Electrical Conductivity: The Pulse of the Soil

In the soil, the conductor of electrical current is water. As soil moisture changes, electrical conductivity can vary.

by Glen Rabenberg & Christopher Kniffen

When we walk into our home on a dark night, the first thing we all do is turn on the lights. With the flip of a switch, we complete the electrical circuit initiating the flow of electricity to the lightbulb, illuminating our home.

In the human body, electricity controls the flow of blood from the heart to all organs. In the same way we flip a switch turning on the lights, electrical signaling in the body tells the heart when and how often to contract and relax. These electrical signals can be altered by the intake of nutrients. Case in point, the intake of high-salt foods can lead to a higher pulse rate. With a higher pulse rate, your heart and other organs must work harder in order to function properly. Certainly this extra work puts added stress on the body. In contrast, consuming a balanced form of energy can reduce the stress put upon the body. Waking up in the morning and only consuming caffeine does not give you the same energy as waking up and eating a balanced breakfast. While both inputs may increase your readiness in the morning, physiologically they affect the human body in different ways. Inputs into any biological system whether human, animal, plant or soil consequently will affect the system in different ways.

In 1946, Albert Einstein theorized that all matter is energy. His theory, which gave us the formula $E=mc^2$, laid the foundation for future generations to begin using energy theories in daily problem-solving. If all matter is equal, simply a form of energy, then conceptually the human system is no different than the soil/plant system. Furthermore, the same concepts which we apply to our own physical health can be applied to soil and plant health.

Quantifying the human body's energy level is done by monitoring pulse rate. In the soil, the current energy level in the field or in the lab can be achieved by measuring the electrical conductivity of the soil. Electrical conductivity is a direct measure of the energy flow in the soil system. Energy, measured in ergs (energy released per gram per second), is a function of the soil's ion concentration, clay type, moisture content, porosity, salinity and temperature. Traditionally soil consultants have used electrical conductivity to measure salinity, however conductivity can tell us much more about the physical structure and health of the soil. Based on these direct measurements, electrical conductivity can also indirectly measure crop productivity.

As consultants and growers we are focused on crop productivity. We often aim to maintain the nutrient or ion concentration in the soil solution best suited for the highest crop production. This ion concentration is expressed by the quantity of ions surrounding the diffuse layer of the soil colloid and also by the soil's moisture content. Electrical conductivity is a direct measurement of these factors and can be used in the field to tell us how much energy is available for plant growth.

It is important to note that natural fluctuations in electrical conductivity can occur. In the soil, the conductor of electrical current is water. As soil moisture changes due to dry periods and/or rainfall events, electrical conductivity can vary. Abiotic factors are variables in the accurate representation of the ion concentration in the soil solution. However, overall, if the electrical conductivity (concentration of ions in the soil solution) is either too high or too low it will be reflected in decreased crop productivity. From our experience, the majority of problems facing growers and consultants can be related to abnormal electrical conductivities.

Crop productivity is governed by three disciplines of science: physics, chemistry and biology. Explaining electrical conductivity on a chemical or biological level requires a much more lengthy and detailed explanation. By focusing on the physics of electrical conductivity, referring to it as energy, simplicity can be brought to such a complex topic.

Einstein taught us that an object's mass is a function of energy. If you apply this concept to crop production, crops (mass) are simply an expression of energy. In order to produce mass (yield), energy is needed. For a plant to perform

photosynthesis and produce mass; an initial energy requirement must be met. This energy requirement comes largely from the electrical current in the soil. Thus, soil electrical conductivity can be utilized as a direct measurement of energy and an indirect measurement of crop productivity.

CROP PRODUCTIVITY

Crop productivity can be simplified into two stages: growth and decomposition. We can discern that the growth stage of the plant life cycle has different energy requirements than the decomposition stage. The energy needed to produce mass in the form of plant growth varies between 200 and 800 ergs. When the energy in the soil falls below or above these values for a prolonged period of time, the plant can no longer produce mass (growth) and decomposition will set in. With the onset of decomposition in the plant tissue, disease and decay will follow. During the growth life cycle of the plant, energy must be present to produce mass (growth).

In order to produce mass in the form of a nutrient-dense, healthy plant, the energy coming from the electrical conductivity of the soil must come from "good" sources. Electrical conductivity coming from biological activity, flocculation, soil moisture and clean balanced nutrients (ions) can be considered "good" sources of energy. Electrical conductivity coming from salinity in the soil solution can be defined as a "bad" source of energy. "Bad" sources of energy will produce nutrient-poor, unhealthy, low-energy and quickly decomposable mass. Nutrient-dense, healthy, high-energy plant mass is what we as consultants and growers should be trying to achieve. Yes, by using these "bad" sources of energy you can produce high quantities of mass (high yields). We see this year in, year out with the use of synthetic fertilizers. However, if your goal is to produce high-quality, nutrient-dense, healthy plant mass, your energy source must come from "good" sources. Low salt fertilizers, organic matter, biological amendments, cover cropping and proper soil stewardship can provide your soil with "good" sources of energy. All of which indirectly restores your soils' fertility and sustainability for future generations.

If all matter is energy and all energy is matter, we as consultants and growers must begin to think in terms of energy. In order for seeds to germinate, an energy requirement must be met. In order for plants to grow, an energy requirement must be met. In order for plants to reproduce, an energy requirement must be met. In order for plants to dry out and be harvested, an energy requirement must be met. In order for your soil to repair itself over winter, an energy requirement must be met. And in order for you to have read this article, an energy requirement was met.

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Glen Rabenberg is the CEO and owner of Soil Works LLC. Soil Works LLC is home to Genesis Soil Rite Calcium, PhosRite, TestRite Labs and GrowRite Greenhouse. Glen Rabenberg still maintains his third-generation farm in Bancroft, South Dakota, and extensively travels the world solving soil problems with a little bit of simplicity and the "rite" tools.

Christopher Kniffen is writer, public speaker and manager of the research and development department of Soil Works LLC. For more information Rabenberg and Kniffen can be reached at Soil Works LLC. 4200 W. 8th St., Yankton, SD 57078, 605-260-0784.

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