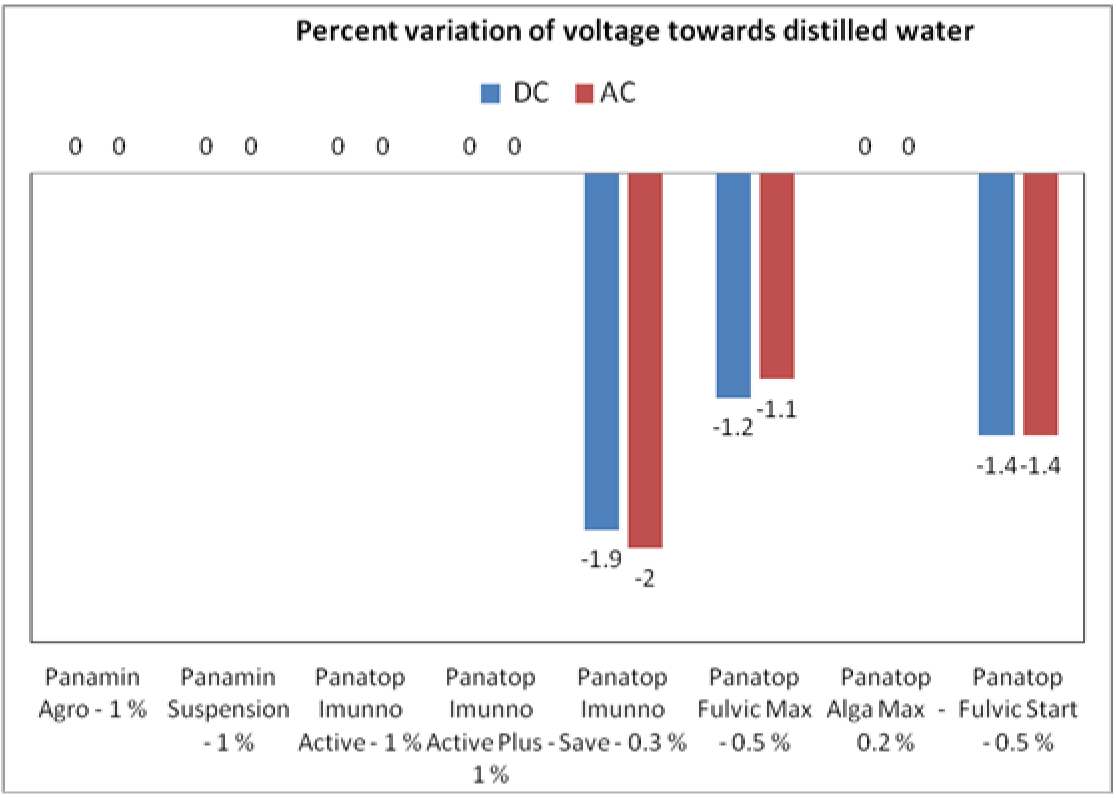

Figure 4. Percent variation of voltage towards distilled water

From the figure above, the received results confirm that there are no differences in the measured voltage when DC or AC is used. From the tested products, the distilled water solutions of Panatop Imunno Safe, Panatop Fulvic Max and Panatop Fulvic Start caused dropping of the electric voltage: -1.9-2% for Panatop Imunno Safe, -1.4% for Panatop Fulvic

Start and -1.1-1.2% for Panatop Fulvic Max. The results for Panatop Fulvic Max were identical with the values received with hard (196 ppm CaCO3) water and were surprising due to the fact that this product contains potassium fulvate - a chemical that is established to have decreased (elimination) the hardness of the water action (Mohamed et al., 2017; Zhou et l., 2018). The other five products do not cause any voltage dropping (i.e. identical action of distilled water), although Panatop Imunno Safe expresses greater voltage dropping, has a similar content as Panamin Agro which do not change the electric voltage. The same was with Panatop Immuno Active +, although this product contains 5.5% copper. However, all of the tested products containing fulvic acids express voltage decreasing activity.

CONCLUSION

The conducted test shows that three of the tested products: Panatop Imunno Safe, Panatop Fulvic Start and Panatop Fulvic Max express electrical activity measured as voltage dropping. Then their distilled water solutions were affected with low voltage electric currents of 5 volts for DC and 6 volts for AC., indicating electrolytic activity and, respectively, sensitiveness to the hardness of the water. The tested hard water (196 ppm CaCO3) causes identical electric activity as that caused by Panatop Fulvic Max. In the conducted trials, the tested organosilicone surfactant (which is non-polar type of sufractant) logically do not show any electric activity. The methods used in this research can be very applicable in the agricultural practice due to the simplicity of the used electrical devices and the accessibility and price of the measured device multimeter.

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