Electrical Conductivity

The Pulse of the Soil

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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 you complete the electrical circuit initiating the flow of electricity to a light bulb that illuminates your home. In the human body, your heart operates in a similar fashion. The flow of blood from your heart to all organs is controlled by electrical signaling. The heart's electrical system tells it heart when and how often to contract and relax. This electrical system or pulse can be altered by the intake of ions and activity level. For example, the intake of high salt foods can lead to a higher pulse rate, which is viewed by physicians as a "bad" form of energy. On the other hand, a balanced form of energy intake affects your electrical system in a positive way. This energy is viewed by physicians as "good" energy. Waking up in the morning and only consuming caffeine does not give you the same energy as waking up and eating a balanced breakfast. Inputs into any biological system either human, animal, plant or soil will affect the energy level of that system.

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 and simply a form of energy than the human electrical system can be analogous to the soil/plant system. Furthermore, the same concepts we apply to matter can be applied to our own physical health as well as the soil and plant health.

Consultants seeking to quantify the soils current energy level can be achieved in the field or in the lab by measuring the electrical conductivity of the soil. Electrical conductivity is a direct measurement of the energy flow in the soil. The level of energy in the soil can be a function of the soils ion concentration, clay type, moisture content, porosity, salinity, and temperature (Rhoades et al., 1989; McNeil, 1980; Johnson et al., 2001). Traditionally soil consultants have used electrical conductivity to measure salinity, however conductivity can also 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 (McBride et al. 1990).

As consultants and growers we are focused on crop productivity. We often aim to maintain the ion concentration in the soil solution best suited for the highest crop production. This ion concentration is expressed by the quantity of ions in the diffuse layer of the soil colloid and also by the soils moisture content. Electrical conductivity can be used in the field to tell us the 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. 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 (Eigenberg et. Al., 2002).

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 $E=MC^2$. This concept expresses that an object's mass is a function of energy. If you apply this concept to crop production, crops (mass) is 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 is a direct measurement of energy and an indirect measurement of 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 a different energy requirements than the decomposition stage. The energy needed to produce mass in the form of plant growth varies between 300 and 800 microsiemens/ergs. When the energy in the soil falls below or above these values for a prolonged period of time, the plant no longer can 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 are all trying to achieve. Yes, by using "bad" sources of energy you can produce high quantities of mass (high yields). We see this year in and 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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