Carey Reams' Testing & Evaluation Methods

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The Reams soil test was developed to reflect, in the test values, characteristics actually observed in the field, including soil compaction and tilth, weed and pest problems, crop quality and yield, and overall stability of soil and plant nutrients. No other testing system can make such a claim.

Because of the drawbacks inherent in traditional soil testing, Reams adopted a system that closely resembled the biologically soluble level of major nutrients. Reams understood that just because a nutrient was present did not guarantee that it was of any value, analogous to being in the middle of the ocean and suffering from a lack of water. He tested calcium, phosphate, potash, nitrate and ammoniacal nitrogens, ERGS (conductivity in micromhos or microsiemen), and various trace elements.

Using this method, now known as the Reams test (which makes use of the LaMotte testing kit and the Morgan procedure), Reams established the following nutrient levels for a minimally balanced soil:

Calcium	2,000-4,000 lbs.
Magnesium	285-570 lbs.
Phosphate	400 lbs.
Potash	200 lbs.
Nitrate nitrogen	40 lbs.
Ammonium nitrogen	40 lbs.
Sulfate	200 lbs.
ERGS 200-600	micromhos
pH	6-7
Sodium	20-70 ppm

Reams developed his ratios by observing nature and evaluating the soil in conjunction with such observation. Consequently, using the Reams soil test, many soil characteristics can be identified before one sets foot in the field.

For example, if the calcium level is less than 2,000 pounds per acre, there will be possible energy-reserve deficiencies, weakened skin and cell strength, bruising susceptibility of fruit, soil compaction — especially if there is a narrow calcium-to-magnesium ratio (7:1) — weakened stems or stalks, and grass/weed problems. Further related to the calcium-to-magnesium ratio is the fact that a narrow ratio reduces nitrogen efficiency, requiring additional applications of that nutrient.

When the phosphate-to-potash ratio is less than 2:1 for row crops and 4:1 for forage crops, it will be difficult to sustain crop refractometer readings above 12 brix at the crop's weakest point. There also will be less than maximum production and crop vigor, as well as broadleaf weed problems and the possibility of insect and disease infestation.

The nitrate nitrogen levels indicate the potential growth status of the nutrient reserves in the soil. If this level gets too high, there will be problems with blossom drop and in getting fruit to set. High nitrate nitrogen levels also increase the potential for frost damage and winter kill, especially if the phosphate levels are less than desirable.

A low ammoniacal nitrogen level indicates poor biological activity and stability. The nitrate nitrogen levels on the Reams test are relatively easy to achieve with applications of chemical nitrogen. The ammoniacal nitrogen, however, will not remain until a very active microorganism system is established. The ammoniacal nitrogen seems to be one of the last factors to come into line when regenerating a soil.

Sulfate, the next item on the test, is not to be confused with elemental sulfur. Elemental sulfur can cause rot at maturity of fruit and can tie up or interfere with calcium. Sulfate, on the other hand, can help enhance calcium availability, is needed in certain protein and enzyme complexes, and sometimes can aid in mellowing the soil. However, it is possible to apply too much sulfate, which seems to be happening in some areas in an attempt to "hammer down" soil pH with large amounts of gypsum and sulfuric add. This practice causes additional salt problems, calcium demand and microbial stress.

ERGS (energy released per gram of soil), measured in micromhos or microsiemen, represents the amount of energy available to the growing crops and microorganisms. The reading must be interpreted in relationship to the inherent conductivity of the base soil due to salts and nonnutrient minerals. If the overall reading gets above 1,000, there is generally a salt problem, energy loss and waste, and increased potential for root burn and nematode proliferation. If the ERGS level drops below 200, little or no crop growth is occurring. Late-season crop finishing is directly correlated to the ERGS level.

Soil pH is an indicator of energy resistance. It varies throughout the growing season and is a reflection of what types of microorganisms are flourishing. Extremes in pH can indicate problems — with vegetative growth if pH is too low, or with fruiting if pH is too high. Soil pH will vary throughout the growing season and should be monitored to track this change — maximum nutrient exchange occurs between 6 and 7 pH. It is also a handy indicator in checking foliar sprays. Ideally, the final spray will be between 6 and 7 pH. Some people contend that foliar sprays should be between 4 and 5.5 pH because research has shown that plant sap is close to this level. It is — under inferior nutritional standards and low refractometer readings. It is also easier for the chemical people to get higher-analysis spray solutions when the pH is this low, but that does not mean it is ideal for the plant or the efficiency of the spray.

Sodium is a fairly ubiquitous element, yet it can often become problematic when in excess concentrations. As sodium concentration surpasses 70 ppm, the soil will become increasingly dumpy and compact, exemplify poor water-exchange characteristics, require greater calcium levels for balance, and show excessive ERGS levels.

Reams observed that if he took care to balance the soil sufficiently to achieve these test values, his crops would be free of insect, disease, and weed infestations; they would be nutritionally sound, give excellent yield, be profitable, and be repeatable. Reams knew he could not achieve these results if he ignored the microbiology. Consequently, he taught that it was essential to learn basic biology applied to agronomy. He found that destitute microbes responded to sugar or molasses and calcium. In fact, the microbes responded to the same things he postulated to be necessary for the crops.

The key to Reams' program, though, was energy. He realized that nature could not be described within the confines of any mechanistic theory of chemistry. Nature is energetic and thus encompasses chemistry and every other science.

The major conceptual aspects of Reams's teachings involve the use of fertilizers. Reams advocated applying several tons of high-calcium lime and a ton of soft rock phosphate per acre, as well as several tons of chicken manure. These recommendations are conceptual relative to today's applications. They were developed several decades ago in different conditions, and subsequent experience has shown that if smaller amounts of these materials are applied, we often get better results. The challenge in most areas is determining what to use to get the calcium and phosphate in line.

Reams used soft rock phosphate rather than acidized or hard rock phosphate. Although he was not opposed to hard rock phosphate, he preferred to use soft rock because it was colloidal. Colloidal particles are the key to biological systems. They do not tie up as readily as do noncolloidal materials. Reams found that, over the long term, the only way to achieve the phosphate availability of 400 pounds per acre in a 2:1 ratio with potash on the Reams soil test was by using soft rock phosphate.

Reams used calcium carbonate, never dolomite. He observed that sufficient magnesium would be available if he balanced the calcium, phosphate and microorganisms and then applied fertilizer quantities of sul-po-mag. Magnesium, he found, interfered with nitrogen. Large amounts of magnesium require large amounts of nitrogen and vice versa. An excess of magnesium relative to calcium also causes the soil to compact, thus further degrading the microsystem of the soil.

In traditional agriculture, plant-tissue testing is done in addition to soil testing to evaluate the need for nutrients. Reams placed little credence in plant-tissue analyses for two reasons. First, they test symptoms, not causes — plants are reflections of the soil. Second, they are evaluated using suboptimum health standards. Farmers may find that their crop possesses adequate levels of nutrients according to the tissue analyses, yet the crop still has a low refractometer reading, insect and disease infestation, poor shelf life, and so on.

For tissue analyses to be of value, the standards that the farmer is seeking to achieve for his crop must be increased to represent the actual crop quality that is found when plants are nutritionally sound and not dependent on chemicals to protect them from insect pests.

At present, there are no standard correlations between tissue analyses and refractometer readings. In establishing these correlations, distinctions must be made between leaf, vein and petiole evaluations. The lower the nutrient balance, the greater the variation will be between the parts of the plants, both in the refractometer readings and the nutrient analyses.

Multiple nutrient interactions also must be considered. For example, magnesium regulates nitrogen in the plant's system. If the magnesium level decreases too much, there will be an excess of free nitrogen in the system; this free nitrogen carries water with it, resulting in a diluted nutrient concentration, a lower refractometer reading, and lower plant health.

Using the Reams soil test, we can predict accurately whether soil compaction is present in the field. This can be determined by evaluating the calcium-to-magnesium ratio. If this ratio is less than seven pounds of calcium to one pound of magnesium, compaction will occur. Even at a 7:1 ratio, if there are more than 70 parts per million (mg/liter) of sodium, there will be compaction. As these ratios come into line, compaction decreases until it ceases to be a problem. People often blame compaction on heavy equipment and frequent traffic across the soil. These things do cause compaction of soils with calcium-to-magnesium ratios of less than 7:1. They do not cause compaction of soils with calcium-to-magnesium ratios of 7:1 or more and less than 70 parts per million of sodium. Compaction is a phenomenon of physics (partide attraction/repulsion) and aeration.

Take two magnets and hold them together, north pole to north pole. Then release your grip on the magnets and observe what happens. The magnets separate by themselves. Proper mineral ratios in the soil reflect the same phenomenon. You can press the soil particles together, but as soon as the compression is released, the partides repel each other.

Now take a sponge, place it on the floor, and step on it. It compresses. Lift your foot, and the sponge returns to its original form. Pick up the sponge and inspect it closely. Notice that it contains as much air space as sponge material. The air space allows the sponge to be compressed and then to return to its original form after the compression passes. This is what happens in the soil once biological activity and humus are restored. The soil will function like a sponge, even under the heaviest farm equipment. The biological activity and humus are restored in direct proportion to the restoration of the calcium-to-magnesium ratio.

The calcium-to-magnesium and phosphate-to-potash ratios constitute the bulk of information from the soil test. One must remember, though, that the soil test indicates only *what was happening when the soil was tested.* Traditional opinion suggests that soil be tested only once a year, at the most. Ideally, however, a farmer should use the Reams test each week of the growing season, charting the variations in nutrient levels.

Initially and every few years, it also is beneficial to compare the Reams test results to those of a conventional soil test from a reputable firm to establish a guideline as to the reserve nutrient levels in the soil. The combination of these two tests provides a directive concerning the approach to take in fertilization. For example, if the coinventional test indicated several thousand pounds of calcium but the Reams test indicated only several hundred, we would know that there is poor microbial activity. Initially, our fertilization approach would probably favor those materials that would catalyze the releasing of calcium rather than the building of a calcium reserve. Such materials might be sugar, molasses, vitamin B_{12}, humic acid, fermentation products, enzyme materials, liquid calcium products, hydrogen peroxide, compost, or simply aeration of the soil.

If, on the other hand, both the conventional and the Reams test showed only several hundred pounds of calcium, we could assume that there was very little calcium with which to work. In this case, we would apply a few to several hundred pounds of calcium carbonate (high-calcium lime) in either ground or pelleted form, in addition to the catalyst materials previously mentioned, to gradually build the calcium base.

Even in the first example, if economics permitted, we would probably apply a few hundred pounds of calcium carbonate per acre. In traditional practice, calcium is treated as a soil amendment and is applied by the ton rather than by the pound. We are treating calcium as a nutrient and applying it as a fertilizer, in fertilizer quantities. This is not to say that one cannot benefit from applying a ton or two of calcium carbonate to the soil, but this would be our second choice. Keep the quantities low in the spring or just before a crop is planted. This timing will lessen the chance of reducing the yield. Several applications of a few hundred pounds of lime will give better results more quickly than single large applications.

Farmers often ask how they can decrease their magnesium, potash or other excess nutrients. In some cases, certain nutrients will actually decline when the overall nutrient balance comes into line as the microorganism population is regenerated. One such nutrient is sodium. Often, high sodium levels will actually drop due to soil regeneration. This is due to complexing and perhaps transmutation of the sodium.

To correct the imbalance, raise the other nutrients. If you have a 2:1 calcium-to-magnesium ratio, correct it by raising the calcium. If you have a 4:1 potash-to-phosphate ratio (very common in American agriculture), correct it by raising the phosphate. Sugar is an important component to add to acid phosphates. It helps buffer the phosphate and make it compatible with microorganisms. Especially relative to phosphate is microorganism activity — it is imperative to stimulate this activity in order to get the 2:1 phosphate-to-potash ratio on the Reams test.

It is advisable to couple any soil test with field history and characteristics to further correlate the soil-test nutrient levels to their meanings. The more complete the picture formed from these data, the more effective will be one's fertility recommendations. Accurate record keeping is essential, as is soil testing at least once during the growing season to establish nutrient status under load. Nutrient draw from the soil is greatest during the latter part of the growing season. This is when we want to know how the soil is performing "under load." An analogy would be to evaluate the capacity of a water-well aquifer while the pump is pumping full capacity, versus while the pump is idle. No single item will show you the entire situation. All items must be combined with astute field observation and common sense. No number is perfect unless all the numbers are perfect.

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