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Plant Health Pyramid

Soil health and plant health are closely related. Most pest issues are due to inadequate plant nutrition and poor plant health. Most weeds thrive where at least one plant nutrient is lacking. Healthy plants have adequate nutrients levels to repel insects and disease organisms. Healthy soils promote healthy plants by providing adequate plant nutrition for plants to thrive.

The first step to improving plant health is producing carbohydrates which are the building blocks for proteins. About 50% of a plant's carbohydrates are allocated to above ground growth and 50% to root growth. Plants convert carbon dioxide and water into sugars using sunlight as the energy source in photosynthesis. Plants allocates sugar to the roots to produce root exudates to feed the soil microbes which make soil nutrients plant available for building proteins.

In the second step, the plants are looking for nitrogen to form amino acids, peptides, and proteins. Here is where plant health often starts to decline. The plant prefers whole proteins, peptides, or amino acids first, then urea ($\text{CO}(\text{NH}_2)_2$), ammonia (NH_3), ammonium (NH_4^+) and finally nitrates (NO_3^-). When plants absorb only nitrates, it takes 25% more plant energy (16% of all plant photosynthetic activity) and 3X more water to convert it to the amide form (NH_2^+) which is used to form amino acids, then peptides, and then complete proteins. Growers can take advantage of this preference by supplying growing plants with their preferred nitrogen form as they mature.

The problem for the plant is that ammonia and ammonium nitrogen forms can be toxic, so the plant needs these nutrients at low concentration levels. In other words, the plant needs these nutrients to be spoon fed constantly in small amounts. Soil microbes convert most nitrogen forms to the nitrate form fairly quickly. In most soils and plants, nitrogen is taken up in the least efficient form (nitrates). In healthy soils, plants obtain more of their nitrogen as whole proteins, peptides, amino acids, or in the amide form from soil microbes; which requires overall less plant energy and leads to higher plant health. Part of the reason plants are healthier is because they use less energy.

When plants are becoming really healthy, the third step is that they get fat! As energy is used more efficiently, excess sugar is used to form plants lipids which are fats. The best tasting food (plant or animal) and highest quality food is high in lipids or fat. Fruit high in lipids is unform and nutrient dense with many essential minerals, which means it tastes really good! Livestock

and people can tell the difference! When you eat a really good slice of fruit or vegetable, the flavor is excellent because of the high-density nutrients and the lipids (healthy fat) in that produce. High plant lipid content is an indication of excellent plant health.

High levels of micro-nutrients are needed by the plant to form higher level proteins called enzymes. Enzymes greatly speed up biological reactions in the plant by lowering the amount of energy required to form a molecule. Enzymes are used over and over by the plant to increase biological and energy efficiency. Some enzymes can allow ten thousand or more biological reactions to occur in a matter of seconds. A micro-nutrient that is lacking may be needed to activate a key plant enzyme to increase yield and or grain quality. That's why plant mineral nutrition of all elements is so important. Planting cover crops this fall helps soil microbes make micro-nutrients available to plants next spring.

At the very top level of the plant health pyramid is high density, high quality, high yielding food. Weeds can not compete with healthy plants, due to shading and competition for nutrients. Insects cannot attack, process or digest plants with whole proteins and dense nutrients. Insects are looking for unhealthy plants with high nitrate levels and low protein levels which are easy to digest. Most diseases are related to micro-nutrient deficiencies, insect damage, and unhealthy plants; because these plants are leaky and easy for disease organisms to attack. A goal should be to process all plant nitrogen forms into proteins within 24 hours, an indication of excellent plant health.

Scientists estimate that plants are currently only utilizing 20% of their genetic potential for yield. Corn could potentially produce 1100 bushel and soybeans 600 bushel per acre if conditions were perfect. While it's not realistic to expect these kind of crop yields; improving plant nutrition, plant health, and soil health can improve not only crop yields but also produce healthy nutrient dense food while protecting the environment.