AEA Core Concept #16

Complete nutrition accelerates photosynthesis.

Photosynthesis is at the very foundation of plant health and what it takes to produce healthy, high quality plants. Few recognize that our plants today are not nearly photosynthesizing to the potential that exists. To achieve the sugar and energy production potentials, we need complete nutrition to accelerate that photosynthetic process.

If we look at the overall biological plant growth and soil system, photosynthesis is the limiting factor. It's the engine that drives the entire process. Anything that slows down photosynthesis is going to slow down the entire plant production system.

Photosynthesis can be limited by mineral nutrition. Mineral nutrition can be limited by soil biological activity. Soil biological activity can be limited by photosynthesis. Its a complete circle process, starting with photosynthesis and the sending of sugars to the roots and out of the roots as exudates.

The question for us as farm managers is "where can we hack the system and greatly accelerate performance?" The answer is by ensuring that plants have adequate mineral nutrition. With adequate nutrition we accelerate photosynthesis and the rest of the system responds accordingly.

There are very specific biochemical pathways and chemical processes to form sugars during the photosynthetic process. With proper mineral nutrition, a couple of things begin to happen.

First, leaves usually tend to become bigger, wider, and darker green. That expanded leaf surface equates to greater photosynthetic capacity to support the rest of the plant. At the same time, you also usually get thicker leaves. With thicker leaves you have additional layers of chloroplasts and cells inside the leaf, and you get greater depth of chlorophyll. Lastly, with good nutritional integrity, you get greater concentrations of chlorophyll. This is the greening response that we get when we put on nitrogen, magnesium, iron or manganese. Three of those nutrients (magnesium, iron and nitrogen) are involved in developing the chlorophyll molecules. So when we increase the levels of those nutrients in the leaf, we're going to have increased chlorophyll concentration which allows that leaf to capture more sunlight and consequently produce more sugars.

Many of the crops that we're producing today are consistently only photosynthesizing at 15 – 25% of their capacity, sometimes even less. It is entirely possible to get plants to produce much higher levels of sugar and have much higher levels of energy when they're photosynthesizing to their greatest capacity. That translates to greater levels of yield, quality and all the other benefits.

In hacking the plant growth system we use foliar applications of nutrients to ensure complete nutritional integrity. This is a favorite way to get much higher levels of performance. It's a trigger with which we can put on a small amount of material and get a very big response.

One common question that I get a lot is this, "how can regenerative farming systems (for example, using foliar sprays) lead to long-term, truly sustainable systems?" In regenerative systems, we want to use models in which we're building soil and plant health – and where both of those are constantly evolving to ever higher performance. From my perspective, foliar applications of plant nutrition are a tool that can be used in both a regenerative and a

sustainable model. In a regenerative model, they're absolutely crucial. We need them to get to higher levels of performance, including building soils. Once we have achieved a much higher level of performance, we are no longer dependent on foliar applications. We can still get a strong plant response from using them, but they are no longer required for high levels of performance.

This is what the use of foliar sprays should look like. First, the primary intention of any foliar application should be to accelerate photosynthesis. The secondary intention should be to correct nutritional imbalances. Even when we have nutritional deficiencies, they should always be incorporated into a foliar application that is intended and designed to increase the photosynthetic capacity of that plant. If we put on a foliar application and we do not get an increase of sugar production in that plant, that foliar application has not been successful.

With our intention is to accelerate photosynthesis, foliar applications over time in a regenerative model would look like what follows. Let's say we start with an alfalfa crop, and we have a low sugar content which is common - let's say a brix reading of 4. We put on a properly designed foliar application, that brix reading spikes from a 4 to a 12 in a matter of 6 to 8 hours. If we don't get that spike in sugar production, we've not been successful with our foliar spray, i.e. the material that we used did not get the intended results.

There could be a variety of reasons for no response. If we put on a foliar spray in really dry conditions and there's no moisture and the plant isn't photosynthesizing or it's too hot, we're not going to get that response because the plant isn't going to absorb the nutrition very well.

We need to get that spike in the brix reading from 4 to 12, and that should happen very quickly. Over time, that spike is likely going to drop back down to 4. The time it takes depends on the health of the soil and the crops. If the plants are really unhealthy, and have very low energy, and the soil is really unhealthy with very low in energy, the brix can drop from 12 to 4 in a matter of 1- 3 weeks. If the soil and the plants are really healthy, it will sustain that curve for a much longer time. It'll drop from 12 down to 4 over a period of maybe 6 – 8 weeks.

Once that level has dropped back down, we put on a second foliar application and we spike it back up to a 12. Over time, it gradually drops back down to 4. Then we put on a third foliar application; it spikes it back up to 12. This time, it drops back down to 6. We put on a fourth foliar application, spike it up to 14 and this time it drops back down to 8.

The time to consistently reach high brix levels will depend on the crop, the plant's root system, soil biological activity, and soil health. Over a period of 18 to 36 months, we can usually raise the plateau of the overall sugar production from a baseline of 4 to a baseline of 10 to 12.
At that stage we have a truly sustainable system because at that baseline of 10 to 12, that plant is producing enough sugars and sending enough sugars downstairs to build a really aggressive soil microbial community and is able to extract minerals from the soil mineral matrix and to build soil organic matter while growing a crop. That's the foundation of a really regenerative system – healthy plants that are photosynthesizing really well.

The judicious use of foliar applications is our fastest and most effective hack to get to higher brix levels. Foliar applications are not a replacement for soil amendments if we have soils that are depleted in certain nutrients. I am suggesting that foliar applications are an inexpensive way to get a tremendous response from our crops.

Here is an example. On this farm, the two alfalfa leaves shown here were taken from the same location. The leaves on the right received no foliar application, and the leaves on the left got a

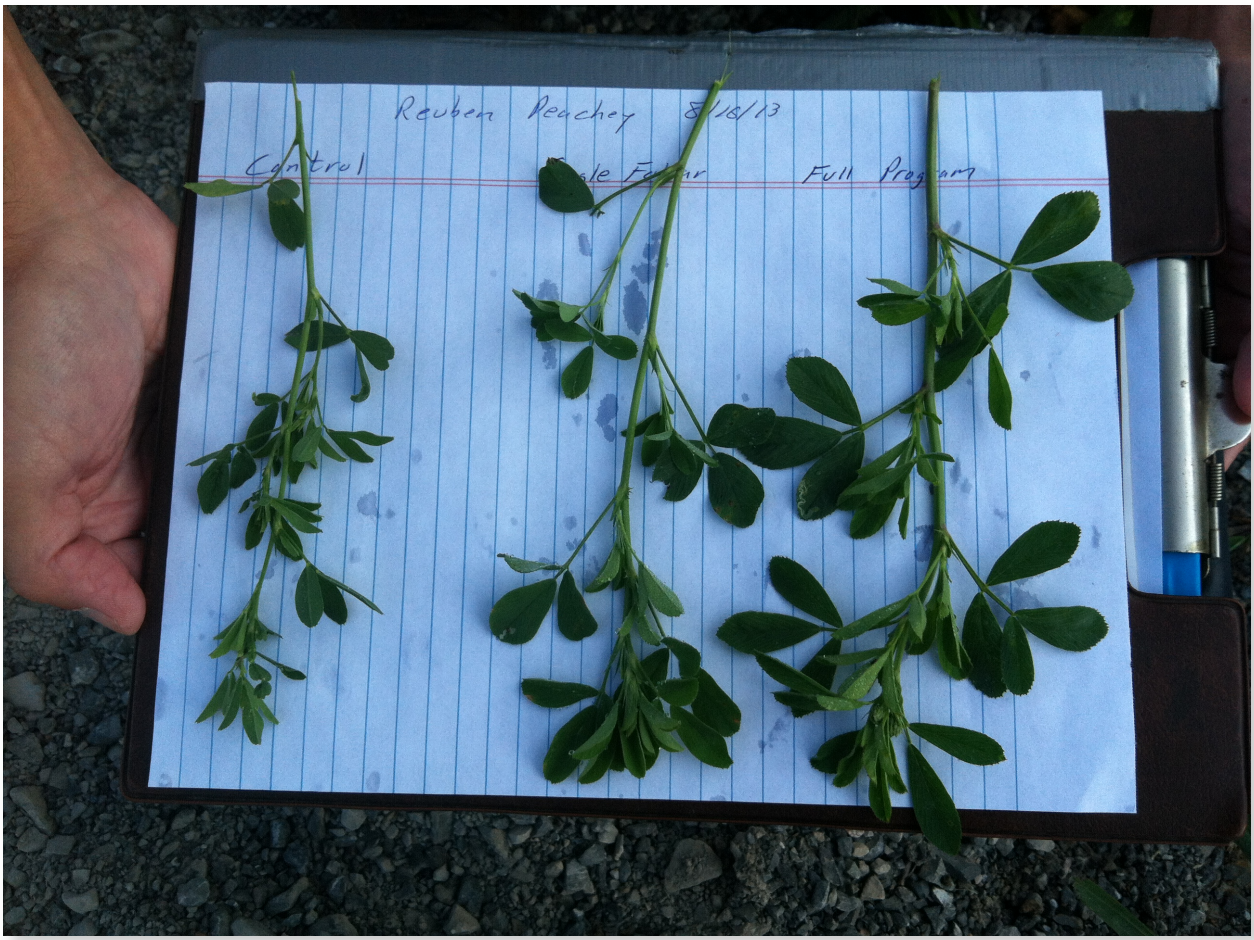
single foliar application. There are obvious differences in the leaf shape and size and the color; the ones with foliar sprays are a much darker green.

There's more to this farm story. A customer that we've worked with for several years moved on to a new farm in the spring of 2013. This farm had several alfalfa fields which were not doing very well. After some soil analysis, he broadcast across the entire field a combination of limestone and phosphate and compost and several other trace mineral soil amendments. The entire field got treated with the dry broadcast.

Then he split the field into three different sections. These pictures were taken at the time of the third cutting. The first section received no foliar applications, the second a single foliar application after the first cutting, and the third section a foliar application after both the first and the second cutting.

This picture was taken before harvesting the third cutting. On the left is the untreated, in the center is the single foliar application, and on the right is the double application. There's obviously very significant differences here in total biomass production. If you look at the difference in leaf to stem ratio, you have much bigger leaves and a lot more leaves on those that had the additional foliars.

Concerning the biomass, the untreated control had the smallest stem – and that stem was hollow. The plants with the single foliar application had a larger stem and that stem was partially



filled with pectins. The plants with the double foliar application had a solid stem, completely filled with pectins. These pectins are highly digestible carbohydrates and an available energy source for dairy cattle or other livestock.

An interesting point. The alfalfa that had the largest and most digestible stem also dried down the fastest. I believe the reason that the healthy, larger stemmed alfalfa dries down faster is due to the plant continuing to respire after it has been cut. This does not happen with plants that are unhealthy.

Yields of the alfalfa significantly increased with the application of foliars. The double foliar application yielded an additional 1½ tons per acre over the course of three cuttings. The cost of the foliars was $26 per acre per application. Beyond the yield is the additional gain that is reflected in the quality.

For the double foliar application, we had much greater absorption and much higher plant levels of calcium, phosphorus, and magnesium than we did on the untreated control, even though there was no calcium and no phosphorous and only limited amounts of magnesium in the foliar application.

If we look at the additional biomass that was removed, there were much greater levels of calcium and potassium removed in pounds per acre on the fully treated crop, even though they were not

applied in the foliar applications. They came from the soil mineral profile because of accelerated soil biological activity.

This example is what we are talking about as the foundation of regenerative concepts and principles. It shows what is possible when soil and plant systems are functioning as they were designed and intended to function. This successful production is an example of what we can produce and maintain on many types of crops.

While photosynthesis is understood to be the very foundation of what makes healthy, high quality plants, our plants today are not photosynthesizing to their full potential. Many crops are only photosynthesizing at 15-25% of their capacity, sometimes even less. Using mineral nutrition, we can get plants to produce much higher levels of sugar and energy, giving us higher yields and better quality crops. The best way to 'hack' the photosynthetic cycle, if you will, is through the use of foliar applications.

If we apply a foliar application and do not see an increase in plant sugar production, the application has not been successful. The primary intention of any foliar application should always be the acceleration of photosynthesis. Foliar applications are no replacement for soil amendments for a nutrient-depleted soil geology; but they are an inexpensive way to derive tremendous benefits from crops with a functional soil mineral matrix.