GENESYS SPECIALTY GROUP MANUAL

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Nutrient Dense Cropping is a relatively new term meaning fertilizing with fewer chemicals, balanced soils, and a cleaner environment. This concept is driven by consumers worried about chemicals in food. Environmentalists concerned with groundwater contamination and soil erosion, and Agriculturists anxious about safe, profitable business that can be passed on to future generations. Unlike other buzzwords such as low-input, organic, alternative, regenerative, and natural to name a few, managed inputs are well defined and have specific guidelines to promote success. The questions are: Does it work? And what effect does it have on quality, weeds, and operations?

First let's look at what Nutrient Dense Cropping is not. It is not strictly organic or just reducing inputs.
Nutrient Dense Cropping is a system a process with rules; working with natural laws, requiring an understanding of goals to be accomplished. When finding a system, goals and objectives need to be examined, such as working with Mother Nature or exploiting her. Now the "what" of Nutrient Dense Cropping is apparent, let us look at the "how".

There are five basic rules to follow in Nutrient Dense Cropping. These have been determined by accident or by decision, either way, they work.

1 - Analysis Aids in Balancing Soil

Good soil is a living thing made up of minerals, water, air, organic matter which converts to humus, all are necessary for healthy, high quality crops. Good soil is not the only factor, plants also need nutrients.

There are at least sixteen elements needed in the proper amounts to balance the soil. These nutrients include nitrogen, phosphorus, potassium, calcium, sulfur, magnesium and others. Both macronutrients and secondary elements or micronutrients are needed. Because these nutrients must be used in specific amounts, soil analysis is necessary. The soil is tested to find nutrient deficiencies and excesses, aiding in choosing a fertilizer suitable for your project and the most for your dollar. Unbalanced soil may reduce quality, and could possibly trigger weed, pest, and disease attack. Weeds aren't a curse, just an index of the character of the soil. By changing the soil structure with correct nutrients balance you can reduce and alter weed populations, how would you know what is happening unless the soil is tested regularly.

We test fourteen parameters: humus, nitrate nitrogen, ammonia nitrogen, phosphorus, potassium, calcium, magnesium, sodium, ERGS, ORP, copper, iron, zinc and manganese. These are the most important to test. For example, less nitrogen is needed in areas with high humus and balanced soil. When putting on what the plants takes off, all essential nutrients are needed. The emphasis is a balance of nutrients in combination with soil life to improve the condition of the soil and plant life. Calcium and phosphates are prime examples. Calcium and phosphates have a major impact on releasing other elements in the soil. All that might be needed is a minor adjustment in calcium levels. Let's over view all the parameters of our soil test so you have a better understanding.

2 - Choose a Fertilizer with Non-toxic and Life Promoting Materials

Not all fertilizers are created equal; therefore we must use products which promote higher quality of soil life. By this we mean not all fertilizers react the same and some over time, will cause adverse reactions in the upper and lower soil profile. That is why we recommend only certain types, which include the following:

Soft Rock Phosphate: Rock phosphates provide a continuous supply of phosphorus, and element needed for normal plant growth and high quality food. Rock phosphates also contain colloidal clay which aides in the binding of materials to the soil for longer periods of time, helping to ease the leaching of properties from the soil.

Compost and green manure crops: The first rules to remember is not all compost are created equal, and composting is an art form. If you are looking at composting please call us and we can cover this better. Green Manure is the most over looked portion of any and all crop rotations. Use common sense when looking at this type of system, and remember the soil is a digester.

Monoammonium Phosphate (MAP): This is a low pH, soluble source of phosphorus, useful for high pH soils.

High Calcium Lime and Pell-lime (Calcium Carbonate): Local quarry limes can vary, some are high calcium lime, but others are dolomite (calcium magnesium carbonate). DOLOMITE LIME SHOULD NOT BE USED.

Hard Rock Phosphate (Slow Release Phosphate): A slow release source of phosphate used to keep environmental levels of phosphate available for quality and vigorous growth.

Gypsum (Calcium Sulfate): A calcium and sulfur source which works well under conditions where calcium saturation is high and the pH is over 7.0 (will aerate soil, not raise calcium).

Potassium Sulfate (0-0-50-18S): A high quality mined potassium source which provides both potassium and sulfur. Compared to potassium chloride, it has a low salt index. It is readily available and its low chloride content does not harm plants.

Ammonium Sulfate (21-0-0-24.5): An excellent source of both nitrogen, and sulfur. Here in the upper Midwest, it works well to reduce high magnesium levels and provide the sulfur needed to make high quality proteins.

Calcium Nitrate (9-0-0-11Ca): A good nitrogen and calcium source for foliar feeding, also a specialty fertilizer for vegetables.

Ammonium Nitrate ($17NH_4$-$17NO_3$): An excellent source of both ammonium and nitrate nitrogen great for quicker green up and healthier turf.

Trace Elements: Trace elements in the sulfate or chelated forms are the most effective. Sulfate forms are also acceptable for the certified organic farmer.

Liquid Foliar: 100% Ortho is preferred because it is in the pure plant food form and 100% available or in the amino acid form which is the way the soil and plant store nutrients. Examples: Foliar Seed set, Rondo, Foliar-N.

Humic Products:
These are materials that are made from layers of material below the coal deposits around the world

Most fertilizers used in mainstream agriculture are not what we consider to be agronomically sound, due to the form in which they are manufactured.

1) Chloride ions flood the root zone and displace important nutrients, creating an *imbalance* that interferes with nutrient uptake, starch-transport and protein synthesis.
2) Anhydrous ammonia dehydrates the soil at the injection point, and does kill certain strains of microbes as well.
3) DAP has free ammonia, and when used as a seed treatment type fertilizer, can cause germination problems.
4) Slow release nitrogen, poly forms, and nitrogen inhibitors,

* *Everything that we have covered in this booklet is documented in college textbooks from Iowa State University, University of Minnesota, and Purdue University, University of Wisconsin.*

Unacceptable Fertilizer Materials:
1) Dolomite Lime (Calcium Magnesium Carbonate) is a calcium and magnesium source. Here in the upper Midwest, most soils are already high in magnesium. Adding more magnesium to the soil unbalances it and interferes with the uptake of other elements, especially potassium. High magnesium makes some soils more compact and tight. Dolomite supplies calcium and magnesium in a 2:1 ratio, two parts calcium, and one part magnesium. Ideally, a balanced soil is at a 6 or 7:1 ratio. Crops such as alfalfa remove calcium and magnesium in a 5:1 ratio, so with continuous use of dolomite lime, magnesium levels will get higher, while soil may become tighter. Under these conditions, it takes more of other elements to grow the same crop. Also, tight soils often lead to reduced nitrogen-fixing nodules and poor root health. A lower proportion of calcium also harms crop quality and health.
2) Diammonium Phosphate (DAP). Because of the many conversions (4) it goes through, you may lose too much for the dollar spent. This may be broadcast on very acidic soils and should not be used in starters that are close to the seed.
3) Potassium Chloride (0-0-60 or 0-0-62). The potassium is fine, but the high percent of chloride (47%) is not. Potassium chloride is a strong salt (with the highest salt index of any commonly used fertilizer). Plants need only eight pounds of chloride to grow example of this would be 120 lbs. of Potassium Chloride is need for crop growth, but can survive with more or less. Therefore adding sometimes hundreds of pounds per acre is unnecessary. Some crops are sensitive to chloride, and chloride in the soil can change to chlorine when nitrate nitrogen is present, which is toxic to soil bacteria.
4) Anhydrous Ammonia. It may be the cheapest per-unit source of nitrogen, but it will cost you in the end. Ammonia is a highly toxic gas. It will kill any life near the injection point. Some

can escape into the air, wasting money. Worst of all, it causes the soil's humus to dissolve and leach, robbing the soil of potential nutrients and making it as hard as concrete.

If you need to find out about other products which are questionable, please contact us or send us a sample and we will analyze for quality as well as heavy metals.

3 - Cultivation Controls Soil, Air, Water and Decay of Organic Materials.

Cultivation aerates the soil, and helps provide moisture for the soil organisms. Tillage of raw organic matter into the upper layers of the soil helps to improve soil structure thus producing better aeration and drainage. Another option is to compost matter and lessen the hauling load before adding it to the soil.

4 - Microbial Residents.

Some microorganisms like a more specific selection of organic compounds, and others have the ability to find a source of energy and food value for their metabolic survival with large quantities of carbon compounds, combined with humification. Complexed polymers are broken down into simple segments. The simple segments are remanufactured by microorganisms into altogether different sequences, thus forming a complete series of new and different complex polymers and eventually forming humic acid molecules.

In general, four major types of microorganisms can be found in soil:

1. Algae
2. Bacteria
3. Fungi
4. Actinomycetes

In balanced soils we can see very high levels of every one of these examples, 1 gram of soil may contain 300,000 algae, 4 billion bacteria, 1 million fungi and 20 million actinomycetes. All these microorganisms are of significant value in the decomposition of organic materials. This process releases elements of nutrient value and captures Nitrogen from the atmosphere.

Algae: This microscopic plant's primary function is decomposition of organic residues and thereby making nutrients available for plant growth.

Bacteria: There are many families of bacteria, the most predominant can be either aerobic, requiring air or free oxygen for life, or anaerobic, capable of growing or existing in the absence of free oxygen. Bacteria are so versatile that they can survive under extreme environmental conditions including variations of solemnities, pH conditions, temperatures of barometric pressures. Bacteria are second only to fungi in their digestive ability, and they will attack and break down almost any organic compound for use as food. They not only digest proteins and sugars, but fats, oils, cellulose and many other carbonaceous compounds.

Fungi: are extensively distributed throughout our environment. All fungi are aerobic, needing free oxygen for life, and are heterotrophic, capable of utilizing only organic materials as food. Fungi are very tolerant of pH variation, living in environments ranging from acidic to alkaline. However, they seem to do best in an acidic environment. Fungi adapt well to complex food systems, specifically the polymeric compounds that are not easily decomposed by bacteria and actinomycetes.

Actinomycetes: are numerous and their distribution is extensive. They are found in oceans, lakes, ponds, sediments and soils. Their abundance is second only to bacteria, and they exist in a very wide array of distinctly different family groups. In soil, they may range from 1 million to 1 billion per gram of soil. These microorganisms are efficient in breaking down the resistant compounds of both plants and animals.

Overview of Microbial Disintegration & Transformation:
The microorganism population is an assemblage of several general families including algae, bacteria, fungi and actinomycetes. There are many other groups and families of microorganisms, but these four make the most important contribution in humification. **These microorganisms are so versatile in their diet that they can actually attack and decompose almost any complex matter. In this process, they transform carbon into new protoplasm and thereby create the energy required for their metabolic functions.**

Summary

Now that you have an understanding of what Managed Inputs is, the "how-to" should be a little easier. First, know your objectives, your goals-- to exploit Mother Nature, or to work with her. You will need to think more, run more tests, dig into the soil, check root systems and evaluate alternative practices.

How long will it take to change over from chemical-intensive farming to Managed Inputs? Remember, your soil did not get in the condition it's in, in a year. It will take several years to get an abused soil into good shape. During the transition, you will notice improvement yearly. You should not have to sacrifice. With proper planning, profits should rise. After a few years, your inputs should lower significantly. We are here to help you. We offer consulting year round. We can supply the highest quality life-promoting fertilizers.

If you are still not convinced that there is a better way to farm, and need to prove it to yourself**.** We can give you names of successful businesses near you who would be happy to show you what they are doing. Test plots are also great sources of information. For those of you starting in Sustainable Fertilization, you are not alone out there. Many more are seeking, searching and experimenting. They are excited about what they are accomplishing.

So, start with information and understanding. Go to soil testing for essential nutrients. Balance your soil with good fertilizers. Start feeding the life in the soil, and stop treating your soil like "dirt". You are then on your way to a profitable, safe and clean way of operating. Remember, a test plot with side-by-side comparisons should be done for up to 30 years to see reasonable results.

Why Potassium Sulfate?

The importance of Sulfur for vegetable yield and quality is well documented in the literature. Both are contributing factors for improved product marketability and profitability. The sulfate source of K is often preferred where crops are sensitive to Cl, where salinity problems exist, or when very high quantities of K are required (Stewart, 1985 and Zehler et al., 1981).

Under different levels of rainfall, leaching was measured when K was applied from various sources (Sartain, 1988). Less K was leached from the sod root zone when K was applied as SOP rather than MOP (**Table 27**).

Table 27. The influence of source on leaching loss of K.

	"Rainfall" applied, inches				
K Source	10	20	50	75	100
	% K Lost				
Potassium chloride, KCI	17	75	91	91	94
Potassium sulfate, K_2SO_4	0	15	53	79	79
Potassium phosphate, K_3PO_4	0	0	0	18	33

Sartain, 1988.

Summary

Plant requirements for K and S supplied in SOP have been summarized for a number of crops around the world. Specific crop requirements and sensitivities emphasize the role of SOP in building sound soil fertility programs. Recognition of the increasing needs for supplemental S in crop production, combined with the established roles of K and S in plant physiology makes SOP a component of choice in balanced plant nutrition.

Management System

The following information is compiled from over a quarter century of hands on experience. The farm which exposed to Dr. Cary Reams and Dr. Dan Skow thoughts, management system, and very unique soil system, which they used and promoted. It made complete sense as it changed three generations of this family farm, the operation would evolve over the next quarter century.

There must be an understanding that this theory has grown into a full-fledged working study and thought program that is no more forgiving than Mother Nature, and needs very careful understanding. One cannot just go out and just fertilizer for established yield, there must be a step by step plan that is designed from a soil test using tissue samples, brix reading, using a conductivity meter, testing for other nutrients other than just N.P.K, and building a balance in the soil.

The traditional agronomist will argue about the science behind this system, but lets look at what they use in the field; soil tests, tissue tests, and other than some understanding of the basics, what do they have to diagnose something that N,P,K, and trace elements will take care of. The fact is most four-year agronomy students receive very little plant physiology, microbiology, and true science, to quote a very close friend of mine,**" We have segregated and specialized ourselves into ignorance".**

With all this said, lets look at where it all starts: Soil tests are the most misunderstood portion of this system. Without a truly great understanding of where you start from, how do you quantify what we are doing? The next step would be to have knowledge of raw materials. Several products out there are sold by the greatest of all sales people. But educated stewards of our soils make well thought through decisions that are designed to affect more than one growing year, but several years into the future, which makes for a better environment for our generation and the next.

The basics are which all students need learn. The basic cell is what micro nutrients need to be present to build the primordial cell; along with nitrogen, calcium, phosphorus, carbon, hydrogen, oxygen, and carbon dioxide. With this said, the elements in discussion are basic to the primary building blocks to all living organisms, once this is understood one can comprehend the importance of the basics. When the six elements that start life are this important maybe the rest of the life cycle would be just as critical. The next step in the basics would be the base understanding of electrical charges and the interaction. This takes place in and around the medium, which you are working with, what effect the largest in quantity will directly have in response on the least in quantity.

The basics have just started since we have spent many years destroying soil tilth, and structure. Through the management of air and controlling the depth and the width of our root mass, through fertility, mechanical reduction of compaction, choices of fertilizers which promote increased soil life, and the health of this very fragile growing medium has been lightly over viewed. Let's go through each area of concern individually. Fertility would be looking at the types of materials, making sure that we only use products that are in the sulfate (SO_4) form, so you are able to make full use of the entire product and no loss to mineral tie up. Keeping the material in the amino acid form is so important to the soil and the plant to make the most use of the fertilizer, which has been prescribed, making sure you're using only light amounts of chloride-based materials. Use products which have several types of phosphate due to the state regulations. Look at using only calcium sources which contain very low magnesium and at least thirty-four percent calcium. Be careful when experts come to the door with product from the by-product industry. Example would be city municipal waste from large communities with large industry and computer industry which would be run through the waste treatment plant.

Next would be to always be mindful of what is treated in the top six inches will at some point move through not just the top soil, but at some point the ground water tributaries and aquifers. With this said we must be compelled to keep all that we apply into the growing medium and increase the medium through proper tillage, timely applications of materials which increase the air movement, soil texture size, and increasing the holding capacity or storage ability for water and nutrients.

The next step would be to make sure we always use materials that are naturally needed in that geographic area. For example when in Missouri, Fe would be needed much more than in Minnesota. This may be confusing to some but most if not all of Minnesota has high Fe due to the Iron Ore deposits, which are very soluble or bio-available. If quick green up is what you are looking for, soil test and find the least available nutrient and apply that nutrient and you may find much longer-term green up and health. The next thought would lead to bacteria and all the microbiology system. With modern mono-crop mentality, we have burned up, chemically eradicated, as well as fumigated possibly several species of bacteria and related soil biology. Most modern soil scientists will overlook this small microscopic critter and not think twice about this living organism and its benefits.

Nitrogen: First of all you need to know there are two forms of nitrogen, **Ammonia** and **Nitrate** forms. Both are needed at differing stages of a plants life. Nitrate is needed when the plant needs to stay in the growth stage or vegetative. Ammonia is the form which is needed for seed production. This doesn't mean we cannot grow crops with ammonia (urea) but it would make more sense to use the right material. Nitrogen is one element that will be nitrate and ammonia, and will switch back and forth with just a simple issue as temperature change. Remember that nitrogen is the only element that will move into the plant without any other element.

Phosphate: This is one of the most controversial elements of the twentieth and twenty-first centuries. Very little solid information and inefficient testing have proven that through scare tactics the system has tried very hard to ban. What most of us don't realize is that phosphorous is the catalyst that brings all the elements into the plant. What is meant by catalyst? An example would be that the minister brings the bride and groom together but doesn't go home with them. With this said we truly need phosphate! Remember this element is non-mobile, and needed in high levels in the sap of the plant, this will aid in weather proofing any and all crops, which relates to increased drought stress, increased color, leaf density, and root retention, just to mention a few.

Potassium: One of the most over applied nutrients in the history of mankind. This doesn't mean we don't need K_2O, we need to keep this element in balance with phosphorous with a minimum of a 2:1 ratio remembering that potassium is needed only half as much when using the LaMotte soil test. When potassium is at high levels we see increased water uptake, chloride flooding the root zone which will remove other nutrients from the root zone, increased fungal or insect problems. The potassium of choice is sulfate of potash (K_2SO_4), So Po Mag, chili nitrate of potash, as well as high-grade liquid potassium.

Calcium: The element, which is truly needed as much by weight and by volume. In keeping with our studies this material keeps a charge flowing through the system. We apply calcium as a nutrient not a soil amendment. By this we can affect calcium solubility with very little calcium. With as small amounts as 100 to 200 lbs. Pell-lime and 500 to 1000 lbs ag lime. We use pH as a guide for nutrient availability. Once you understand the true importance of calcium you can begin to see how self sustaining this program can be.

Some people think that this system and soil test are not true chemistry, but ask this question, "Is true chemistry absolute?" We have changed several science based experts thoughts. With this

said let's look further into this. The system that we use currently for soil testing is based off pH above or below seven pH. This will allow all nutrients to be lifted from the soil and be placed onto a soil analysis. ***As several experts in the turf world have said we need a test which will allow for the testing of what is only truly soluble and available to the plant,*** which means that we need to look closely at our environment, natural resources and how we quantify this with a soil test which takes everything and measures it, whether the nutrient is one hundred percent available or not. This is why we only use the LaMotte soil test method. To simplify we must understand that we are measuring for only plant available nutrients. To achieve this, our lab uses extracts that emulate the acid that the rootlet excretes, giving a measurement of plant absorption. Is this new science or just the common sense approach to soil science?

Magnesium: The largest misconception is the over abundance of this element in our soils. Once this is understood you will understand why we have compaction and a need for higher and ever increasing nitrogen levels. This element is needed but must be kept in ratio with calcium (7 parts calcium and 1 part magnesium). Once this level is achieved, many of the issues which we have covered will no longer persist.

Sodium: When we work with soils that have high sodium levels we need to know the background. If 19-19-19 or 10-10-10 or products like this have been used, these soils will carry much higher ERGS reading. Once having said this you will understand that we must have the back ground of the operation to make the best recommendations. The key to sodium is that a little is not enough, and too much is over kill, this element must be managed.

ERGS: We have covered several issues, from balance to ratios, and a few other terms you may not be familiar with, but if you understand that this system is based from the stand point of energy, and all elements carry a charge, then you will go forward from this point and have a greater comprehension than most four year agronomy students.

ORP: This is a very unique part of our testing system. ORP will tell right away if there is a need for aeration. If there is we develop the program around this, examples would be: aerate and apply 11.5 lb per 1000 sq ft. Gypsum, or Soil Prep Plus. This is a very unique test to soil testing and we are one of a very few which test for this test procedure.

pH: This parameter is a very overrated measurement. The commercial testing lab has this down to a science to explain everything from soup to nuts. The first thing to understand is that pH will guide your nutrient availability. We do not use pH to guide our calcium recommendations since our calcium test as well as the rest of the parameters are in the soluble form.

Sulfates: This test is seldom run at the lab. We have over years found with higher calcium levels, as a soluble reading, the higher or greater sulfates the system can handle. The same would be for lower testing calcium soils, the lower or fewer sulfates the system can handle. The largest differences between the types of sulfates we recommend are in the SO_4 form, not the SO_3. Examples of this element are elemental sulfur (yellow in color) and oxy sulfates.

Boron: This element has several functions which over lap other elements. The largest of benefits which *Boron* affects and regulates include the translocation of sugar across membranes, starch production, and promotion of energy release in the cell.

Copper: This is the next of our four trace elements we test for, and the least in available in the upper Midwest. This nutrient has natural fungicide properties, reduction of plant diseases, and over all health issues.

Iron: This element is one of the most over used and abused nutrients in the history of turf. Someone figured out that through the use of Iron sulfate or oxy-sulfate and green dye, along with some nitrogen you get great response on turf, but they forgot what happens when you forget to add large amounts of calcium, you get Iron toxicity. The best thing is to test before applying any Iron and you will find out as we have, it is not needed. If green turf is your goal, understand your varieties of grass and apply a balanced program.

Zinc: This element is one we question the need to add into a program. This is one element that we do watch and add into corn programs when we first start working with a new farm. Once things are balanced we add very little, since all our dry fertilizers have natural trace elements.

Manganese: This element is very critical to life itself. Without Mn you won't have cell initiation or development. This is so very critical to grass production. Remember manganese is the element of life, without it there will be no cell structure.

The last few pages have been put together to give you a better understanding of this program and what the long-term opportunities for you and your company. We would challenge each and everyone that looks at this system or program to truly understand what has been presented to them and to understand this material that we stand on, is not just dirt but a living breathing organism.

See What You Look At!

This was the charge Dr. Carey Reams drilled into Dan Skow over and over again. Nowhere is this more important than when dealing with the foundation of human health: soil.

The soil test is our eye into the complex world beneath our feet. This leads us to the ever-important question of what soil test should be used to help us see what we are looking at. There are many different kinds of soil tests that have been developed over the years. Without getting into the chemical complexities lets explore the basic concepts of the various types of soil tests. Chemical analyses of soil nutrient levels involve mixing soil with water and an additional chemical that extracts or dissolves nutrients from the soil. This mixture of soil, water, and chemical extract is then filtered and tested to determine the level of nutrients in the soil.

The extract solutions can be divided into 3 basic classes:

1) Strong Acids
2) Weak Acids
3) No Acid – just uses water A.KA. Water Extract

Most testing laboratories and state agricultural colleges use strong acids. This type of extract can test the total amount of nutrients in the soil and compute Base Saturation and Cation Exchange Capacity. Dr. Reams rejected this type of soil test for one basic reason; this test didn't let him really see what he was looking at. With this test nutrient levels, Base Saturation, and Cation Exchange Capacity might all be in the desired range and yet the plants could show deficiency symptoms of various elements and yield poorly. Why? Because the amount of nutrients dissolved by strong acids is not the same amount made available by the weak acids in the exudates given off by the plant roots. An equally poor choice is to use no acid at all. This measures only the amount of nutrients that is dissolved by water. Plant exudates are weak carbonic acids that will extract more nutrients from the soil than just water. Dr. Reams rejected this type of soil test for the same reason as the strong acid test—neither of them squared with what was actually available to the plant.

The test of choice for Dr. Reams and International Ag Labs is the weak acid test. This test uses a chemical extract that was patterned after the exudates that roots give off. It is called the Morgan Extract. The Morgan extract is a "universal" extractant, meaning all major nutrients (including phosphorus) and many micronutrients can all be measured in the one extract. Dr. M.F. Morgan developed the Morgan extract in the 1930's and 40's at the University of Connecticut. This test more accurately reveals what the plant can actually utilize from the soil. This was the test Dr. Reams used to see what he was looking at. What was Dr. Reams really looking to see with this test? **Nutrients that is biologically active.** This test closely relates to the visual symptoms plants display. Plants may be grown directly above limestone bed but show a calcium deficiency. The Morgan test picks this up and shows a low reading of biologically calcium even though there is plenty of calcium in the soil.

Through out the years the weak acid test has stood the test of time and it has produced brilliant results. Dr. Reams built on this test and determined the ideal nutrient levels and ratios that we use today as benchmarks. When the soil is balanced according to the "available nutrients" it produces an abundance of high-quality produce.

Using the right tool to "see" the true condition of the soil is only half the battle—the other half knows what to do once you have the numbers. One must also have the insight into what the numbers signify. To understand what is really happening in the soil

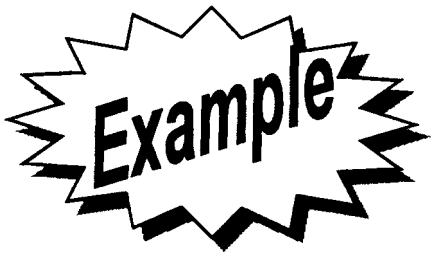
WHAT IS IN A SOIL TEST?

The Reams Method

When you send us a soil sample, you will find that the results may not be what you expected, or what you have received in the past. First, all soil testing is conducted by International Ag Labs, utilizing the LaMotte method, using the Morgan extracting solution, not the more common A & L method. Second, you will find several factors listed on the results sheet that you may not be used to seeing.

Field Data

In order to make the most of the soil consultation included with each soil test, be sure to send complete data in with each sample. Remember, the more you can tell us, the better we can tune in to what is going on in your field. Information supplied should include the following: previous year's crop and yield; current year's intended crop and yield goal; weed pressure type and intensity, fertilizer used and methods of application available to you, products available in your area, budget, drainage and irrigation, herbicides used and tillage practices.



SOIL ANALYSIS REPORT

	DESIRED RATIO	DESIRED LEVEL	LAB RESULTS
HUMUS		30-40	8
NITRATE NITROGEN		40	6
AMMONIA NITRATE		40	12
PHOSPHORUS	1 to 1	174	80
POTASSIUM		167	35
CALCIUM	7 to 1	3000	1235
MAGNESIUM		429	140
SODIUM		50	5 (PPM)
ERGS		200	40
ORP		28	32.4
pH		6.5	7.5
B		0.8-1.2	N/A
Cu		0.8-2.5	0.36 (PPM) **TRACE**
Fe		10-25	26.72(PPM) **MINERALS**
Zn		1-6	0.32 (PPM) **RECORDED**
Mn		8-30	1.82 (PPM) **ON AIR**
FORMAZAN		600	N/A **DRIED SOIL**

GENESYS™ 13359 Black Road ▪ Morrison, IL 61270 ▪ 715-690-1106

HUMUS

* Organic matter is added from crop residues, animal manure and green manures, which then decompose in the soil.

* An important part of soil organic matter in the HUMUS

* Earthworms and soil microbes live on organic matter and turn it into humus, which then helps feed the plant.

* Organic matter improves soil structure (tilth), reduces erosion, increases aeration and improves water intake and retention.

* A large percentage of our nitrogen can come from humus, earthworms and microbes.

* Our main goal is to provide the proper environment for soil life and to discontinue using toxic fertilizers that destroy soil life.

NITROGEN

Some potential benefits of nitrogen may include increased plant growth, higher Protein content, increased ear size in corn, better chlorophyll production and Increased enzyme functions.

SOURCES OF NITROGEN

* Ammonium sulfate (21-0-0-24S)
* Liquid 28% or 32%
* Manure
* Legume plow down
* Nitrogen fixing bacteria
* Earthworms
* Urea (prilled)
* Trizone nitrogen
* Ammonium thio-sulfate 12-0-026S
* Calcium nitrate 9-0-0-11Ca
* Ammonium Nitrate

OPTIMUM LEVELS

40 pounds per acre - Nitrate N
40 pounds per acre - Ammonia N

NN: NITRATE NITROGEN (40 - 50 pounds per acre)

Nitrate nitrogen is the primary element to start the formation of a cell. Ideally, one should maintain 40 pounds throughout the growing season. In low organic-level soils, it is easily washed out of the root zone.

AN: AMMONIA NITROGEN (40-50 pounds per acre)

Here we like to see 40 pounds per acre for seed crops at seed-set time. Before that, readings of 10-20 are quite adequate.

PHOSPHORUS

Phosphorous acts as a catalyst in the conversion of nutrients. Some potential benefits of
Phosphorus may include more vigorous and rapid growth, early root growth, Better development and quality of grain, hastened maturity, increased nitrogen Uptake, increased mineral content and a high sugar level in the plant. Phosphorus Also promotes energy release in cells, cell division and enlargement, photosynthesis and neutral pH. Phosphorus is contained in the cell DNA and is non-toxic.

SOURCES OF PHOSPHORUS

* Monammonium phosphate (MAP 11-52-0)
* Idaho phosphate
* North Carolina phosphate
* Soft Rock Phosphate

OPTIMUM LEVELS

174 pounds per acre
2:1 ratio (for grass crops)

P: PHOSPHORUS (175 pounds per acre)

The density of soluble phosphate pounds per acre determines the sugar content and oil content of your crop (This cannot be done with acid-treated hard phosphates). All nutrients, except nitrogen, must be in phosphate form to be taken into the plant. Multiply the phosphorus pounds per acre reading on your soil test x 2.3 to convert to a phosphate reading for comparison with potassium. Always keep your P to K ratio in line (see potassium for ratios by crop).

POTASSIUM

Some potential benefits of potassium may include better stalk strength and lodging resistance, improved winter hardiness, more resistant to disease, increased protein and carbohydrate production, better sugar translocation, enhanced enzyme functions and cell division. Potassium is non-toxic and neutral pH.

SOURCES OF PHOSPHORUS

* Potassium sulfate (0-0-50-17S)
* Potassium hydroxide
* Potassium Thio Sulfate
* Potassium Carbonate

OPTIMUM LEVELS

167 pounds per acre

COMMENT

An excess can cause problems

K: POTASSIUM (166 pounds per acre)

Potassium is very important for the opening and closing of the stomata to get Increase nutrients from the air as per carbon dioxide. Its three most vital contributions
To healthy plants are the caliber (thickness) of the leaves and stack, the size of the Fruit produced and the number of fruit which set on a plant. In seed crops Potassium should be maintained in a maximum 4:1 ratio with phosphorus. In Grass crops that ratio should be 2:1. Multiply the pounds per acre reading on Your soil test x 1.2 to reach the potassium oxide reading needed to compare ratios To phosphate ($P_2 0_5$).

CALCIUM

Some potential benefits of calcium may include improved soil structure, stimulated growth of soil microbes and earthworms, mobilization of nutrients into the plant, increased nitrogen utilization and protein content, increased root growth, leaf growth, cell wall building and cell division. Calcium promotes enzyme functions, increases the sugar content of the plant and enhances overall plant health, resulting in high quality grain or fruit.

SOURCES OF CALCIUM

* **Calcium sulfate (gypsum)**
* **Calcium phosphate**
* **High calcium lime (calcium carbonate)**
* **Chelated calcium**
* **Idaho phosphate**
* **Calcium nitrate**

OPTIMUM LEVELS

3000-4000 pounds per acre

Ca: CALCIUM (2000-4000 pounds per acre)

Calcium is the main element to provide resistance against the organic acids in the soil, thereby creating the energy to grow a crop. With this testing method, the minimum level of calcium should not be allowed to dip below 1 ton per acre. It is not advisable to use bacterial and enzymatic products when calcium is below recommended levels unless you are adding high calcium lime, calcium sulfate (gypsum) or calcium nitrate at the same time. Calcium solubility and availability is determined by three things - proper aeration, active bacteria and adequate sulfate availability. Calcium should be a 7:1 ratio with magnesium. If the ratio is less than 4:1 it indicates a biologically deficient soil unless in a high magnesium area.

MAGNESIUM

Magnesium is a key element in chlorophyll. Some potential benefits include increased protein production, enzyme functions and energy release in cells. Magnesium aids phosphorus uptake, oil formation, and starch translocation.

SOURCES OF MAGNESIUM

* Chelated magnesium
* Magnesium sulfate

OPTIMUM BALANCE

429 pounds per acre
1:7 ratios with calcium

COMMENT

An excess can cause problems

Mg: MAGNESIUM (300-570 pounds per acre)

Magnesium is very important in the process of photosynthesis, however it is not needed in great quantities in the soil. Most of the plants needs can be met by obtaining magnesium from the air through the stomata. It helps control nitrogen levels in the plant. Excesses of magnesium can cause soil compaction and loss of aeration. Magnesium should be kept in a low ratio to calcium (Ca 7:1 Mg)

ERGS

ERGS: ELECTRICAL CONDUCTIVITY

(150-500 micro ohms/cm)

ERGS is a unit of conductance equaling the amount of energy given off per gram of soil per second. The reading on your sample means the resistance of the reciprocal alternating current between two probes on the conductivity tester. Small and highly mobile ions with the most concentration will be the ones represented in the display. The display is reading the charge that is transferred. If the reading gets above the 1200 micro ohms per centimeter, crop production will be affected, over 2000, there will be **no** crop in the average soil.

ORP

ORP: OXIDATION-REDUCTION POTENTIAL

(Ideal: 28-29)

ORP is the measurement of the level of hydrogen ions versus oxygen ions in the soil. If the ORP reading is above 30, there is evidence of excessive oxidation causing dehydration and loss of organic matter. A reading below 27 indicates the soil has excess hydrogen ions causing anaerobic breakdown of crop residues leaving toxic metabolites.

SOIL pH

* The pH scale runs from 0 (most acid) to 14 (most alkaline), with 7 being neutral:

* 0 ---------- 7 ---------- 14

* A **misconception** about pH is that if your pH is 6.5 - 6.8, you do not need any calcium ---**WRONG!!!**. The fact is, your soil may not need pH adjustment, but you can still be low in available calcium. This can be corrected through using water-soluble calcium.

pH: ACID OR ALKALINE (6.4 - 6.8)

pH is the measure of hydrogen ion activity. It is an indirect measurement of the speed of the hydrogen ions. pH is affected by temperature, water and time of day. In most crops, the pH should be just slightly acidic. Factors that force pH down include sulfate, air, aerobic bacterial activity, 0-20-0 (super phosphate) and 11-52-0 (MAP). Factors that force pH up include calcium, ammonia, magnesium, potassium, anaerobic metabolites and formaldehydes.

BORON

BENEFITS

1. Promotes flowering and pollen (silk and tassel in corn)
2. Seed development
3. Root and leaf growth
4. Cell wall formation
5. Protein production
6. Sugar translocation
7. Energy release in cells
8. Improves quality
9. Increases calcium uptake

BEST SOURCES

* Calcium borate
* Chelated boron

IDEAL BALANCE

0.8 - 1.2 ppm or 1.6-2.4 pounds per acre

B: BORON

Boron affects the rate of cell division in plants, regulates translocation of sugars across membranes, starch production, and promotes maturity and seed development. Boron deficiencies appear in plants as a "witch's broom" effect on terminal bud growth. Tuber or root crops develop soft or necrotic spots. Pollination can also be affected. Normal levels of boron in corn are about 29 ppm in young corn and 13ppm in the leaf opposite and below the ear.*

COPPER

BENEFITS

1. Controls mold and fungi
2. Photosynthesis
3. Releases energy in cells
4. Enzyme function
5. Normal leaf growth
6. Increases stalk strength
7. Animal health
8. Gives the bark on a plant the ability to stretch - no cracking of bark.

BEST SOURCES

* Copper sulfate, 25%
* Chelated copper, 7.5% (liquid)

IDEAL BALANCE

10 - 25 ppm or 20 pounds per acre

Cu: COPPER

In plants, copper acts as an activator of several enzymes, converts amino acids in addition, may be involved in Vitamin A production. Copper deficiency symptoms appear as stunted growth, pale younger leaves, lack of flower production and possibly wilting and death of leaf tips.

IRON

BENEFITS

1. Chlorophyll production
2. Energy release in cells
3. Needed by nitrogen-fixing bacteria
4. Produces a thicker leaf

BEST SOURCES

* Chelated iron

IDEAL BALANCE

8 - 30 ppm or 30 pounds per acre

COMMENT

High iron ties up phosphorus

Fe: IRON

In plants, iron is essential for the formation of chlorophyll, and therefore, photosynthesis. It also serves as an activator for respiration, photosynthesis and symbiotic nitrogen fixation. Deficiency symptoms for iron are most notably interveinal chlorosis of younger leaves. In severe cases, the limbs of plants may die or even entire plants may die. Normal levels in young corn should be around 170 ppm, in soybeans about 95 ppm.

ZINC

BENEFITS

1. **Contributes to test weight**
2. **Increases ear size in corn**
3. **Promotes silking in corn**
4. **Hastens maturity**
5. **Chlorophyll formation**
6. **Enzyme functions**
7. **Regulates plant growth**

BEST SOURCES

* **Zinc sulfate, 35%**
* **Chelated zinc (9%)**

IDEAL Balance

1 - 6 ppm or 10 pounds per acre

COMMENT
Very important in crop production
Over-use may cause a weed problem

Zn: ZINC

Zinc is important in controlling growth regulators in the plant, especially the production of indoleacetic acid. It is an important part of the enzyme system in plants. Deficiency symptoms of zinc are expressed as interveinal chlorosis, striping or white banding of leaves, rosetting of terminal buds, reduced fruit bud growth and stunted plants.

MANGANESE

BENEFITS

1. Normal growth and photosynthesis
2. Oil production
3. Energy release in cells
4. Enzyme functions

BEST SOURCES

- Manganese sulfate, 28%
- Chelated manganese, 6% (liquid)

IDEAL BALANCE

5 ppm or 10 lbs. per acre (manganese-to-iron: 1 to 1 ratio). It is an absolute requirement in seed production and in humus.

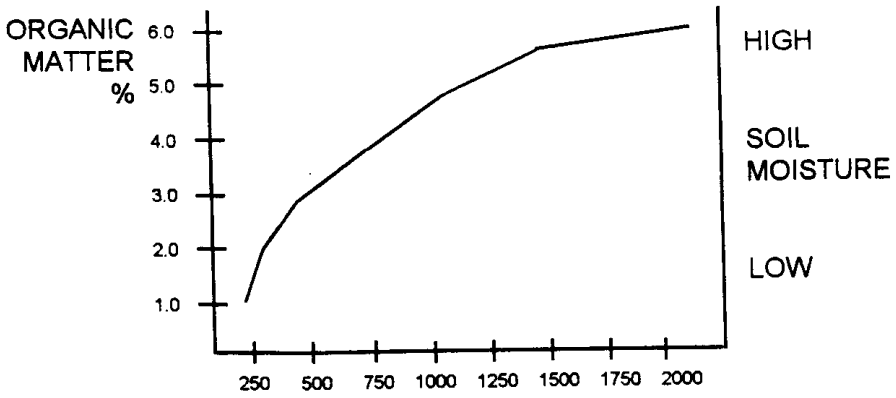
Mn: MANGANESE

In plants, manganese serves as an enzyme activator, helps break down carbohydrates and metabolizes nitrogen. Manganese deficiencies usually appear as interveinal chlorosis. The deficiency will first appear on younger leaves and appears similar to an iron deficiency.

FORMAZAN

There are methods for estimating the microbial activity in soil. The method used at International Ag Labs, Inc. is a commonly used test for the measurement of dehydrogenase activity. Biological utilization of organic compounds is generally a dehydrogenation process. Soil microorganisms contain many dehydrogenase enzymes that catalyze this process. Therefore, the dehydrogenase activity estimates the average activity of the active microbial population. This is known as the Formazan test. The higher the readings of formazan, the greater the soil microbial activity.

The soil test indicates an increase in organic matter and humus, as well as nitrogen and phosphorus.



Effects of soil moisture and organic matter and dehydrogenase activity.
Most soils are at approximately 250; should be 600 or better.

Soil Test summary

The steps we use to evaluate your soil test and build your program. When starting with the Morgan Extract Test there will be 3 critical ratios to look at:

1. Nitrate Nitrogen to Ammonal Nitrogen. The tighter or closer these two are the higher the activity of soil microbiology becomes.

2. Phosphorous to Potassium. The first issue we generally see is Potassium is much higher than is needed. We need to have Phosphorous at a minimum of 2 parts to 1 part Potassium and 4 parts Phosphorous to 1 part Potassium.

3. Calcium. This is going to be a tough one for most of you since someone told you a long time ago that pH is the measure of available calcium. If you use the logic and common sense your parents taught you there is no way the measurement of hydrogen has any correlation to soluble calcium.. The level we would like to see you at is 3000 lbs. per acre calcium and your magnesium levels will vary based where your calcium once you have balance. The ratio you must achieve is 7 parts Calcium and 1 part Magnesium.

The critical parameters needed are as follows:

1. Calcium
2. Phosphate
3. Sodium
4. Copper
5. ERGS
6. Humus — This would be based off a vegetative or seed crop
7. Nitrate
8. Ammonal
9. ORP

As we build your program we will use the Olsen/Bray Test to give ways to correlate to your old soil tests.

There are several tests out there but what you need is a test which measures what the plant sees, not the test measures.

LIQUID STARTERS

LIQUID FORMULAS
(Please call for pricing)

8-14-2 AMAZING STARTER

- 180 gal/ton or 11.09#/gal
- 100% Orthophosphate
- 100% Chloride-free Potassium
- Brown in color

75% ortho phosphates and 25% organic Bio N LQ. This formula has 50% natural organic nutrients, no chlorides, no salt, but has the energy to increase germination. This starter was designed as a starter to get the crop ahead with a healthy starts.

Application Rate: 5 gal/acre

FOLIARS

LIQUID FOLIARS (Please call for pricing)

Foliar Seed Set
(6-6-1-1ca)

Foliar Seed Set was designed beyond industry foliar standards. We designed our foliar with plant physiology in mind, understanding the stage of the crop, conscious of yield, and creating a price competitive product. Foliar Seed Set was formulated to be applied at 20 gals/acre water with a minimum of 80 psi. The written visual would be as follows: you should see on a 40 rod length, 20 rods of fog, which would be no more than 3 feet above the ground. This type of application will insure the droplet size is small enough to be absorbed through the stomata.

Application Rate: 1-1.5 gals/acre per application
2-3 applications for the greatest yield response

Rondo (7-5-2)

This would be a companion product to seed setter with a couple unique additions. Our formula triggers the plant to bulk once the reproduction stage has finished. This allows the crop to hasten fill and increase test weight, or increasing germ, or protein content and aiding with yield when both seed setter and seed bulker are applied.

Application Rate: 1 gal/acre
1-2 applications

GENESYS 13359 Black Road ▪ Morrison, IL 61270 ▪ 715-690-1106

FOLIAR (Please call for pricing)

*** Please note freight is not included in the prices***

5-0-0-0.1 Zn-0.1 Mn-0.1 Cu
Bulk
30 or 55 gallon drums
2 ½ or 5 gallon containers
- 218 gal/ton or 9.17#/gal
- Brown to black liquid

3-0-0-0.5Zn-0.5Mn-0.5Cu: This formula was designed to be applied once the crop has reached the reproductive stage when the following trace elements are short.
Stage of Application: Late July, early August to be added as a fungal detergent.

Application Rate: 0.5 – 1.5 gals/acre

Legume Maker 6-6-1-1Ca
Bulk
30 or 55 gallon drums
2 ½ or 5 gallon containers

- 170 gal/ton or 11.79#/gal
- Made with Calcium Nitrate, Monopotassium Phosphate, Phosphoric Acid, Urea, PGRs, RL-37 and Sugar
- Dark brown liquid

Legume Maker: This product is produced by combining nitrogen, phosphate and potassium while adding calcium. **Legume Maker** can be used on most field crops, vegetables, fruit and nut trees and more. **Legume Maker** can also be applied through drip irrigation systems. To insure best performance, use **Legume Maker** when there is adequate humidity, moderate temperatures and adequate soil moisture. Foliar sprays should be made during the early morning and late evening hours.

Stage of Application: Alfalfa: 2.5 qt/acre after each cutting
Soybeans: 2.5 qt/acre prior to June 20th and 1.5 qt/acre one week after Blossom set.

Application Rate: 2.5 qt/acre

PLANT GROWTH

REGULATORS

BIO-STIMULANTS AND PLANT GROWTH REGULATORS
(Please call for pricing)

Micro-Pack
2x2.5 gals
30 gal drum
Bulk

- 210 gal/ton or 9.5#/gal
- 100% Bacteria Treatment
- 100% Chloride-free
- Brown in color

Bio-Pack: Kick start crop faster and safer with **Bio-Pack** Starter Seed Treat Program. Predictably produce faster increased hair roots with this program.

Starter
It's simple, fast, inexpensive, and effective. **Bio-Pack** hydrates new seedlings, provides key nutrients known to increase root activity, and plant hormones proven to stimulate root development. The application as a starter has been the most popular by this formula blend well into most if not all grades of starter, we have found that using a 100% Ortho based fertilizer seems to be synergistic to yield response, **Bio-Pack** produces a healthier crops that establish faster, and aid in resisting stress. **Bio-Pack** is a complete package that provides all the building blocks your crop will need in a natural formula that is easy to mix and safe. **Bio-Bug** is a high powered Organic Based Fertilizer formulated to build healthy crops by promoting root development while aiding photosynthesis through the increased plant mass. The benefits of using the **Bio-Pack** Starter Program is that the seedlings start faster grow healthier, resist stress better, while aiding in yield. **Bio-Pack** helps protect roots that may have been damaged from environmental stress with a special combination of organic carbon and natural soil inoculant's, while **Bio-Pack** Starter Program promotes healing and new root development.

Application rate: 26 oz/acre.

Stimulate
2x2.5 gals
30 gal Drum
Bulk

Stimulate is produced by combining natural plant growth regulators while adding organic carbons, natural occurring carbon bio-lith, kelp, and seaweed. **Stimulate** has a broad label including corn, soybeans, vegetables, fruit and nut trees and more. **Stimulate** may be added to early foliar programs or as a stand alone product. **Stimulate** can also be applied through drip irrigation systems. To insure best performance use **Stimulate** when there is adequate humidity, moderate temperatures and adequate soil moisture

Beans V1 – V4	24 oz/acre
Corn V1-V4	24 oz/acre
Small grains prior to boot	24 oz/acre
Any other crops please call	

Residue Digester
And
Nitrogen Stabilizer

Residue Digester and Nitrogen Stabilizer (Please call for pricing)

BIO-DIGESTER: Designed to breakdown GMO residue. The difference is based off the live culture of bacteria we to your soil when using this material you have a test product that has been used all over the mid-west with success.

Application Rate: 3-5 gals/acre.

B-HUME: Was designed to as a Humate but also as a to compliment as traditional fertility program (0-1-0) Contains Natural Polyhydroxy Acids 3%.

Mix 1-2 quarts in 10-20 gallons of water or fertilizer solution.

Carbon (Liquid Carbon)

Carbon has been added to most if not all of formulas but when the customer needs additional carbons we carry this as a floor stock item.

Application Rate: 2-6 lbs/acre for your starter and foliars.

LIQUID

MICRONUTRIENTS

LIQUID MICRONUTRIENTS DEFENDER LINE OF MICRO-NUTRIENTS
(Please call for pricing)

10% Boron
2 x 2.5 gal
10% Boron: Summit Brand Liquid Boron is designed for use in all liquid fertilizers (except aqua ammonia) and suspensions or water as a soil application for all crops requiring boron.
Application Rate: 12 -16 ozs/acre

3% Calcium EDTA
2 x 2.5 gal
3% Calcium EDTA: Fully chelated EDTA plant nutrient for prevention and correction of deficiencies. Calcium EDTA supplements soil fertilization by supplying certain essential nutrients when plant food needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 16 – 32 oz/acre
7.5 % Copper EDTA
2 x 2.5 gal

7.5 Copper EDTA: Fully chelated EDTA plant nutrient for prevention and correction of deficiencies. Copper EDTA supplements soil fertilization by supplying certain essential nutrients when plant food needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 6 – 12 oz/acre

4.5% Iron HEDTA
2 x 2.5 gal
4.5% Iron HEDTA: Fully chelated HEDTA plant nutrient for prevention of deficiencies. Iron HEDTA supplements soil fertilization by supplying certain essential nutrients when plant needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 4 – 8 oz/acre

2.5% Magnesium EDTA

2 x 2.5 gal

2.5% Magnesium EDTA: Fully chelated EDTA plant nutrient for prevention and correction of deficiencies. Magnesium EDTA supplements soil fertilization by supplying certain essential nutrients when plant food needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 12 – 16 oz/acre

6% Manganese EDTA

2 x 2.5 gal

6% Manganese EDTA: Fully chelated EDTA plant nutrient for prevention and correction of deficiencies. Manganese EDTA supplements soil fertilization by supplying certain essential nutrients when plant food needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 8 – 12 oz/acre

9% Zinc EDTA

2 x 2.5 gal

9% Zinc EDTA: Fully chelated EDTA plant nutrient for prevention and correction of deficiencies. Zinc EDTA supplements soil fertilization by supplying certain essential nutrients when plant food needs are highest (at flowering and/or fruiting stages or in stress condition). It is recommended as a supplement to a conventional fertility program, potentially enhancing yield and/or quality.

Application Rate: 6 – 12 oz/acre