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FOREWORD

Loveland Products, Inc. welcomes you to the ABCs of Plant Nutrition. Loveland Products' goal with this book is to give the reader a basic understanding of plant fertility as well as the products that Loveland Products has to offer for the soil applied, foliar applied, and seed applied markets. The book also contains a section detailing our NutriScript[®] software program that takes soil and tissue sample data and creates agronomically correct and field specific fertilizer recommendations. So let's begin with a brief overview of how nutrients react in the soil.

INTRODUCTION TO PLANT NUTRITION

One of the major factors affecting crop production and overall plant condition is its nutritional status. Today, growers can control this factor through the use of soil and tissue sampling in an effort to manage the overall fertility level of the crop, but these management tools are often underutilized. For example, in the United States, it is estimated that less than 15% of the cropland is soil tested each year. There are 17 essential nutrients required for plant growth, and unless deficiencies become so severe that visual symptoms appear, many plants lack the necessary nutrients to maximize yield production. An insufficient supply of a single essential nutrient can have a detrimental effect on plant growth and ultimately crop yields.

The usefulness of soil testing in determining nutrient needs can be greatly improved by combining it with tissue analysis whenever possible. A tissue analysis can supply information about the nutrients taken up by the plant and at times can be a better indicator of nutrient availability than a soil test. Tissue analysis is used to: 1) verify plant deficiency or toxicity symptoms; 2) determine the adequacy of a fertility management program; and 3) provide a basis for foliar nutrient applications.

Foliar feeding has become widely used and accepted as an essential part of crop production, especially as it relates to micronutrients. Quantities needed are small for most crops and can be applied to the foliage for greater uptake and utilization. Micronutrient deficiencies are relatively common due to the fact that all micronutrients, except molybdenum, become less available as soil pH increases.

SOIL SAMPLING

Chemical analysis of soils, or soil testing, is a means to determine the nutrient supplying power of the soil.

The sample should be a true representation of the area sampled, as the laboratory results will reflect only the nutrient status of the sample which is received.

To obtain such a sample, the following items should be taken into consideration.

SAMPLING TOOLS

Several different tools, such as an auger, soil sampling tube, or spade may be used. Sample tubes or augers should be composed of either stainless steel or be chrome plated.

If using a pail to collect the soil, it should be plastic to avoid contamination from trace elements (i.e., zinc).



Tools for soil sampling.

SAMPLE PREPARATION

Mix the various cores or slices together in a clean plastic container and take subsamples to be put into the sample bag. A subsample should be 1 to 1 ½ cups of soil, which is taken from a well-mixed composite from 10 to 20 random locations in the field. It is advisable to air dry extremely wet samples before they are bagged. Identify the sample bags with name, sample number, and field number which correspond with identification on the appropriate sample information sheet.

SAMPLE AREA

Area to be sampled generally should not be more than 40 acres. Smaller acreage may be sampled when the soil is not uniform throughout the field. Soils that differ in soil type, appearance, crop growth or past treatment should

be sampled separately provided the area can be treated in that manner. Avoid small areas that are dead furrows, end rows, and which are poorly drained. Stay away from barns, roads, lanes and fence rows.

SAMPLING DEPTH

The required depth of sampling is influenced by many factors which are discussed in this section.

1. Tillage Method

- a. Conventional plow depth
- b. Reduced Tillage.....3/4 of tillage depth if
nutritional problems 0-4" and 4-8"
- c. Continuous Ridging 0-6" in ridge
0-4" in valley } **comb.**
- d. No Till0-8", to check pH, 0- 2"
- e. Deep Placement plow depth and below
- f. Band Placement.....plow depth

2. Crop

In general, samples are taken at depth where the main root system exists.

- a. Established Lawns and Turf
Sample depth of 3 to 4 inches, which is the actual rooting depth. The sample should not include roots and accumulated organic material from the surface.
- b. Orchards
The greatest root activity occurs at a depth of 8 to 12 inches. The sampling depth in orchard soils, therefore, should be up to 12 to 14 inches, taken at the edge of the dripline. Take one core sample from each 15 to 16 trees selected at random in the orchard. Mix the cores to obtain a composite sample which should be from an area no larger than 20 acres.
- c. Flower Beds
One sample per 100 sq. ft. consisting of a composite of three cores taken up to 6 inches depth.
- d. Vegetable Garden
Sample up to 6-inch depth at various locations and prepare a composite sample.
- e. Shrubs and Small Trees
Take samples at the edge of the limb spread to a depth of 8 to 10 inches.

3. Sampling for Nematodes

The best time to sample for most nematodes is during the summer months as crop growth can indicate the presence of nematodes by having a stunted appearance. Take the samples, one per every 5 acres, to a depth of 8 inches in the row from 20 to 25 locations. Mix the samples as soon as possible and put a composite sample of 1 to 2 pints into a soil bag. Do not let the soil dry out or get hot. The best method for nematode identification sampling is to collect root tips and feeder root samples. Remember that nematodes can be present in large numbers without any visual symptoms showing on the plant roots.

4. Sampling for Nitrate, Ammonia Nitrogen, and Soluble Salts

Rapid changes in nitrate and ammonia levels can occur after taking a soil sample, if the sample is stored under moist, warm conditions. It is advisable to dry the sample at 40° to 50° C (100° to 110° F) prior to shipping, unless the sample is refrigerated.

Because nitrate nitrogen leaches easily, deeper sampling is required to effectively determine the total available nitrogen in the soil. Sample to a 2-3 foot depth with samples taken at 7-inch to 1-foot increments to form possible composite samples. Sampling for soluble salts should be in accordance with instructions for nitrate sampling. Soil should be air dried before shipping or storage for any length of time.

5. Subsoil Sampling

Subsurface or subsoil sampling is frequently of value, and samples can be collected to explain unexpected crop growth patterns resulting from either chemical or physical characteristics of subsoil layers.

Such sampling is also of importance in areas where deep-rooted crops are grown, which obtain the majority of their nutrient requirements at such depths.

To estimate the available soil nitrogen for crop use, the determination of nitrate-nitrogen levels in the soil profile is made.

Separate samples from plow depth and subsurface can be taken if sodium or salinity problems are anticipated.

SOIL SAMPLING TIMING

Generally, soil tests should be taken on all fields at least once every 2 to 4 years, but soils on which vegetables or other high cash crops are grown may need to be tested annually.

It really does not make much difference whether one is sampling cotton, corn, wheat, or soybean fields, the ideal time to sample is right after harvest. At that time of year, fields are generally very accessible and good representative soil samples are easy to obtain. More time is also available for the evaluation of the soil test data and setting up a good soil fertilization program.

Due to the variation in nutrient availability that may be associated with time of sampling, it is suggested that any given area be sampled about the same time each year.

However, samples taken for diagnostic purposes (fertilization response, poor crop growth, evaluation of soil conditions) are best obtained while the problem areas are delineated by crop or other visual differences.

SOIL REACTION (pH)

Soil reaction is important as it affects nutrient availability, solubility of toxic substances like aluminum, the rates of microbial activities and reactions, soil structure and tilth, and pesticide performances.

Soil pH is expressed as a numerical figure and can range from 0 to 14. A value of 7.0 is neutral, a value below 7.0 is acid, and above 7.0 is alkaline.

The pH value reflects the relative number of hydrogen ions (H^+) in the soil solution. The more hydrogen ions present, compared to the hydroxyl ions (OH^-), the more acidic the solution will be and the lower the pH value. A decrease in hydrogen ions and increase in hydroxyl ions will result in more alkaline or basic conditions.

The ratio between hydrogen ions and hydroxyl ions changes tenfold for each unit change in pH. Therefore, a soil with a pH of 5.0 is ten times as acidic as a soil with a pH of 6.0.

Soils are becoming more acid as a result of the removal of the cations calcium, magnesium, potassium, and sodium through leaching or by growing crops. As the cations are removed from the soil particles, they are replaced with acid-forming hydrogen and aluminum. Most common nitrogen fertilizers also contribute to soil acidity, since their reactions increase the concentration of hydrogen ions in the soil solution.

Many agricultural soils are in the pH range 5.5 to 8.0. The growth of crops on these soils is influenced by the favorable effects of near-neutral reaction on nitrification, symbiotic nitrogen fixation and the availability of plant nutrients. The optimum pH range for most crops is 6.0 to 7.5 and for leguminous and other alkaline preferring crops 6.5 to 8.0. A desirable pH range for organic soils is 5.0 to 5.5.

Hydrogen ions in the soil solution are increased when the salts increase. This results in a more acid condition or lower pH. The salts may be a result of fertilizer residues, irrigation water, natural conditions, or microbial decomposition of organic matter.

Infertile, sandy, highly leached soils usually contain very little soluble salts (Table 1).



Nutrient Availability in Relation to pH

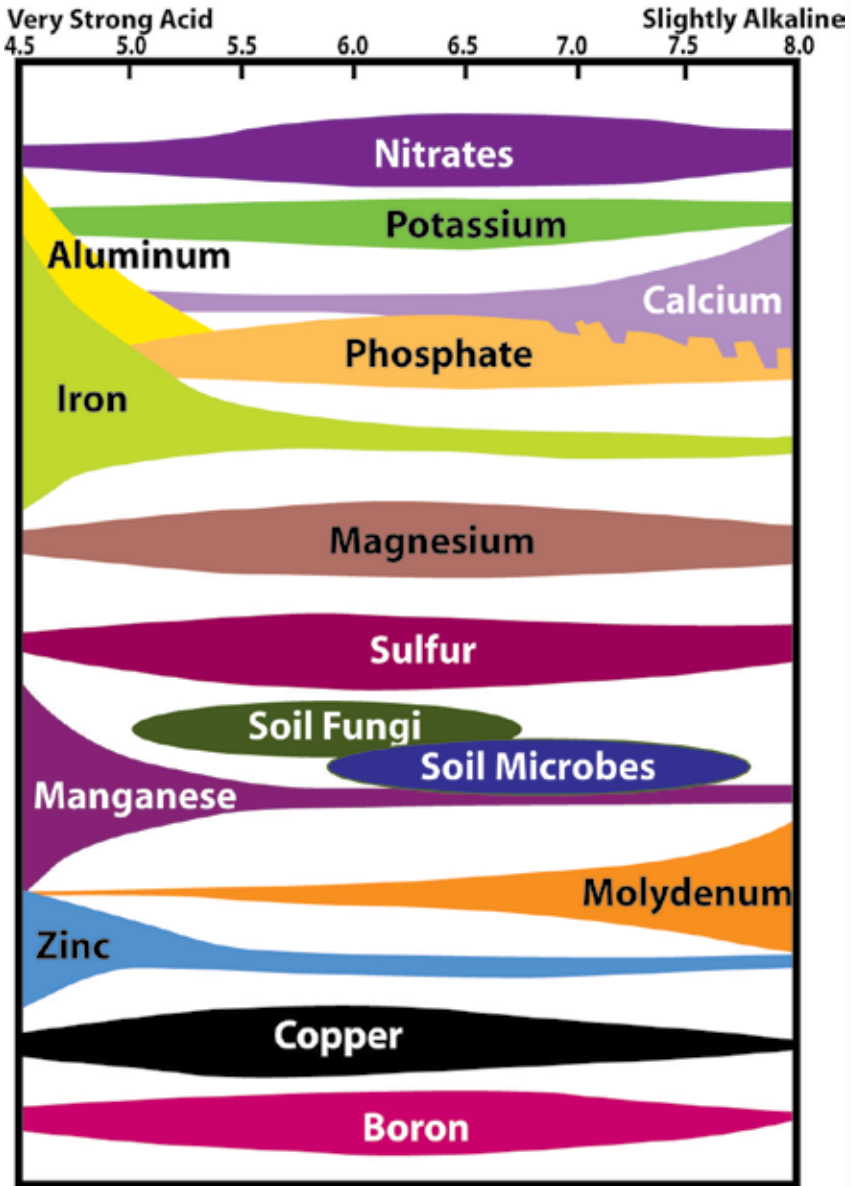


Table 1. Source: Loveland Products Tech Services Agronomist, 2006.

DESIRABLE SOIL pH RANGES

Field Crops and Forages	Range	Field Crops and Forages	Range
Alfalfa	6.5-7.5	Millet	5.5-6.5
Barley	6.0-7.0	Milo	5.5-7.0
Clover (Alsike)	6.0-7.5	Oats	5.5-7.5
Clover (Arrowleaf)	5.5-7.0	Peanuts	5.5-7.0
Clover (Crimson)	5.5-7.0	Rice	5.5-6.5
Clover (Red)	6.0-7.0	Rye	5.5-6.5
Clover (Sweet)	6.5-7.5	Sorghum	5.5-7.0
Clover (White)	6.0-7.0	Soybeans	6.0-7.5
Coastal Bermuda	5.5-7.0	Sugarcane	5.5-7.0
Corn	6.0-7.0	Sunflower	6.0-7.5
Cotton	5.5-7.0	Tobacco	5.5-7.5
Fescue	6.0-7.5	Velvet Beans	5.5-6.5
Grass (Orchard)	6.0-7.0	Vetch (Hairy)	5.5-7.0
Grass (Sudan)	5.5-6.5	Wheat	6.0-7.0
Lespedeza	6.0-7.0		

Vegetables	Range	Vegetables	Range
Asparagus	6.5-7.5	Kale	5.5-7.0
Beans (Field)	6.0-7.5	Lettuce	6.0-7.0
Beans (Kidney)	6.0-7.5	Mustard	5.5-6.5
Beans (Snap)	6.0-7.5	Okra	6.0-6.5
Beets (Sugar)	5.5-6.5	Onions	5.5-7.0
Brussels Sprouts	6.0-7.5	Parsley	5.5-7.0
Cabbage	6.0-7.5	Parsnips	5.5-7.0
Cantaloupes	6.0-7.0	Peas	6.0-7.0
Cauliflower	6.0-7.0	Peppers	5.5-7.0
Carrot	6.0-7.5	Potatoes (Sweet)	5.5-6.0
Celery	5.5-7.0	Potatoes (White)	5.0-6.0
Collards	5.5-6.5	Pumpkin	5.5-7.5
Corn (Sweet)	5.5-7.5	Radishes	6.0-7.0
Cowpeas	5.5-7.0	Spinach	6.0-7.0
Cucumbers	5.5-7.0	Squash	6.0-7.5
Eggplant	5.5-6.0	Tomatoes	6.0-7.0
Endive	5.5-7.0	Turnips	5.5-7.0

DESIRABLE SOIL pH RANGES

Fruits and Nuts	Range	Fruits and Nuts	Range
Almond	6.0-7.0	Hazelnuts	6.2-6.8
Apples	5.5-7.0	Peach	6.0-7.5
Apricot	6.0-7.0	Pear	6.0-7.5
Blueberries	4.5-6.0	Pecan	6.0-8.0
Cherry (Sour)	6.0-7.0	Plums	6.0-7.0
Cherry (Sweet)	6.0-7.5	Strawberries	5.0-6.5
Citrus	6.0-7.0	Walnut	6.0-8.0
Grapes	5.5-7.0	Watermelon	5.5-6.5

Ornamental Shrubs and Trees	Range	Ornamental Shrubs and Trees	Range
Abelia	6.0-7.0	Maple (Silver, Sugar, Red)	6.0-7.0
Althea (Rose of Sharon)	6.0-7.0	Mimosa	5.5-6.5
Annual Flowers (various)	5.5-6.5	Mulberry	6.0-7.0
Ash (Green)	6.0-7.0	Oak (Scarlet or Red)	6.0-7.0
Azalea	4.5-5.5	Oak (White)	5.5-6.5
Beech	6.0-7.0	Pine	5.0-6.5
Birch	5.0-6.0	Poplar	6.0-7.0
Boxwood	6.0-7.0	Rhododendron	5.0-6.0
Camellia	4.5-5.5	Roses	5.5-7.0
Cedar (Red)	5.0-7.0	Spirea	6.0-7.0
Cherry (Flowering)	5.0-7.0	Spruce (Norway)	5.0-6.5
Cottonwood	5.5-7.0	Sweet Gum	6.0-7.0
Crab Apple (Flowering)	6.0-7.0	Viburnum	6.0-7.5
Crape Myrtle	5.0-6.0	Willow	6.0-7.0
Cypress (Bald)	5.0-6.5	Yew	6.0-7.0
Dogwood	5.0-6.5		
Elm	6.0-7.0		
Gardenia	5.0-6.0		
Holly (American)	4.0-6.0		
Holly (Japanese)	5.0-6.0		
HoneySuckle	6.0-7.0		
Hydrangea (blue flower)	4.5-5.5		
Hydrangea (pink flower)	6.0-7.0		
Juniper	5.0-7.5		
Locust	6.0-7.0		
Magnolia (deciduous)	5.0-6.0		

PLANT ANALYSIS

REASONS FOR USING PLANT ANALYSIS

For growth, development and production, plants require a continuous, well adjusted supply of essential mineral nutrients. If any of these nutrients are in limited supply, crop performance decreases and ultimately results in nutritional disorders. Shortages of mineral nutrients manifest themselves in terms of reduced crop yields and/or poor quality of the crop.

Soil testing generally precedes plant testing for routine fertilizer advisory purposes; however, plant analysis in combination with soil testing is an excellent way to develop a strong fertility program for crop production. As soil analysis indicates the relative availability of nutrients in the soil for crop use, plant analysis provides an indication of which nutrients have been or are absorbed by the plants.

Leaves are considered as the focus of physiological activity and changes in mineral nutrition appear to reflect in the concentrations of leaf nutrients.

Motivation for the determination of nutrient concentration in leaves for diagnostic purposes arises from the assumption that a significant relationship exists between nutrient supply and levels of elements, and that increases or decreases in concentrations relate to higher or lower yields, respectively.

SAMPLING

Selective sampling, of course, is the first important step and it is necessary to standardize plant/leaf/petiole sampling techniques as perfectly as possible. Plant tissue sampling procedures are given in the following Figure 1 and Table 2.

It is important that these instructions are carefully followed, as the interpretation of the analysis data is based on the time of sampling and plant part which was sampled for analysis.

When nutrient disorders are suspected, sampling may be done at the time at which they are observed, AND it may be advisable to collect samples at the same time from healthy plants, which are growing in the same area. Soil sample analysis data from poor and good areas will greatly enhance the ultimate reliability of the interpretation and recommended treatments.

Samples should NOT be taken from plants, which are damaged by disease, insects, or chemical applications, unless it is the objective of a study. Dead plants or plant materials also should not be included in the sample. Do not ship leaf samples in sealed plastic bags.

HANDLING AND PACKAGING

If possible, fresh tissue should be air dried before packaging and shipment to prevent decomposition during transit.

Where samples are large, as during the later stages of growth of corn, it is advisable to stack the leaves and cut the tip and base off the leaves, leaving the middle 10- to 12-inch portions of the leaves for mailing and analysis. This can greatly reduce the shipping volume and cost.

Mailing soil or dust covered samples should be avoided. Such samples can be cleaned with a damp cloth or paper towel. Do NOT place root portions or soil and plant parts together into the same mailer.

Include a sample information sheet, which gives the name and address of the sender and grower, party to be billed, party which should receive the analytical data and interpretation, plant species and plant part sampled, stage of growth, visual symptoms when sampled, analysis desired, and any other information which is of importance.

Select the best and fastest method of sending the package.



Desired Sample Location From Common Crops



Corn...before tasseling

Collect the first fully developed leaves from the top of 15 to 20 plants. (If the plant is less than 12 inches tall, collect all of the above ground portion).



Corn...from tasseling to silking

Collect the leaves below and opposite from the ear of 15 to 20 plants.



Sorghum

Collect the second leaf from the top of 20-30 plants before or at heading.



Alfalfa

Collect top 6 inches or upper third of the plant at fourth bloom stage or before.

Pistachios, Walnuts, Citrus

Collect terminal leaflets/leaves at mid to late season.



Grapes

Collect the leaves opposite basal cluster at bloom.



Pecans, Figs, Olives, Peaches, Nectarines

Collect the mid-shoot leaflets/leaves at mid season.

Apples, Pears, Almonds, Apricots, Cherries, Prunes, Plums

Collect the leaves from non-fruiting, non-expanding, spurs at mid season.



Soybeans

Collect recently mature trifoliate leaves from the top of 20 to 30 plants prior to or during flowering. (In the seeding stage, collect all of the above-ground portion).



Small Grains

Collect the four uppermost leaf blades from the top of 25 to 40 plants. (In the seeding stage, collect all of the above-ground portion). Sample should equal two cups.

Cotton

Collect recently mature leaves from the main stems on 40 to 50 plants selected at random at full bloom.

Figure 1. Source: AandL Laboratories, Sampling Guide For Plant Tissue Analysis.

TISSUE SAMPLING TECHNIQUES FOR SPECIFIC PLANTS

CROP	WHEN TO SAMPLE	WHERE TO SAMPLE	# TO SAMPLE
FIELD CROPS			
Alfalfa	Early bloom stage	Upper 3rd of plant	12 - 30
Canola	Before seed set	Recently mature leaf	60 - 70
Cereal grains (small grains)	Seedling stage or	All above-ground portion	25 - 40
	Before seed set	4 uppermost blades from the top of the plant	25 - 40
Clover	Before bloom	Upper 3rd of plant	30 - 40
Corn/Sweet corn	Seedling stage or	All above-ground portion	15 - 20
	Before tasseling or	Recently mature leaf	12 - 20
	Tasseling to silking	Leaf opposite/below ear	12 - 20
Cotton	Full bloom	Recently mature leaf	40 - 50
Flax	Seedling stage	All above-ground portion	50 - 60
Grasses/forage mixes	Stage of best quality	Upper 4 leaves	30 - 40
Hay, forage, or pasture grasses	Before seed head emergence or at the stage of best quality	4 uppermost leaf blades	50 - 60
Peanuts	Before/at bloom	Recently mature leaf	40 - 50
Sorghum (milo)	Before/at heading	2nd leaf from top	20 - 30
Soybeans	Before/at bloom	Recently mature leaf	20 - 30
Sugar beets	Midseason	Recently mature leaf at center of the whorl	25 - 30
Sugarcane	Up to 4 months old	4th fully developed leaf from top	15 - 20
Sunflowers	Before heading	Recently mature leaf	20 - 30
Tobacco	Before bloom	Recently mature leaf	10 - 15
ORNAMENTALS AND FLOWERS			
Carnations	Newly planted	4th - 5th leaf pair from base	20 - 30
	Established	5th - 6th leaf pair from base	20 - 30
Chrysanthemums	Before/at bloom	Top leaves on flowering stem	20 - 30
Ornamental trees	Current year's growth	Recently mature leaf and shrubs	30 - 70
Poinsettias	Before/at bloom	Recently mature leaf	15 - 20
Roses	At bloom	Recently mature compound leaf on flowering stem	25 - 30

TISSUE SAMPLING TECHNIQUES FOR SPECIFIC PLANTS

CROP	WHEN TO SAMPLE	WHERE TO SAMPLE	# TO SAMPLE
Turf	Active growth	Leaf blades. Avoid soil contamination	2 cups

VEGETABLE CROPS

Asparagus	Maturity	Fern from 18 - 30" up	10 - 30
Beans	Seedling stage or	All above-ground portion	20 - 30
	Before/at bloom	Recently mature leaf	20 - 30
Broccoli	Before heading	Recently mature leaf	12 - 20
Brussels Sprouts	Midseason	Recently mature leaf	12 - 20
Celery	Midseason	Outer petiole of recent mature leaf	12 - 20
Cucumbers	Before fruit set	Recently mature leaf	12 - 20
Head Crops (cabbage, cauliflower)	Before heading	Recently mature leaf at center of whorl	12 - 20
Leaf crops (lettuce, spinach, etc.)	Midseason	Recently mature leaf	30 - 50
Melons	Before fruit set	Recently mature leaf	12 - 20
Peas	Before/at bloom	Leaves from 3rd node from top	40 - 60
Peppers	Midseason	Recently mature leaf	25 - 50
Potatoes	Before/at bloom	3rd - 6th leaf from growing tip	25 - 30
Root/bulb crops (carrots, beets, onions, etc.)	Midseason	Recently mature leaf root or bulb enlargement	20 - 30
Sweet Corn	Before tasseling or	Entire fully mature leaf below the whorl	20 - 25
	At tasseling	Entire leaf at the ear node	20 - 25
Tomatoes (field)	Mid-bloom	3rd - 4th leaf from growing tip	15 - 20
Tomatoes (trellis or indeterminate)	Mid-bloom from 1st to 6th cluster stage	Petiole of leaf below or opposite to cluster	15 - 20 12 - 20
Tomatoes (greenhouse)	Before or during fruit set	Young plants: leaves from 2nd and 3rd clusters	20 - 25
		Older plants: leaves from 4th - 6th cluster	20 - 25

TISSUE SAMPLING TECHNIQUES FOR SPECIFIC PLANTS

CROP	WHEN TO SAMPLE	WHERE TO SAMPLE	# TO SAMPLE
FRUIT AND NUT CROPS			
Almonds, apples, apricots, cherries, pears, plums, prunes	Midseason (June-July)	Leaves from current season's non-fruiting, non-expanding spurs	50 - 100
Blueberries	2 - 4 weeks before harvest	Mid-shoot leaves from current season's shoots	50 - 100
Citrus	Late season (September-October)	Terminal leaves from current season's non-fruiting shoots	25 - 40
Figs, olives, peaches, nectarines	Midseason (June-July)	Basal to mid-shoot leaves from current season's non-fruiting shoots	25 - 100
Grapes	Mid-bloom	Recently mature petioles or leaves adjacent to basal clusters	50 - 100
Kiwi fruit	Midseason	1st - 3rd leaf beyond fruit or mid-cane leaves if non-bearing	50 - 60
Lemons, Limes	Midseason	Mature leaves from last flush of growth on nonfruiting terminals	30 - 40
Oranges	Midseason	Spring cycle leaves, 4 to 7 months old, from nonfruiting terminals	25 - 30
Pecans	Midseason	Paired mid-shoot leaflets from non-fruiting shoots	25 - 60
Raspberries	Midseason	Recently mature leaves from laterals of primo canes	30 - 50
Strawberries	Midseason	Recently mature leaves	25 - 40
Walnuts	Midseason (June-July)	Terminal leaflets from non-fruiting shoots	25 - 40

SUBMITTED SAMPLE SHOULD EQUAL TWO CUPS OF MATERIAL, THEREFORE REDUCE COMPOSITE SAMPLE ACCORDINGLY.

Table 2. Source: AandL Laboratories, Sampling Guide For Plant Tissue Analysis.

DIAGNOSIS OF FIELD PROBLEMS

If fields are checked regularly, there is often time to correct problems if action can be taken immediately. The cause could be obvious; however, a guideline could be very helpful in making a diagnosis.

The objective is to use all resources to identify and correct any conditions restricting the plant's potential for producing seed, fruit, fiber, and/or forage.

Visual Plant Symptoms

Check each part of the plant thoroughly and record unusual growth, color, deficiency symptoms, delayed maturity, quality of crop, mechanical damage, and injury by insects. Also examine the root system for injury or specific growth patterns.

Soil Conditions

Soil analysis measures only the chemical factors, which influence plant health. However, the physical make-up of the soil affects water holding capacity, water penetration, aeration, and root growth. When the soil's physical characteristics are such that plant roots cannot supply plants with sufficient water and nutrients, or plants suffer from lack of oxygen, the soil has a physical problem.

Such problems could be caused by compaction layering or stratification of different soil textures or hardpans (natural or man-made).

Crop rotation, reduced tillage practices, change in irrigation practices or drainage methods and deep tillage can provide a better environment for root development.

Field History

Obtain information about the previous crop grown in the field, weed, insect/disease problems, fertilization and liming programs, soil and plant analysis data, and yield potential of the soil type. Also, know the crop variety, tillage method, and pesticides used.

Weather Observations

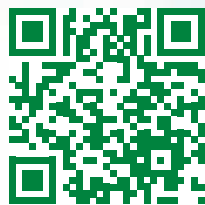
Rainfall and temperature have a great influence on nutrient uptake and they can be indirect contributors to fertility problems.

Soil and Plant Analysis

The most effective use of these analyses consists of comparing soil and plant analysis data from good and bad areas.



a complete nutritional
prescription service.



The Importance of Soil and Tissue Sampling



Soil Sampling: Soil testing has become an important tool for assessing soil fertility and arriving at proper fertilizer recommendations.

Tissue Sampling: Crop nutrition deficiencies are not always visible, that's why tissue sampling is so important during the growing season.

For additional information on NutriScription, training and information videos visit: <http://www.lovelandproducts.com/product/nutriscription> OR scan the QR[®] code above to activate the videos and learn more about a complete nutritional prescription service.




NutriScript[®]

NUTRISCRPTION[®] is a complete nutritional prescription service which takes soil and tissue analysis data and creates agronomically correct and field specific fertilizer recommendations.

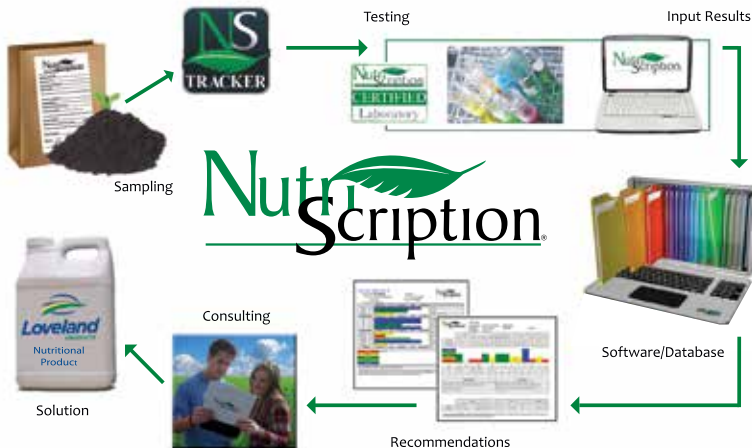
- Creates a user-friendly graphic analysis of your crop or turf nutritional status and provides specific recommendations
- Captures soil and tissue data
- Progressive soil, tissue and vertical soil reports (comparing fields, crops or time)
- Assists in providing a sound nutrient program

What is a “Recommendation”?

A recommendation connects a **nutrient range** with a potential **product**

Low End	High End	Bar Color	Recommendations
3.01	6.00		Optimum
1.50	3.00		N-Pact at 1-2 gal/ac or discuss options
0.10	1.49		Nitrogen deficient - discuss options including N-Pact

The Process



PROGRESSIVE TISSUE REPORT

Standard tissue report delivered automatically via email, but also generated manually using a **NutriScript** account

Tissue: Corn - Midwest Labs - V14

Grower Name

Field Name

Crop Corn

Sample Date 7/19/2010

Test Date

Field Rep

Sample ID

Subfield




	Very Low	Low	Optimum	High	Excessive	
Total N	3.09					N-Pact at 1 g/A
Total P	0.33					Optimum
Total K	1.74					1 g/Lokomove per acre
Macronutrients						
Ca	0.54					Optimum
Mg	0.21					Fullback @ 1-2 pts
Na	0.00					Optimum
S	0.18					Sulfone @ 1lb/A
Micronutrients						
Zn-ppm	30.00					Optimum
Mn-ppm	95.00					High
Fe-ppm	110.00					Optimum
Cu-ppm	9.00					Optimum
B-ppm	18.00					High
Petioles						
	Very Low	Low	Optimum	High	Excessive	

Very Low	Comments:
Low	
Optimum	
High	
Very High	

Analytical data provided by Midwest Labs. Recommendations provided in this report are proprietary in nature whereby nutrient thresholds used as a reference may or may not match Midwest Labs ranges for this particular crop and growth stage.

VERTICAL SOIL REPORT

Used in the Midwest markets



Soil: Corn

Grower Name: _____

Field Rep: _____

Field Name: _____

Sample Date: 7/20/2010

Test Date: 7/20/2010

	p H+	Buffer P _h	NO ₃ -N ppm	P ²⁻	P ³⁻	K ppm	Ca ppm	Mg ppm	Zn ppm	B ppm	Fe ppm	Mn ppm	Cu ppm	S ppm
F10191-0003	6.7	0	0	25	0	130	1190	255	2.3	0.3	42	34	1.9	10
Average	6.7	0	0	25	0	130	1190	255	2.3	0.3	42	34	1.9	10
Avg in 100cc	-	-	-	60	-	270	2700	610	4.8	0.6	64	68	3.8	20

Very High

High

Optimum

Low

Very Low


Crop	Coal	Lime	N	P2O5	K2O	Ca	Mg	Zn	B	Fe	Mn	Cu	S
Corn	180	2	225	75	95				1				15
Soybean	90	2		50	95				1				10

Liquid Products		Dry Products	
1-3 gal/A Accomplish LM or Iron P&K w/upto of 4 gal/A Iron P&A w/aly		Nutor 10 @ 10 to 40 lbs/A - Call 800-292-3072	
		Copper 12 @ 5 to 25 lbs/A - Call 800-292-3072	
		62.20 @ 15 to 40 lbs/A - Call 800-292-3072	
* Wash Day ** Strong Day		* (1:1) water Sol	

CEC	OM %	Lime Req	Ca %	Mg %	K %	Na %	H %	Saltity	SAR	CaCO ₃	Glyc Res	Ca Mg %CEC	K Mg ppm
8.1-15	2.6-4.3	0.3-1.6	55.1-15	10.1-16	4.7	3.1-4	12.6		0.5-3	0.1-0.5	0.3-1	6.1	0.5-1
F10191-0003	5.6	12.0	52.0	16.8	2.8	0	20.1					3.2	0.6
Average	5.6	12.0	52.0	16.8	2.8	0	20.1					3.2	0.6

PROGRESSIVE SOIL REPORT

Used in irrigated or specialty markets



Soil: Cotton - Cotton (2 bale/ac) (CPS)

Grower Name: _____

Field Name: _____

Crop: Cotton

Sample Date: 10/15/2010

Lab Name: _____

Test Date: 10/19/2010

Field Rep: _____

Sample_ID: _____

Sample Depth: _____

	Deficient	Low	Optimum	High	Excessive	
pH (1:1)						8.50
Org Mat %						1.30
Primary Nutrients - ppm	Very Low	Low	Optimum	High	Excessive	
NO ₃ -N						7.00
Ammon N-P						12.00
K (sech)						387.00
Secondary Nutrients	Very Low	Low	Optimum	High	Excessive	
Ca (sech)						5190.00
Mg (sech)						606.00
Na (sech)						212.00
SO ₄ -S						13.00
Micronutrients - ppm	Very Low	Low	Optimum	High	Excessive	
Boron						0.50
Copper						0.40
Iron						3.00
Manganese						2.00
Zinc						0.20
Soluble Salts	Very Low	Low	Optimum	High	Excessive	
Soil Salts (1:1) meq/100g						0.41
% Base Saturation	Very Low	Low	Optimum	High	Excessive	
CEC						33.00
% Ca CEC						79.00
% Mg CEC						18.00
% K CEC						3.00
% Na CEC						3.00

Very Low

Low

Optimum

High

Very High

Comments:

Top Res. ton/acre @ 1/2 N-P-K or Add Organic Acid

120 - 180 lbs N/ha, Nontrace Black Label

120 - 120 lbs S/ha, Nontrace Black Label

40 lbs K/ha, Nontrace RatiOnse K, RT5.

See Ca % Base Sat.

See Mg % Base Sat.

See Na % Base Sat.

30 - 70 lbs/A S from CaTS, RatiOnse K, RT5.

0 - 1 lb/acre Borax 10 or 1 - 3 lbs dry 17.5% B

2 - 3 gal/A Actagro Cu or 4 - 6 lb/A dry

2 - 3 gal/A Actagro Iron or 10 - 15 lb/A dry

2 - 3 gal/A BlackJack Zn or 10 - 15 lb/A

2 - 3 gal/A BlackJack Zn or 10 - 20 lb/A

0 - 0.5 lb/A Accomplish @ 1 gal/A, CaTS, N-P-K or

SR Loam - City Loam

Maintain Level

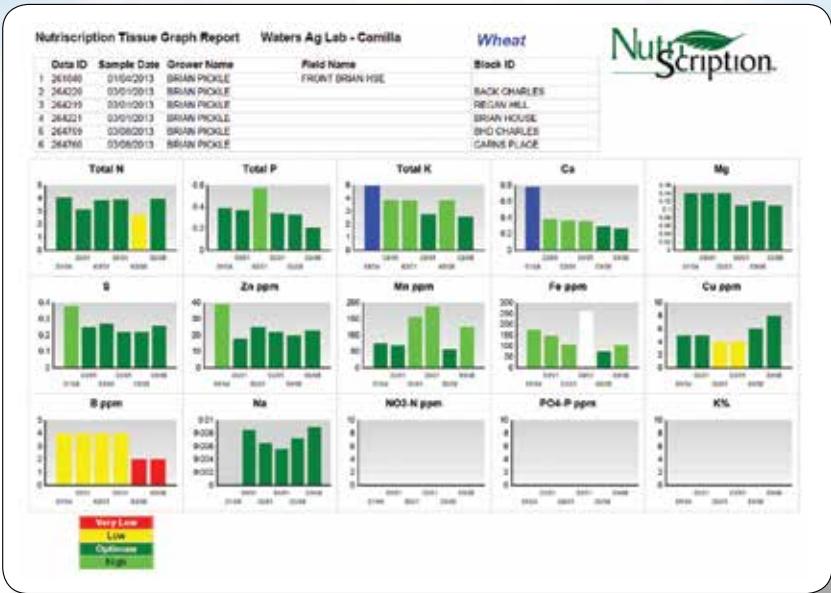
0 - 100 lbs Mg/ha, Mag/Ths, KMag

50 - 300 lbs K/ha, KMag, Nontrace RatiOnse K, RT5

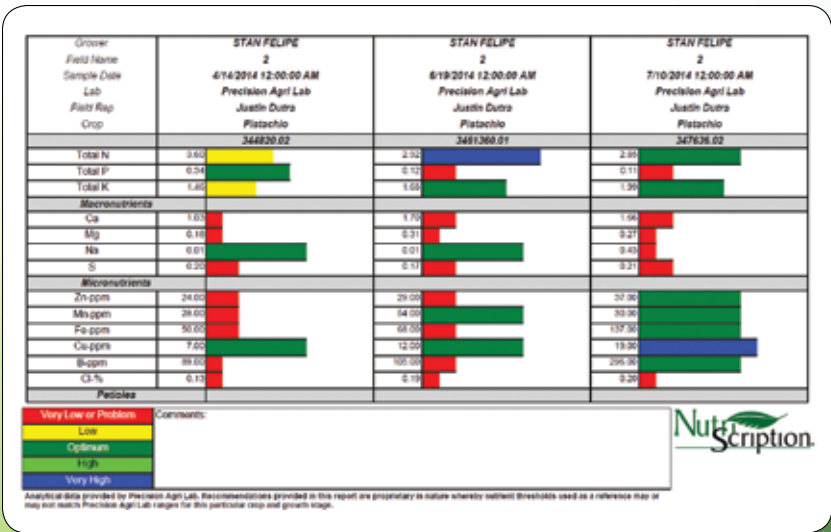
0 gal/A Accomplish

Analytical data provided by Servo-Tech - Amurto. Recommendations provided in this report are proprietary in nature whereby nutrient thresholds used as a reference may or may not match Servo-Tech - Amurto ranges for this particular crop and growth stage.

MULTI GRAPH REPORT



THREE SAMPLE REPORT



APPROXIMATE POUNDS OF PLANT FOOD NUTRIENT REMOVAL

CROP	UNIT	N	P ₂ O ₅	K ₂ O	Mg	Ca	S
GRAINS							
Barley	Bu.	1.10	0.40	0.35	0.07	0.04	0.08
Corn	Bu.	0.80	0.40	0.29	0.06	0.03	0.07
Oats	Bu.	0.75	0.25	0.20	0.04	0.03	0.07
Rice	Bu.	0.65	0.28	0.17	0.05	0.04	0.04
Rye	Bu.	1.20	0.35	0.35	0.08	0.07	0.21
Sorghum (Milo)	Bu.	0.85	0.40	0.25	0.08	0.07	0.09
Wheat	Bu.	1.20	0.55	0.35	0.14	0.06	0.10
FORAGES (DRY BASIS)							
Alfalfa	Ton	56.0	15.0	60.0	5.0	28.0	5.0
Bluegrass	Ton	35.0	12.0	35.0	4.0	8.0	4.0
Brome Grass	Ton	40.0	12.0	44.0	4.0	8.5	3.4
Coastal Bermuda	Ton	50.0	12.0	40.0	4.5	7.5	6.0
Corn Silage (wet)	Ton	8.3	3.5	8.0	1.0	1.2	0.9
Cowpeas	Ton	62.0	12.0	42.0	7.5	27.0	6.5
Fescue	Ton	40.0	16.0	48.0	4.8	9.0	4.4
Lespedeza	Ton	48.0	15.0	45.0	7.0	20.0	6.0
Orchard Grass	Ton	45.0	14.0	55.0	4.4	8.0	5.5
Red Clover	Ton	56.0	12.5	45.0	6.0	24.0	5.0
Sorghum/Sudan	Ton	40.0	15.0	55.0	6.0	9.0	4.5
Sweet Clover	Ton	44.0	11.0	44.0	4.8	29.0	8.2
Timothy	Ton	36.0	13.5	54.0	3.5	8.0	3.5
Vetch	Ton	55.0	15.0	45.0	5.0	24.0	5.0

APPROXIMATE POUNDS OF PLANT FOOD NUTRIENT REMOVAL

CROP	UNIT	N	P ₂ O ₅	K ₂ O	Mg	Ca	S
FRUITS and VEGETABLES							
Apples	100 Bu.	17.5	7.5	32.0	4.0	10.0	4.0
Beans, Dry	Bu.	2.5	0.8	0.9	0.1	0.08	0.17
Cabbages	Ton	6.5	2.4	8.0	1.0	2.4	2.2
Cantaloupes	Ton	6.8	2.3	11.5	1.2	3.5	1.1
Celery	Ton	5.2	2.2	10.0	0.8	2.6	1.4
Cucumbers	Ton	9.0	3.0	15.0	2.0	8.0	1.6
Grapes	Ton	5.5	2.0	10.0	0.4	1.0	1.1
Lettuce	Ton	7.0	2.3	10.0	0.7	2.8	0.8
Onions	Ton	6.0	2.7	5.3	0.6	1.6	2.4
Oranges	Ton	9.0	2.0	9.0	1.4	7.0	1.0
Peaches	100 Bu.	16.0	6.4	20.0	4.0	15.0	3.5
Pears	100 Bu.	15.0	6.0	24.0	3.5	12.0	3.0
Potatoes	Cwt.	0.33	0.15	0.53	0.025	0.025	0.016
Spinach	Ton	10.0	3.0	6.0	1.0	2.4	0.8
Sweet Potatoes	100 Bu.	25.0	10.0	50.0	5.0	3.0	4.0
Tomatoes	Ton	3.8	1.45	7.0	0.5	0.6	0.7
Turnips (roots)	Ton	4.5	2.0	8.0	0.6	1.2	0.85
Turnips (tops)	Ton	8.3	0.8	6.0	0.4	4.2	1.0
OTHER CROPS							
Canola	Bu.	3.00	1.31	2.37	0.25	0.25	0.20
Cotton (SandL)	Bales	40.0	20.0	16.0	4.0	3.0	4.5
Flax	Bu.	2.70	1.10	0.30	0.18	0.25	0.20
Peanuts	1000 lbs.	35.0	6.0	8.0	1.2	2.5	2.5
Soybeans	Bu.	4.10	0.85	1.45	0.23	0.22	0.20
Sugar Beets	Ton	4.10	0.6	7.0	0.4	1.2	0.4
Sugarcane	Ton	1.6	0.9	3.5	0.3	0.5	0.45
Sunflowers	Cwt.	3.60	1.70	1.10	0.28	0.30	0.33
Tobacco (flue)	Cwt.	2.80	0.50	5.2	0.9	2.9	0.7
Tobacco (burley)	Cwt.	4.30	0.44	4.7	1.0	2.6	0.9

Source: Agronomy Handbook, Midwest Laboratories, Inc.

NUTRIENT UPTAKE BY YIELD GUIDE

TOTAL NUTRIENT UPTAKE (LBS/A)

	UNIT	N	P ₂ O ₅	K ₂ O	Mg	S
GRAIN and OIL						
Canola	35 bu/A	105	46	83	-	21
Corn	200 bu/A	266	114	0266	53	33
Cotton	1,500 lb/A	240	72	210	32	36
Grain Sorghum	8,000 lb/A	238	84	240	40	38
Oats	100 bu/A	115	40	145	20	19
Oil Palm	220 cwt/A	172	74	268	55	-
Peanuts	4,000 lb/A	240	39	185	25	21
Rice	7,000 lb/A	112	60	168	14	12
Spring Barley	120 bu/A	180	66	180	20	24
Soybeans*	60 bu/A	315	58	205	24	20
Sunflower	3,000 bu/A	151	60	110	36	14
Wheat	80 bu/A	166	54	184	17	20

SILAGE and HAY

Alfalfa*	10 tons/A	560	150	600	50	50
Bermudagrass	8 tons/A	368	96	400	26	44
Birdsfoot Trefoil*	4 tons/A	192	84	272	32	20
Bromegrass	4 tons/A	144	52	236	16	16
Clover* - Grass	6 tons/A	300	90	360	30	30
Corn Silage**	27 tons/A	266	114	266	53	33
Fescue	3.5 tons/A	135	65	185	13	14
Forage Sorghum	8 tons/A	198	67	268	35	18
Orchardgrass	6 tons/A	300	100	375	25	25
Sorghum-Sudan	8 tons/A	320	122	466	48	-
Timothy	4 tons/A	150	55	250	10	16

NUTRIENT UPTAKE BY YIELD GUIDE

	UNIT	TOTAL NUTRIENT UPTAKE (LBS/A)				
		N	P ₂ O ₅	K ₂ O	Mg	S
GRASS/MISCELLANEOUS						
Burley Tobacco	4,000 lb/A	307	38	330	35	45
Coffee	1,620 plants/A	230	40	250	29	22
Flue-cured Tobacco	3,000 lb/A	126	26	257	24	19
Guineagrass	11.5 tons/A	288	101	436	99	46
Napiergrass	12.5 tons/A	303	147	605	63	75
Pangola Grass	11.8 tons/A	299	108	430	67	46
Paragrass	12 tons/A	308	98	460	79	41
Pensacola Bahia	7 tons/A	303	87	242	35	27
Pulpwood	40 cords/A	340	37	140	50	-
Ryegrass	5 tons/A	215	85	240	40	-
Sugar Beets	25 tons/A	212	33	458	67	37
Sugarcane	50 tons/A	210	100	330	28	25
FRUITS and VEGETABLES						
Bell Peppers	180 cwt/A	137	52	217	40	-
Cabbage	700 cwt/A	270	63	249	36	64
Cantaloupes	175 cwt/A	65	21	117	12	-
Celery	75 tons/A	280	165	750	-	-
Cucumbers	10 tons/A	90	28	174	25	-
Lettuce	400 cwt/A	90	30	185	-	-
Onions	600 cwt/A	180	80	160	18	37
Peas	25 cwt/A	164	35	105	18	10
Pineapple	357 cwt/A	153	125	596	64	14
Potatoes	500 cwt/A	269	90	546	50	22
Snap Beans	4 tons/A	138	33	163	17	-
Sweet Corn	90 cwt/A	140	47	136	20	11
Sweet Potatoes	400 bu/A	103	40	210	11	-
Table Beets	500 cwt/A	360	43	580	104	41
Tomatoes	40 tons/A	232	87	463	36	54

NUTRIENT UPTAKE BY YIELD GUIDE

	UNIT	TOTAL NUTRIENT UPTAKE (LBS/A)				
		N	P ₂ O ₅	K ₂ O	Mg	S
FRUITS and VEGETABLES CONT.						
Apples	250 cwt/A	100	46	180	24	-
Bananas	1,200 plants/A	400	400	1,500	156	-
Cocoa	900 lb/A	416	108	733	119	-
Coconuts	12,000 nut/A	96	31	206	13	8
Grapes	12 tons/A	102	35	156	18	-
Oranges	540 cwt/A	265	55	330	38	28
Peaches	600 bu/A	95	40	120	22	-

* Legumes get most of their nitrogen from the air.

** Corn silage at 65% moisture. Other crops are measured on a dry matter basis.

TITAN[®]

XC 

Accomplish^{LM}

START STRONG
END STRONG
 with Accomplish LM
 and Titan XC



Get your growing program off to a great start and keep it going strong all season long with Accomplish LM and Titan XC, Loveland Products' biochemical fertilizer catalysts that quickly increase the availability and uptake of applied nutrients. Whatever your starter program, Accomplish LM and Titan XC ensure that your nutrients are available when and where your plants need them, for greater yield potential and maximum plant performance throughout the season.

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Crop
 Production
 Services 


 Loveland
 PRODUCTS

PRODUCT COMPARISON CHART

LIQUID MATERIAL	ANALYSIS	LBS/GAL	GALS/TON	pH [†]
ACA Concentrate	15-0-0-17Zn	10.54	189.57	11.6
ACA Plus	7-0-0, 8.5Zn	10.05	193.98	6.8
Accomplish LM	—	8.30	232.55	6.40 8.0
Awaken	16-0-2	10.29	196.07	6.4
Black Label	6-22-0	10.90	183.48	6.4-6.6
Black Label Zn	6-20-0-0.77Zn	11.00	181.81	6.1-6.3
BlackMax 22	0-0-4	10.00	200	12.5-13.0
Borosol 10	10B	11.09	178.89	8.25
Extract	6-0-0, 13S	10.00	206.18	7.0-8.0
Fullback	6Mg	10.12	199.80	5.5
Levitate	5-15-5	10.58	191.02	6.7 – 7.5
LoKomotive	2-0-25	10.85	185.19	8.5
Maximum N-Pact	24-0-0 (33% SRN)	9.95	200	9.0
N-Pact	26-0-0 (33% SRN)	10.01	198.01	9.0
Nitrain	—	8.93	223.96	—
Nitrain Express	—	8.99	222.47	9.4
NutriSync Boron	5B	9.84	206.61	8.15
NutriSync Calcium	4-0-0, 10Ca	11.51	188.68	5.0-5.6
NutriSync Complete	10-7-4	10.01	199.80	—
NutriSync Copper	8-0-0, 4.5Cu	9.37	211.86	9.0
NutriSync D	0-2-1	9.01	219.53	4.4-4.8
NutriSync M	0-0-2	9.09	216.91	2.2-2.5
NutriSync Magnesium	5Mg	10.43	191.75	5.2-5.8
NutriSync Manganese	3Mn	8.92 9.43	224.22	5.0-5.7

PRODUCT COMPARISON CHART

LIQUID MATERIAL	ANALYSIS	LBS/GAL	GALS/TON	pH [†]
NutriSync Micro Pak	13-0-1	9.95	201.01	7.4-7.7
NutriSync Phos	4-10-4	9.68	207.47	2.2-2.9
NutriSync Sulfur	6-0-0, 6.3S	9.84	203.46	5.0-5.6
NutriSync Zinc	6Zn	10.43	199.80	4.6-5.4
Quick Ultra with Awaken	7-28-4	11.73	192.49	5.0-5.8
Radiate	—	8.68	230.41	3.1-3.7
Rebar 2	3 Fe	11.00	181.82	6.03
Re-Nforce K	5-0-20,13S	11.70	171.23	10.0
Re-Nforce KS	15-0-12, 8S	11.75	176.67	11.0
RiseR	7-17-3	10.56	188.85	6.5
Task Force 2	11-8-5	10.12	194.9	7.0
Titan XC	—	8.40	238.10	7.74
Validate	—	8.64	231.48	3.6
Water	—	8.33	240.10	—

† Measuring by undiluted stock solution of material.

ELEMENT ROLES INSIDE OF PLANTS

ELEMENT	ROLE(S) IN PLANT (NOT ALL INCLUSIVE)
B	Forms some complexes with some CHOs and there is direct evidence for involvement on CHO transport.
C	Fixed through photosynthesis from Carbon Dioxide and is used to build carbohydrates and proteins.
Ca	Constituent of the middle lamella of cell walls. Required to activate some enzymes involved in the hydrolysis of ATP and phospholipids.
Cl	Required for photosynthetic reactions involved in O ₂ evolution.
Cu	Essential component of ascorbic oxidase, tyrosinase, monoamine oxidase, uricase, and cytochrome oxidase.
Fe	Component of cytochromes and non-heme proteins involved in photosynthesis, N ₂ fixation and respiration.
H	Necessary for building sugars. Helps drive photosynthesis and respiration.
K	Enzyme activator for over 60 enzymes, osmotic regulator, maintains electrical neutrality. Essential for protein synthesis, breaks down carbohydrates, moves heavy metals in the plant such as iron, helps plant to overcome effects of diseases and is vitally important in fruit formation.
Mg	Constituent of the chlorophyll molecule. Indirectly involved in phosphate transfer.
Mn	Required for the photosynthetic evolution of O ₂ (splitting of H ₂ O). Required to activate many dehydrogenases, decarboxylases, kinases, oxidases and peroxidases.
Mo	Constituent of nitrate reductase. Essential for N ₂ fixation.
N	Constituent of amino acids, proteins, nucleic acids (DNA and RNA), nucleotides and coenzymes. Necessary for chlorophyll synthesis and is involved in photosynthesis. Builder of proteins.
Ni	Essential for the function of urease and N nutrition in general.
O	Necessary for plant cellular respiration. Through the breakdown of Carbon Dioxide during photosynthesis oxygen is released to the atmosphere and a small amount is used in the respiration process.

ELEMENT ROLES INSIDE OF PLANTS

ELEMENT (cont.)	ROLE(S) IN PLANT (NOT ALL INCLUSIVE) (cont.)
P	Component of sugar phosphates, nucleic acids (DNA and RNA), nucleotides, coenzymes, phospholipids, phytic acid, ATP, ADP, AMP. Assists in photosynthesis, respiration, cell enlargement, energy storage and transfer. Accelerates maturity.
S	Component of S-containing amino acid cysteine, cystine and methionine and thus many proteins / enzymes. Promotes nodulation for N fixation by legumes, aids in seed production.
Zn	Essential constituent of alcohol dehydrogenase, glutamic dehydrogenase, carbonic anhydrase, and other enzymes.

HORMONES	ROLE(S) IN PLANT (NOT ALL INCLUSIVE)
ABSCISSIC ACID (ABA)	Moves sugar out of leaves, terminates cell life, causes grain seed to go dormant or dry down.
AUXINS (IBA, IAA)	Produced in all new tissue, cell division, moves food to new tissue, stimulates root growth.
CYTOKININS (CYK, KINETIN)	Produced in roots, cell division, controls hormone cycle (agina) of cells.
ETHYLENE (ETH)	Regulates movement of Auxins, first defense against stress/disease, ripening, helps terminate cell life.
GIBBERELIC ACID (GA)	Produced in all plant parts especially seed, increases cell sizing.

HORMONE HELPERS	ROLE(S) IN PLANT (NOT ALL INCLUSIVE)
CALCIUM (CA++)	Controls plant response to climate change, protects against toxicity, regulates nutrient uptake.
POLYAMINES (PA)	Controls hormones, protects against diseases, stresses, increases activity of all cell membranes.

PLANT AVAILABLE FORMS AND SOURCES OF ELEMENTS

SYMBOL	ELEMENT	ATOMIC WEIGHT	FORM(S) TAKEN UP BY PLANT	PRINCIPAL NATURAL SOURCE	ADVANCED SOIL/FOLIAR APPLIED SOURCES
B	Boron	10.82	$H_3BO_3, H_2BO_3^-$	Tourmaline	Awaken, Borosol 10, NutriSync Boron, NutriSync D, NutriSync M, Task Force 2
C	Carbon	12.01	CO_2	Air	Accomplish LM, Black Label Zn, Titan PBA
Ca	Calcium	40.08	Ca^{+2}	Limestone, Gypsum	NutriSync Calcium
Cl	Chlorine	35.46	Cl^-	Salts	(KCl - Murate of Potash)
Cu	Copper	63.54	Cu^{+2}	Chalcopyrite, SOM*	Awaken, Levitate, NutriSync Copper, Task Force 2, RiseR
Fe	Iron	55.85	Fe^{+2}, Fe^{+3} Chelates	Fe-oxides, gethite, SOM*	Awaken, BlackJack Fe, Levitate, Rebar 2, RiseR, Task Force 2
H	Hydrogen	1.01	H_2O	Water	Accomplish LM, Black Label Zn, Titan PBA
K	Potassium	39.1	K^+	"Feldspars, micas, clay minerals"	LoKomotive, Levitate, Re-Nforce K, RiseR, Task Force 2
Mg	Magnesium	24.32	Mg^{+2}	Dolomite	Fullback
Mo	Molybdenum	95.95	MoO_4^{-2}	Misc. Minerals	Awaken, NutriSync D, NutriSync M, Task Force 2
Mn	Manganese	54.94	Mn^{+2}	Mn-oxides, SOM*	Awaken, Levitate, NutriSync M, NutriSync Mn, Task Force 2, RiseR
N	Nitrogen	14.01	NO_3^-, NH_4^+	SOM*	Black Label Zn, Levitate, Maximum N-Pact, N-Pact, RiseR, Task Force 2
Ni	Nickel	58.71	Ni^{+2}	Misc. Minerals	*NA
O	Oxygen	16	CO_2, H_2O, O_2	Air, Water	Accomplish LM, Black Label Zn, Titan PBA
P	Phosphorous	30.98	$H_2PO_4^-, HPO_4^{-2}$	Apatite, SOM*	Black Label, Black Label Zn, Levitate, QuickUltra w/Awaken, RiseR, Task Force 2
S	Sulfur	32.07	SO_4^{-2}	SOM*	NutriSync Sulfur, Re-Nforce K(S)
Zn	Zinc	65.38	Zn^{+2}	SOM*	ACA Plus, Awaken, Black Label Zn, Levitate, NutriSync M, NutriSync Zinc, RiseR, Task Force 2

*Soil Organic Matter

*Not Applicable



Biocatalyst
Technology

Fertilizer

Biocatalyst Technology

Loveland's biocatalyst products are based on innovative plant health technology to ensure maximum nutrient release from applied fertilizers and the soil system, while also facilitating nutrient uptake by the crop. By helping to convert organic nutrients into inorganic forms that the crop can use, these products enhance the performance of liquid and dry fertilizers, also significantly boosting plant performance to allow growers to get the most out of their fertilizer investments.

Key benefits of the biocatalyst technology:

- Increases nutrient availability and uptake
- Enhances nutrient use efficiency
- Promotes better root growth and development
- Improves plant performance
- Optimizes yield potential

Loveland's biocatalyst product portfolio includes:

Accomplish^{LM}

TITAN[®]
XC

Extract
powered by Accomplish



Loveland – Get Growing

PRODUCTS
www.lovelandproducts.com

© 2017 Loveland Products Inc. Always read and follow label directions.

SOIL APPLIED

Biocatalyst
Technology

Accomplish[®] LM

Non-Plant Food Ingredients:

Microorganisms..... <1%

Bacillus licheniformis 1×10^3 cfu/ml*

Bacillus megaterium 1×10^3 cfu/ml

Bacillus pumilus 1×10^3 cfu/ml

*colony forming units/milliliter

Inert Ingredients:

Water-based culture medium 99%

The **ACCOMPLISH[®]** line of products are innovative biochemical fertilizer catalysts designed for use with both liquid and dry fertility programs, significantly increasing fertilizer availability and improving overall plant performance. **ACCOMPLISH LM** is specifically formulated for use with liquid fertilizer and broadcast applications.

FEATURES AND BENEFITS:

- Improves nutrient availability and uptake
- Enhances nutrient use efficiency
- Promotes better root growth and development
- Improves plant performance
- Improves water penetration
- Reduces salt stress
- Increases yield potential

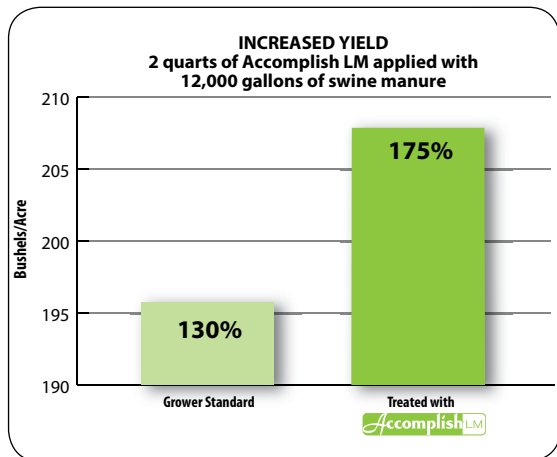


Grower Standard Treated with

Accomplish^{LM}

APPLICATION RATE RANGE:

- 1-4 pts/A with starters or sidedress
- 2-4 qts/A with broadcast applications



REFER TO STATE-SPECIFIC LABELING

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.



Biocatalyst
Technology

SOIL/FOLIAR APPLIED

Get the most out of what you put in with...

Extract

POWERED BY *Accomplish*[™]

Guaranteed Analysis

Total Nitrogen (N)	6.00%
6.00% Ammoniacal Nitrogen	
Sulfur (S)	13.00%

Derived from: Ammonium Thiosulfate

EXTRACT Powered by Accomplish[™] is a Loveland Products proprietary blend of proven fertilizer biocatalysts — Accomplish[®] LM and a nitrogen source, designed to help growers not only manage crop residue but also easily and effectively optimize the release of nutrients from residue and those in the soil.

FEATURES AND BENEFITS:

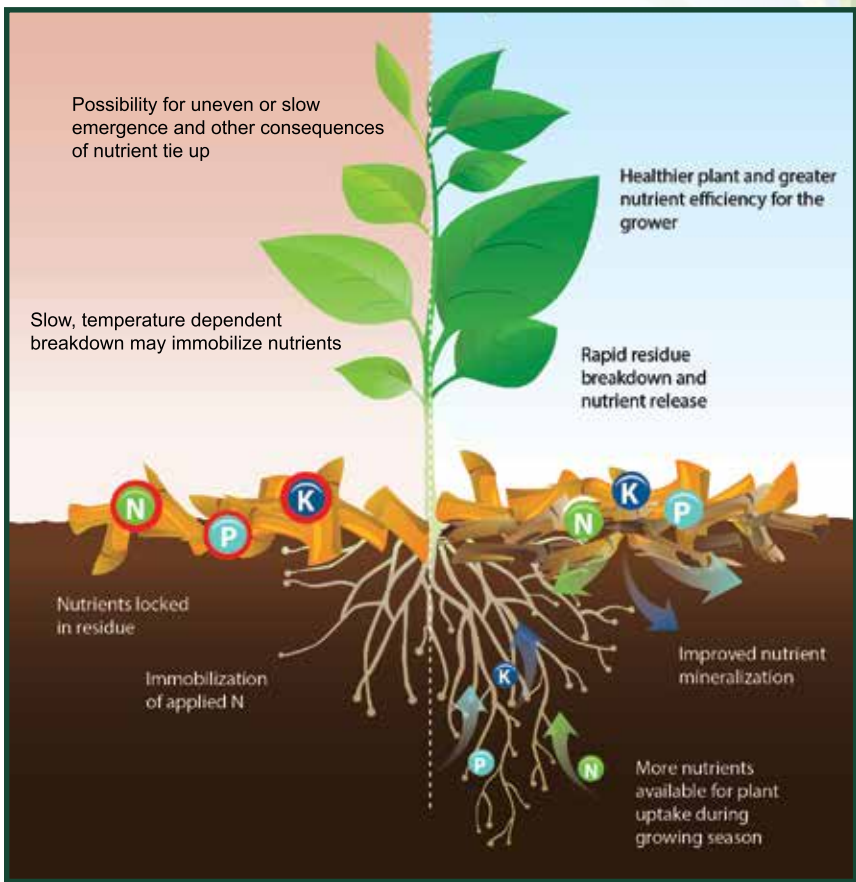
- Promote release of nutrients trapped in residue or bound in soil
- Extend existing nutrient availability later into the season
- Optimize plantability in the spring
- More even crop emergence
- Improve yield potential

APPLICATION RATE:

1-2 gals/A

APPLICATION TIMING:

Apply post-harvest or at pre-emergence timing
(compatible with many herbicides)



ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL APPLIED

Biocatalyst
Technology

TITAN[®]

XC

Release More Nutrition. Expect More Results.

NON-PLANT FOOD INGREDIENTS:

Microorganisms <1%

Bacillus licheniformis 1×10^3 cfu/ml*

*colony forming units/milliliter

Inert Ingredients:

Water-based culture medium 99.00%

IMPROVES DRY FERTILIZER EFFICIENCY.

Get more from every dry fertilizer application with **TITAN XC**. Specifically formulated for impregnation on dry fertilizer blends, **TITAN XC** is the key to quick release and uptake of vital plant nutrients. The unique and concentrated biochemistry in **TITAN XC** provides the broadest range of activity to maximize the return on your dry fertilizer investment.

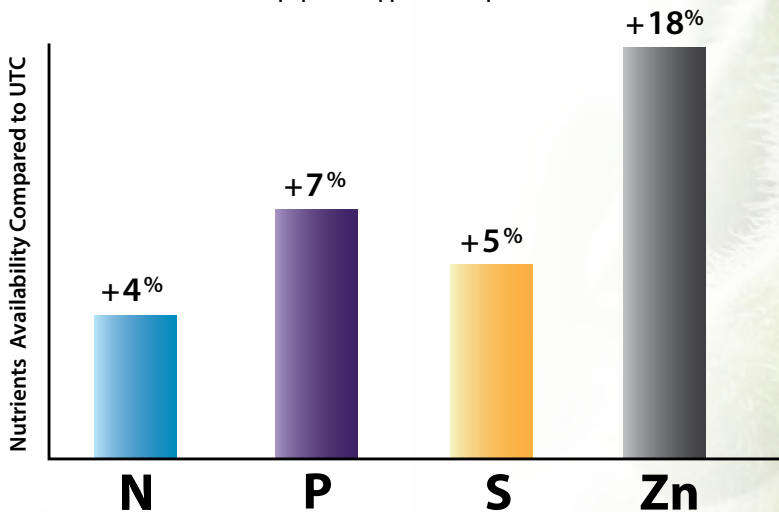
FEATURES AND BENEFITS:

- Expedites nutrient availability and uptake
- Enhances nutrient use efficiency
- Promotes better root growth and development
- Optimizes yield potential
- Consistent performance across plant and soil types
- Compatible with a variety of dry fertilizer blends (P & K, MESZ, MES, pell lime, sulfate of potash, ammonium sulfate, gypsum)
- Extra concentrated formulation for superior impregnation on fertilizer prill



Tissue Levels 5 Plot Average

* Plots compared various rates of 12-40-0 10s 1Zn with and without Titan XC at 1pt per ton applied in strip till



ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

FULLBACK®



Guaranteed Analysis

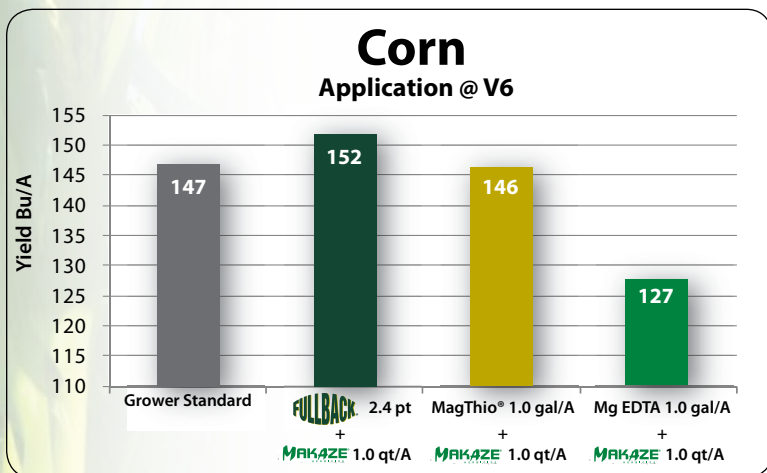
Magnesium (Mg) 6.00%

Derived from: Magnesium Acetate

FULLBACK® (6% Magnesium Acetate) is a unique type of liquid magnesium that delivers significant benefits over other foliar and soil applied magnesium sources. Unlike other magnesium sources, **FULLBACK** has been designed to deliver maximum magnesium uptake with minimal potential for plant phototoxicity.

FEATURES AND BENEFITS:

- Agronomically superior form of magnesium
- Superior foliar uptake and translocation within the plant
- Excellent crop safety



Source: CMS Research, Germansville, PA 2010



Sample Plot
Fullback 2.4 pts/A + Makaze® 1 qt/A



Source: Loveland Products Tech Services Agronomist, 2010.

Sample Plot
Mg EDTA 1 gal/A + Makaze 1 qt/A



Source: Loveland Products Tech Services Agronomist, 2010.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

LoKomotive®



Guaranteed Analysis

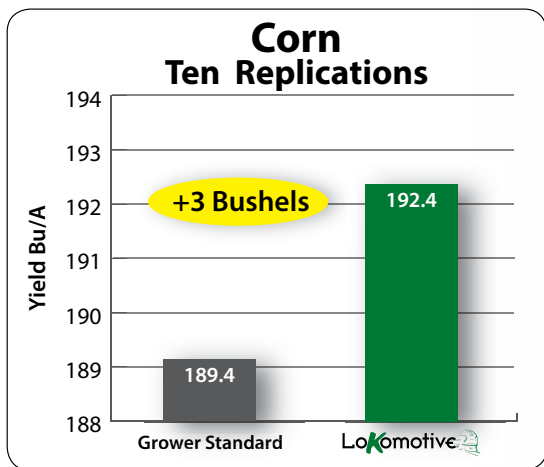
Total Nitrogen (N)	2.00%
2.00% Urea Nitrogen	
Soluble Potash (K ₂ O)	25.00%

Derived from: Urea and Potassium Acetate

LOKOMOTIVE® (2-0-25 Potassium Acetate) is a new type of liquid potassium that has significant advantages and benefits over other foliar applied potassium sources. Unlike other liquid potassium sources, **LOKOMOTIVE** has been specifically designed to provide maximum potassium uptake with minimal potential for phytotoxicity. **LOKOMOTIVE** is a hybrid of an inorganic salt and organic salt making it a truly unique foliar fertilizer.

FEATURES AND BENEFITS:

- Superior foliar uptake and translocation
- Excellent crop safety
- High analysis and absorption equals lower use rates
- Chlorine free
- Superior source of K
- Increased nutrient remobilization
- Can be used on ALL field and specialty crops to enhance growth and quality, correct nutritional deficiencies, and help plants rebound from stressful conditions. LoKomotive is the solution to solving nutrient uptake needs during peak demand periods. Apply **LOKOMOTIVE** at 2-6 qts/A based on soil and/or tissue analysis for potassium.



Source: 2010 Innovative and Focus Research Trials, Minnesota



Dr. Richard W. Taylor, Univ. DE

Photo: Notice that leaf yellowing along the leaflet margins has expanded and has moved up the plant closer to the terminal.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

N-PACT[®]

26-0-0

Guaranteed Analysis

Total Nitrogen (N)26.00%
 17.40% Urea Nitrogen
 8.60% Other Water Soluble Nitrogen*

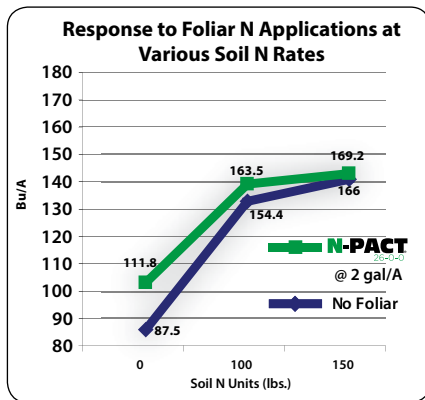
Derived from: Urea-Triazone Solution

*8.60% Slowly Available Nitrogen from Urea-Triazone Solution.

N-PACT[®] (26-0-0, 33% SRN) is a patented triazone Slow Release Nitrogen, with a nitrogen stabilizer which provides increased foliar nitrogen uptake and translocation, reduced volatility and excellent crop safety. **N-PACT** consists of 17.40% urea nitrogen and 8.60% other water soluble nitrogen (Urea-Triazone Solution).

FEATURES AND BENEFITS:

- Improved formulation with nitrogen stabilizer
- Excellent source of foliar nitrogen
- 31% more efficient in uptake versus other nitrogen sources
- Foliar safety
- Patented Triazone nitrogen allows for:
 - » Increased nitrogen absorption
 - » Increased translocation
 - » Increased remobilization



Source: University of Illinois, 2007.

N-PACT[®]

26-0-0

PLANT NUTRITION

Difference after Application between Urea and N-Pact



N-PACT
26-0-0



UREA

TRANSLOCATION and REMOBILIZATION

<u>SOURCE</u>	<u>%*</u>
Triazone	62.2
Nitrate	18.1
Urea	24.7
Ammonium	28.5

*Translocated and remobilized from treated leaf to non-treated leaf tissue, petioles and stems

31% more Nitrogen was absorbed from Triazone than from Urea

<u>NITROGEN SOURCE</u>	<u>LEAF ABSORPTION (mg of N)</u>	<u>UPTAKE VS. NO₃</u>
Triazone	9.60	29
Nitrate	7.40	-
Urea	7.31	-2
Ammonium	6.75	-9

Source: Widders, Michigan State University, 1999.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

Maximum N-PACT® 24-0-0

Guaranteed Analysis

Total Nitrogen (N)	24.00%
16.08% Urea Nitrogen	
7.92% Other Water Soluble Nitrogen*	

Derived from: Urea-Triazone Solution

*7.92% Slowly Available Nitrogen from Urea-Triazone Solution.

MAXIMUM N-PACT® (24-0-0, 33% SRN) is an enhanced triazone nitrogen which provides a stable source of foliar nitrogen for increased uptake, translocation and assimilation of nitrogen, reduced volatility, and excellent crop safety with increased stress tolerance. **MAXIMUM N-PACT** consists of 16.08% urea nitrogen and 7.92% other water soluble nitrogen (Urea-Triazone Solution).

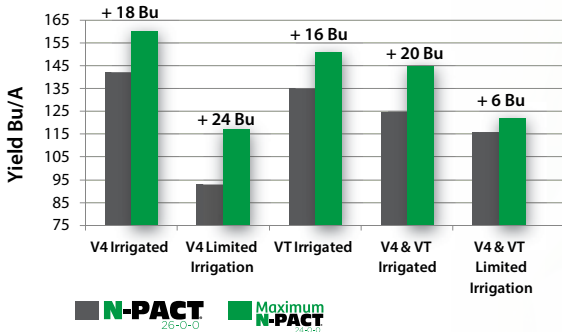
FEATURES AND BENEFITS:

- Excellent source of foliar nitrogen
- 31% more efficient in uptake vs. other nitrogen sources
- Improved crop safety
- Increased drought and salinity tolerance
- Increased photosynthesis
- Faster response to stress
- Can be used on most specialty and field crops to enhance growth and quality, correct nitrogen deficiencies, and help plants recover from stressful conditions

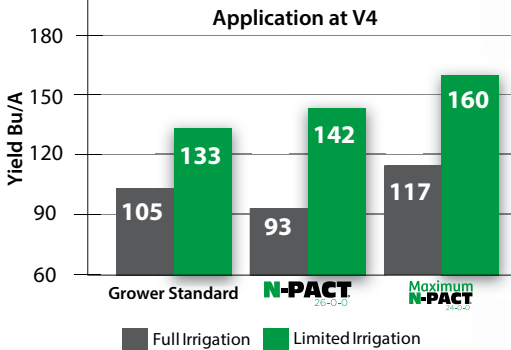
**Maximum
N-PACT**
24-0-0

PLANT NUTRITION

Maximum N-Pact vs N-Pact on Corn



Maximum N-Pact and N-Pact Comparison Under Different Irrigation Regimes



Source: Research Designed for Agriculture, Yuma, AZ, 2010

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

Re-Nforce K

Guaranteed Analysis

Total Nitrogen (N).....	5.00%
3.33% Urea Nitrogen	
1.67% Other Water Soluble Nitrogen*	
Soluble Potash (K ₂ O).....	20.00%
Sulfur (S).....	13.00%
13.00% Combined Sulfur (S)	
Derived from: Urea, Urea Triazone and Potassium Thiosulfate.	
*1.67% slowly available Nitrogen from Urea-Triazone Solution.	
Chlorine, not more than	1.00%

RE-NFORCE® K (5-0-20-13S) is a unique blend of urea-triazone and potassium thiosulfate. It is a chlorine free, clear solution containing 5% nitrogen, 20% potassium, and 13% sulfur in the potassium thiosulfate form. It may be applied soil sidedress, as a foliar feed, and/or injected through the irrigation system. It may also be used in conjunction with other fertilizer solutions in pre-emergent and post-emergent sprays.

FEATURES AND BENEFITS:

- Excellent crop safety-chlorine free
- Contains a superior source of K and S that is readily absorbed by the plant
- Contains 5% urea-triazone nitrogen

Solubility of Potash Fertilizers in 100 gallons of cold water*

	<u>Lbs of Material</u>	<u>Lbs of K₂O</u>
Potassium Nitrate	108-263	47-117
Potassium Sulfate	83-92	41-46
Potassium Chloride	238	170
RE-NFORCE K	1,170	234

*Data summarized from: Solubility in cold water (20°C or 68°F). Mississippi State Univ. Bulletin b1003-t.htm, 3003. New Mexico State Univ. Guide A-113m, 1996. Tessenlerlo Kerley, 2007.

Re-Nforce K

Solubility of fertilizers not only affects the amount that will dissolve in water, it also affects the availability of the fertilizer to crops. As the soil dries out, such as in drought conditions, the less soluble K becomes, and therefore the less available to the crop. As illustrated on page 52, **RE-NFORCE K** is the most soluble material used; thus will remain more available than any other form of K, especially important in drought prone areas.

Re-Nforce K applied to a soybean field**Re-Nforce K****Grower Standard**

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

Re-Nforce[®] KS

Guaranteed Analysis

Total Nitrogen (N).....	15.00%
6.00% Urea Nitrogen	
9.00% Other Water Soluble Nitrogen*	
Soluble Potash (K ₂ O).....	12.00%
Sulfur (S).....	8.00%
8.00% Combined Sulfur (S)	

Derived from: Urea, Urea Triazone and Potassium Thiosulfate.

*9.0% Slowly Available Nitrogen from Urea-Triazone Solution.

Chlorine, not more than 1.00%

RE-NFORCE[®] KS (15-0-12-8S) is a unique blend of urea-triazone and potassium thiosulfate. It is a chlorine free, clear solution containing 15% nitrogen (40% of which is slow release nitrogen (SRN) in the patented Triazone compound), 12% potassium and 8% sulfur in the potassium thiosulfate (KTS) form. **RE-NFORCE KS** is a clearly superior fertilizer solution.

RE-NFORCE KS may be applied as a foliar feed and/or injected through the irrigation system. It may also be used in conjunction with other fertilizer solutions in pre-emergent and post-emergent sprays.

FEATURES AND BENEFITS:

- Increased crop safety
- Increased nitrogen absorption
- Increased translocation
- Increased nutrient remobilization

RE-NFORCE KS IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

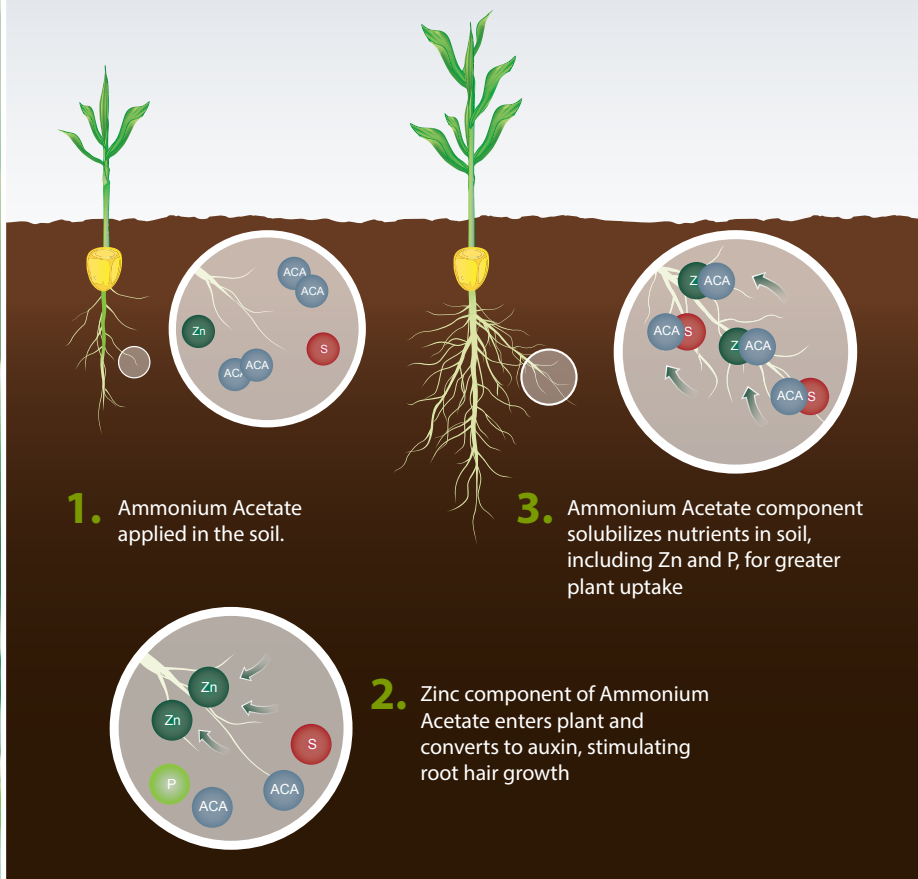
Acetate Technology



ACA or Acetate Technology is a formulation of zinc and ammonium acetate that increases soluble phosphate in the application zone, promotes shoot and root growth through cell enlargement and division, and improves nutrient uptake through increased root mass.

How It Works - Acetate Technology

- Enhances nutrient efficiency through increased interception
- Increases root hair and shoot growth
- Promotes nutrient solubilization



SOIL/FOLIAR APPLIED

AWAKEN

Guaranteed Analysis

Total Nitrogen (N).....	16.00%
5.70% Ammoniacal Nitrogen	
3.40% Nitrate Nitrogen	
6.90% Urea Nitrogen	
Soluble Potash (K ₂ O).....	2.00%
Boron (B)	0.02%
Copper (Cu).....	0.15%
0.15% Chelated Copper (Cu)	
Iron (Fe).....	0.15%
0.15% Chelated Iron (Fe)	
Manganese (Mn).....	0.15%
0.15% Chelated Manganese (Mn)	
Molybdenum (Mo).....	0.0006%
Zinc (Zn).....	2.70%
0.15% Chelated Zinc (Zn)	

Derived from: Urea Ammonium Nitrate, Anhydrous Ammonia, Potassium Acetate, Sodium Borate, Copper Citrate, Iron Citrate, Manganese Citrate, Sodium Molybdate, and Zinc Citrate.

AWAKEN® (16-0-2) is a complex of zinc ammonium acetate with potash and a balanced micronutrient package designed to deliver essential foliar nutrients to help the crop reach its full yield potential.

FEATURES AND BENEFITS:

- Enhanced early root growth
- Promotes plant health and vigor
- Provides essential foliar nutrients
- Increases the crop's ability to overcome stress conditions



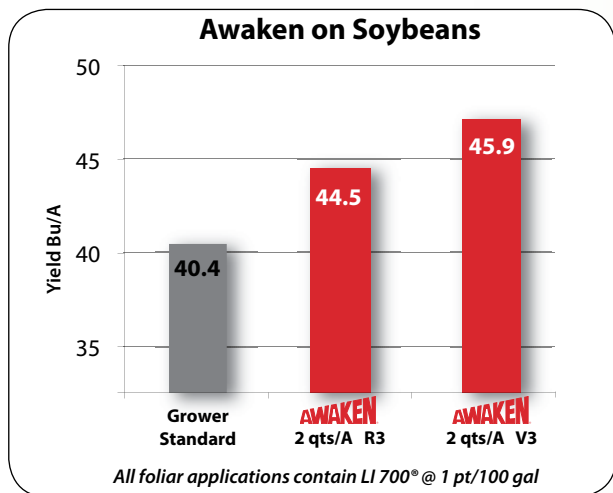
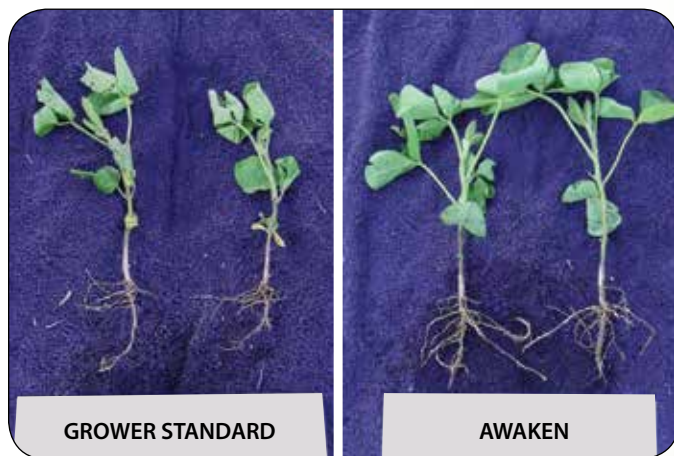
Courtesy: A.W. Saettler from D.R. Christenson

Zinc-deficient dry edible bean
Note: Stunting caused by zinc deficiency

AWAKEN[®]



PLANT NUTRITION



Source: Loveland Products Tech Services Agronomist, 2005.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

Quick Ultra™ with **AWAKEN®**

Guaranteed Analysis

Total Nitrogen (N).....	7.00%
7.00% Ammoniacal Nitrogen	
Available Phosphate (P ₂ O ₅)	28.00%
Soluble Potash (K ₂ O).....	4.00%
Boron (B)	0.04%
Copper (Cu).....	0.10%
0.10% Chelated Copper (Cu)	
Iron (Fe).....	0.20%
0.20% Chelated Iron (Fe)	
Manganese (Mn).....	0.10%
0.10% Chelated Manganese (Mn)	
Molybdenum (Mo).....	0.0005%
Zinc (Zn).....	0.10%
0.10% Chelated Zinc (Zn)	

Derived from: Ammonium Polyphosphate, Monopotassium Phosphate, Sodium Borate, Copper EDTA, Iron HEDTA, Manganese EDTA, Sodium Molybdate, Zinc EDTA.

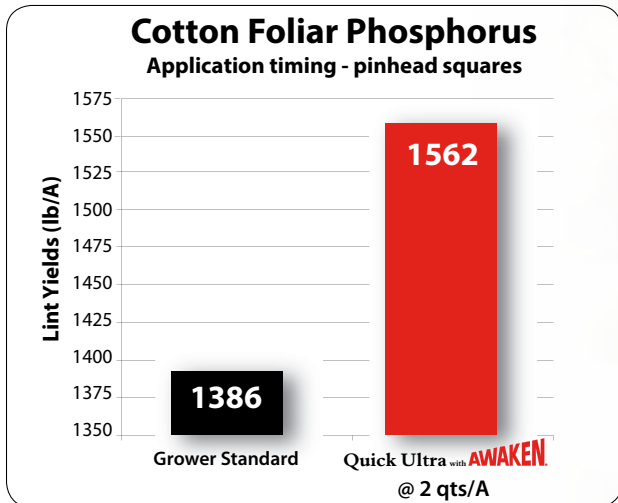
QUICK ULTRA™ WITH AWAKEN® (7-28-4) is a dual source of micronutrients in the highly available EDTA form. It contains both ortho and poly-phosphates, and is designed to supply vital nutrients to plants at the time that they are most needed.

FEATURES AND BENEFITS:

- High phosphorous foliar feed
- Dual source micronutrient package
- Non-phytotoxic
- Contains naturally occurring enzyme activators and hormones
- Organic acid-nutrient uptake enhancer

Quick Ultra
with
AWAKEN

PLANT NUTRITION



Source: G. Harris (UGA), Sunbelt, GA 2005.

Treated 3 days before cold weather with Quick Ultra with Awaken @ 1 qt (left)
Untreated in the same field (right).



QUICK ULTRA WITH AWAKEN IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

Get your nutrition on the move, with

NutriSync®

Growers who want to get the most out of their nutrition program look to NUTRISYNC® brand micronutrients. Powered by NUTRISYNC proprietary nutrient transport technology - NUTRISYNC brand micronutrients enhance nutrient assimilation, mobilization and utilization within a variety crops. Available in a complete line of highly effective formulations there is a NUTRISYNC brand micronutrient available to suit your unique needs.

Get your nutrition on the move, with NUTRISYNC!

KEY FEATURES OF NUTRISYNC PRODUCTS

- Mobilize essential nutrients to areas of peak demand
- Utilize key nutrients at critical growth stages
- Enhances plant metabolism and transport of nutrients
- Increases the integrity of plant cells and overall plant growth and vigor

NutriSync® D

0-2-1 .70% Boron .90% Molybdenum 2% Phosphate 1% Soluble Potash

NutriSync® M

0-0-2 .07% Boron .30% Manganese 2% Soluble Potash .70% Zinc

NutriSync® Boron

5% Boron

NutriSync® Calcium

4-0-0 10% Calcium

NutriSync® Complete

10-7-4 .02% Boron .05% Copper .10% Iron .05% Manganese .05% Zinc



NutriSync® Copper

8-0-0 4.5% Copper



NutriSync® Magnesium

5% Magnesium

NutriSync® Manganese

3% Manganese

NutriSync® Micro Pak

13-0-1 .12% Copper .12% Iron .12% Manganese 2% Zinc



NutriSync® Phos

4-10-4



NutriSync® Sulfur

6-0-0 6.3% Sulfur

NutriSync® Zinc

0-0-0 6% Zinc

FOLIAR APPLIED

NutriSync® D

Guaranteed Analysis

Available Phosphate (P ₂ O ₅)	2.00%
Soluble Potash (K ₂ O)	1.00%
Boron (B).....	0.70%
Molybdenum (Mo).....	0.90%

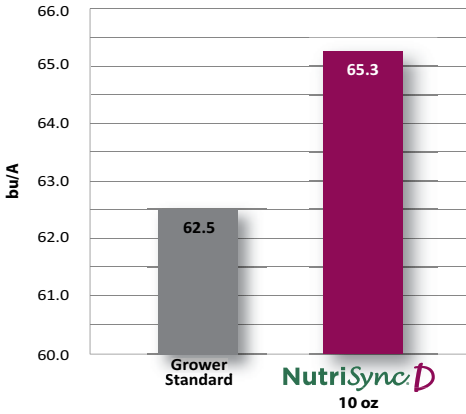
Derived from: Monopotassium Phosphate, Ammonium Molybdate, and Boric Acid

NUTRISYNC® D (0-2-1) is a unique liquid foliar nutritional enhancement tool that supports the physiological activity and growth of dicot crops, such as legumes, root and tubers as well as tree crops. NutriSync technology helps plants more efficiently translocate and utilize nutrients within the plant driving productivity throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater nutrient utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Dicot Crops
- Wide window of application timing and performance

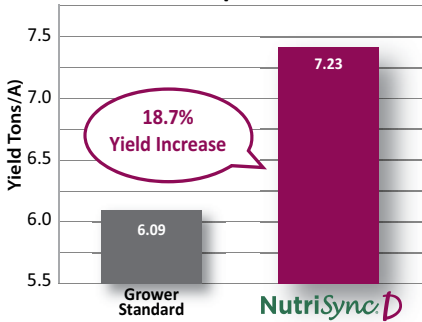
NutriSync D Soybean Trials, 2016



All treatments applied v6 6-26. All include LI 700@ 0.125%

Source: Tech Services, 2016.

Evaluation of Foliar Supplements on Snap Beans



1st application @ V2 5 oz/A 2nd application @ bloom 5 oz/A

Source: Loveland Products Tech Services Agronomist, Erie, IL 2006.

FOLIAR APPLIED

NutriSync® M

Guaranteed Analysis

Soluble Potash (K ₂ O)	2.00%
Boron (B).....	0.07%
Manganese (Mn).....	0.30%
Zinc (Zn).....	0.70%

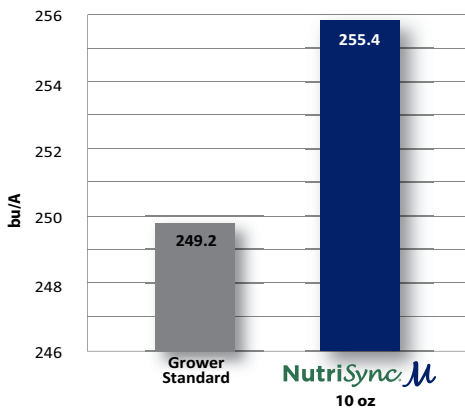
Derived from: Sulfate of Potash, Boric Acid, Manganese Chloride and Zinc Sulfate

NUTRISYNC® M (0-0-2) is a unique liquid foliar nutritional enhancement tool that supports the physiological activity and growth of monocot crops, such as corn, wheat, rice and other cereal grains. NutriSync technology helps plants more efficiently translocate and utilize nutrients within the plant driving productivity throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater nutrient utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Monocot Crops
- Wide window of application timing and performance

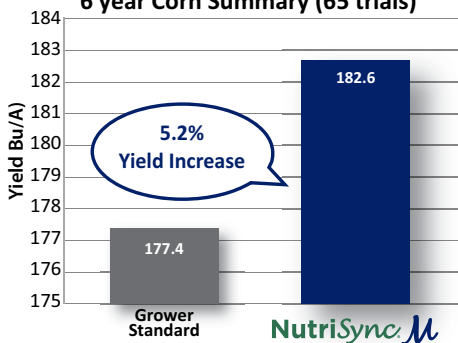
NutriSync M Corn Trials, 2016



All treatments applied v6 corn. All include LI 700@ 0.125%

Source: Tech Services, 2016.

CPS Innovative & Focused Plots 6 year Corn Summary (65 trials)



Source: MN & SD Trials from 2009-2015

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync® Boron

Guaranteed Analysis

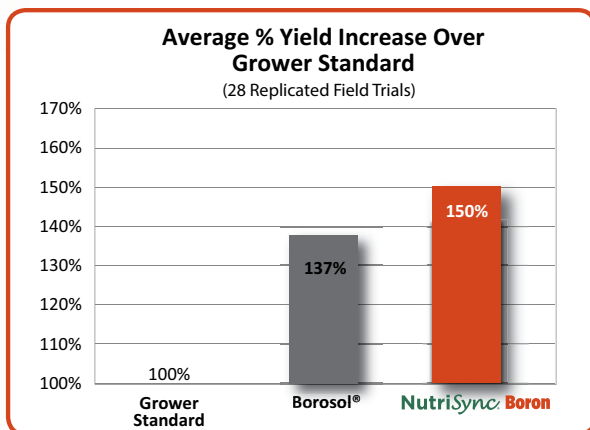
Boron (B)..... 5.00%

Derived from: Boric Acid

NUTRISYNC® BORON (0-0-0 5B) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of crops that demand Boron. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Boron utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Boron Critical Crops
- Wide window of application timing and performance



Source: Loveland Products Tech Services Agronomist, 2012.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

PLANT NUTRITION

NutriSync[®] Calcium

Guaranteed Analysis

Total Nitrogen (N)	4.00%
4.00% Nitrate Nitrogen	
Calcium (Ca)	10.00%

Derived from: Calcium Nitrate and Calcium Chloride

NUTRISYNC[®] CALCIUM (4-0-0 10CA) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of crops where Calcium is critical to yield and quality. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Calcium utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for crops demanding complete balanced foliar nutrition
- Wide window of application timing and performance

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync[®] Complete



Guaranteed Analysis

Total Nitrogen (N)	10.00%
1.90% Ammoniacal Nitrogen	
0.19% Nitrate Nitrogen	
7.91% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	7.00%
Soluble Potash (K ₂ O)	4.00%
Boron (B).....	0.02%
Copper (Cu)	0.05%
0.05% Chelated Copper	
Iron (Fe).....	0.10%
0.10% Chelated Iron	
Manganese (Mn).....	0.05%
0.05% Chelated Manganese	
Zinc (Zn).....	0.05%
0.05% Chelated Zinc	

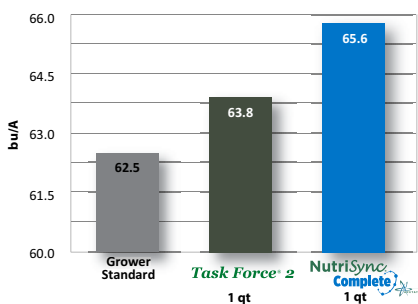
Derived From: Anhydrous Ammonia, Urea, Urea Ammonium Nitrate, Ammonium Polyphosphate, Potassium Acetate, Sodium Borate, Copper EDTA, Iron HEDTA, Manganese EDTA, and Zinc EDTA.

NUTRISYNC[®] COMPLETE (10-7-4 WITH MICROS) is a fully formulated foliar nutrition tool powered by NutriSync proprietary nutrient transport technology and contains key plant major and micronutrients. NutriSync technology has been shown to improve nutrient assimilation, mobilization and utilization - critical to promote nutrient transport to areas of vigorous growth providing better utilization of nutrients to fulfill plant demands.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater nutrient utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for crops demanding complete balanced foliar nutrition
- Wide window of application timing and performance

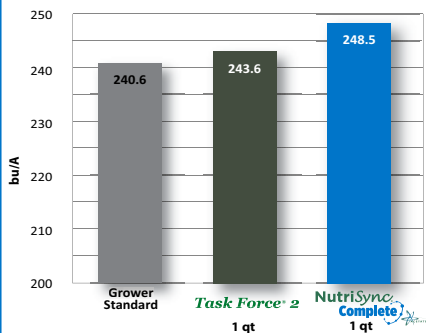
NutriSync Complete Soybean Trials, 2016



All treatments applied v6 6-26. All include LI 700@ 0.125%

Source: Tech Service, 2016.

NutriSync Complete Corn Trials, 2016



All treatments applied v6 corn. All include LI 700@ 0.125%

Source: Tech Services, 2016.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync® Copper



Guaranteed Analysis

Total Nitrogen (N).....	8.00%
8.00% Ammoniacal Nitrogen	
Copper (Cu).....	4.50%

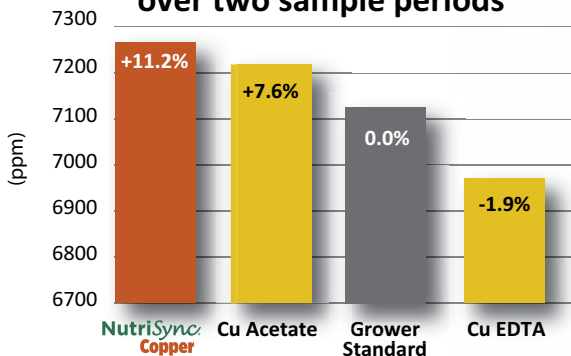
Derived from: Copper Acetate and Anhydrous Ammonia

NUTRISYNC® COPPER (8-0-0 4.5% Cu) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of Copper demanding crops. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

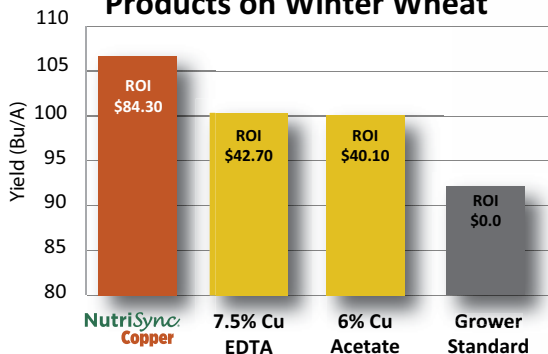
- Enhances nutrient uptake and mobilization
- Greater Copper utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding Copper for yield and quality
- Wide window of application timing and performance

Average Nutrient Uptake over two sample periods



Source: Loveland Products Tech Services Agronomist, 2013.

Comparison of Copper Products on Winter Wheat



Source: Loveland Products Tech Services Agronomist, 2013.

Please refer to page 68 for more information on Inositol.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync[®]

Magnesium

Guaranteed Analysis

Magnesium (Mg) 5.00%
 5.00% Water Soluble Magnesium

Derived from: Magnesium Sulfate and Magnesium Chloride.

NUTRISYNC[®] MAGNESIUM (0-0-0 5MG) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of Magnesium demanding crops. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Magnesium utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding Magnesium for yield and quality
- Wide window of application timing and performance

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync® Manganese

PLANT NUTRITION

Guaranteed Analysis

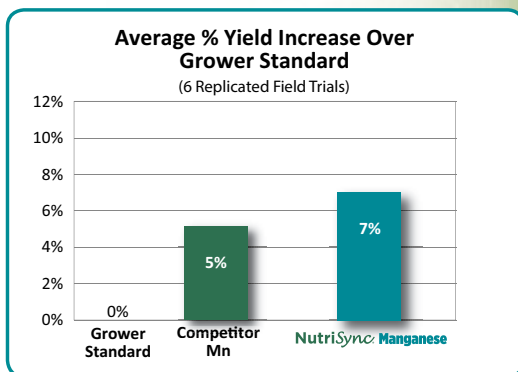
Manganese (Mn)..... 3.00%
3.00% Water Soluble Manganese (Mn)

Derived from: Manganese Sulfate

NUTRISYNC® MANGANESE (0-0-0 3MN) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of Manganese demanding crops. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Manganese utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding Manganese for yield and quality
- Wide window of application timing and performance



ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

Source: Loveland Products Tech Services Agronomist, 2012.

FOLIAR APPLIED

NutriSync®

Micro Pak



Guaranteed Analysis

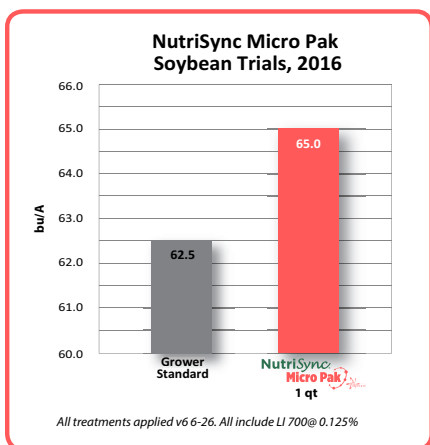
Total Nitrogen (N)	13.00%
4.6% Ammoniacal Nitrogen	
2.8% Nitrate Nitrogen	
5.6% Urea Nitrogen	
Soluble Potash (K ₂ O)	1.00%
Copper (Cu)	0.12%
0.12% Chelated Copper	
Iron (Fe).....	0.12%
0.12% Chelated Iron	
Manganese (Mn).....	0.12%
0.12% Chelated Manganese	
Zinc (Zn).....	2.00%
2.00% Chelated Zinc	

Derived from: Urea Ammonium Nitrate, Anhydrous Ammonia, Potassium Acetate, Copper Citrate, Iron Citrate, Manganese Citrate, and Zinc Citrate.

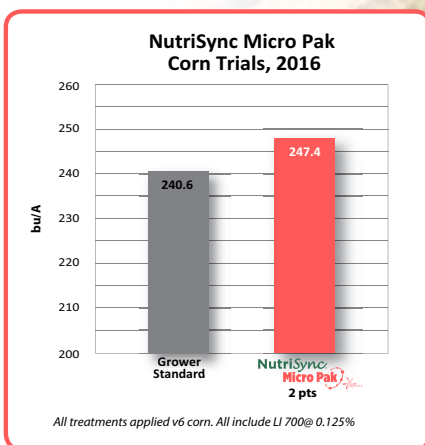
NUTRISYNC® MICROPAK (13-0-1 WITH MICROS) is powered by proprietary nutrient transport technology and contains key plant major and micronutrients. NutriSync technology has been shown to improve nutrient assimilation, mobilization and utilization - critical to promote nutrient transport to areas of vigorous growth providing better utilization of nutrients to fulfill plant demands.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater micronutrient utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for crops demanding complete balanced foliar nutrition
- Wide window of application timing and performance



Source: Tech Services, 2016.



Source: Tech Services, 2016.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

NutriSync® Phos

Guaranteed Analysis

Total Nitrogen (N)	4.00%
4.00% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	10.00%
Soluble Potash (K ₂ O)	4.00%

Derived From: Urea phosphate, Urea, Potassium phosphate dibasic

NUTRISYNC® PHOS (4-10-4) is a unique liquid foliar nutritional that promotes the physiological activity and growth of crops. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant -enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Phosphorus utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding timely phosphorus for yield and quality
- Wide window of application timing and performance

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

NutriSync®

Nutrition On The *Move*

Growers who want to get the most out of their nutrition program look to NUTRISYNC® brand micronutrients from CPS. Powered by NutriSync proprietary nutrient transport technology - NutriSync brand micronutrients enhance nutrient **assimilation**, **mobilization** and **utilization** within a variety of crops.

Available in a complete line of highly effective formulations there is a NutriSync brand micronutrient available to suit your unique needs. **Get your nutrition on the move, with NutriSync!**

Crop
Production
Services 


Loveland
PRODUCTS



FOLIAR APPLIED

NutriSync® Sulfur

Guaranteed Analysis

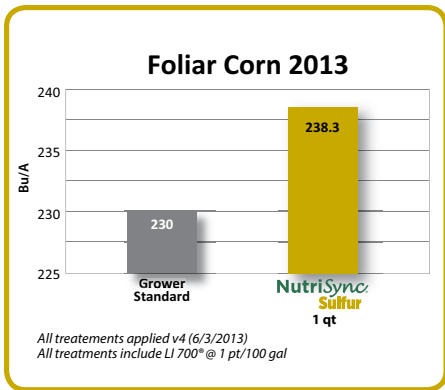
Total Nitrogen (N)	6.00%
6.00% Ammoniacal Nitrogen	
Sulfur (S)	6.30%

Derived from: Ammonium Sulfate

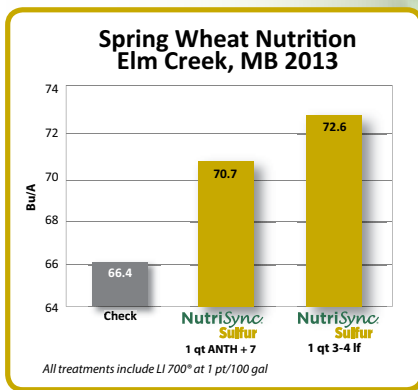
NUTRISYNC® SULFUR (6-0-0 6.35) is a unique liquid foliar nutritional designed to enhance the physiological activity and growth of crops where Sulfur is critical to yield and quality. This enhanced nutrient technology helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant - enhancing crop growth throughout the season.

FEATURES AND BENEFITS:

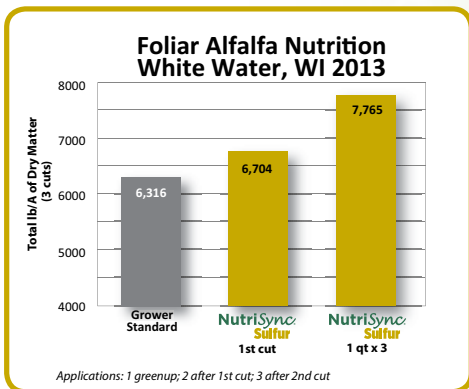
- Highly available form of sulfur
- Enhances nutrient uptake and mobilization
- Greater Sulfur utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding Sulfur for yield and quality
- Wide window of application timing and performance



Source: CP Bio, 2013.



Source: CP Bio, 2013.



Source: CP Bio, 2013.

FOLIAR APPLIED

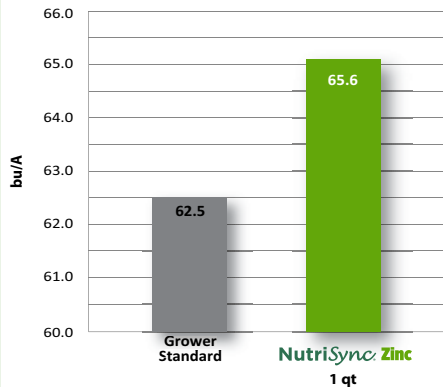
NutriSync® Zinc

Guaranteed Analysis
 Zinc (Zn).....6.00%
 6.00% Water Soluble Zinc

Derived from: Zinc Sulfate

NUTRISYNC® ZINC (0-0-0 6ZN) is a unique liquid foliar nutritional that promotes the physiological activity and growth of crops that demand zinc. Powered by NutriSync proprietary nutrient transport technology – NutriSync Zinc helps plants more efficiently mobilize and utilize applied nutrients as well as those that are already within the plant, enhancing crop growth throughout the season.

NutriSync Zinc Soybean Trials, 2016



All treatments applied v6 6-26. All include LI 700@ 0.125%

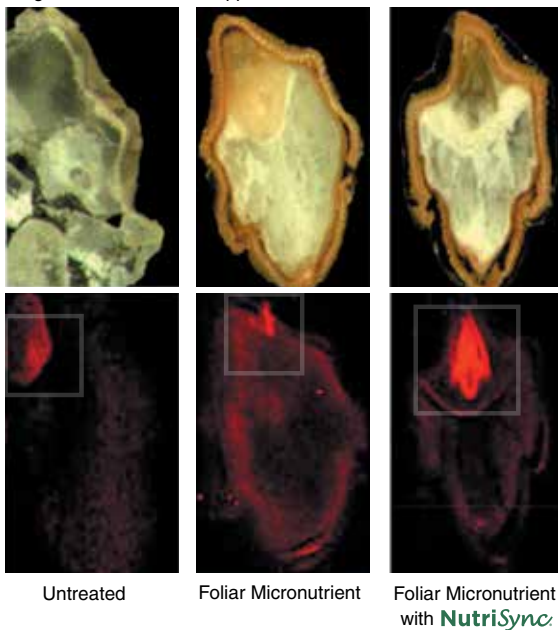
Source: Tech Services, 2016.

FEATURES AND BENEFITS:

- Enhances nutrient uptake and mobilization
- Greater Zinc utilization
- Promotes healthier plants, more consistent quality and higher yield potential
- Optimized for the needs of Crops demanding highly available zinc for yield and quality
- Wide window of application timing and performance

**NutriSync Products Performance -
Rice Kernal Cross Section**

* Higher accumulation of applied nutrient as shown below.



Source: Dr. Patrick Brown, UC Davis, data generated at Stanford National Lab

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

FOLIAR APPLIED

Task Force® 2

POWERED BY LoKomotive®



Guaranteed Analysis

Total Nitrogen (N).....	11.00%
2.09% Ammoniacal Nitrogen	
0.21% Nitrate Nitrogen	
8.70% Urea Nitrogen	
Available Phosphate (P ₂ O ₅).....	8.00%
Soluble Potash (K ₂ O).....	5.00%
Boron (B).....	0.02%
Cobalt (Co).....	0.0005%
Copper (Cu).....	0.05%
0.05% Chelated Copper (Cu)	
Iron (Fe).....	0.10%
0.10% Chelated Iron (Fe)	
Manganese (Mn).....	0.05%
0.05% Chelated Manganese (Mn)	
Molybdenum (Mo).....	0.0005%
Zinc (Zn).....	0.05%
0.05% Chelated Zinc (Zn)	

Derived from: Urea, Ammonium Polyphosphate, Potassium Acetate, Sodium Borate, Cobalt Sulfate, Copper EDTA, Iron HEDTA, Manganese EDTA, Sodium Molybdate, and Zinc EDTA.

TASK FORCE® 2 is an 11-8-5 fertilizer with micros including boron, cobalt, copper, iron, manganese, moly and zinc. **TASK FORCE 2** is an excellent “catch all” nutritional product.

FEATURES AND BENEFITS:

- Can be applied foliar to soybeans, corn and alfalfa
- When sprayed early in soybeans, **TASK FORCE 2** will help retain blooms, discourage aborting blooms, and offer a greater opportunity for the plant to set more pods.



CROP RECOMMENDATIONS:

Alfalfa:

Use **TASK FORCE 2** at 2-4 pts/A.
 Apply after each cutting at 2nd trifoliolate.

**Cereal grains
 (barley, oats, rye, wheat):**

Use **TASK FORCE 2** at 2-4 pts/A.
 Begin after development and continue at
 2-week intervals.

**Corn
 (field and sweet):**

Use **TASK FORCE 2** at 1-2 qts/A.
 Begin after the 2nd leaf unfolds for a total of
 6 applications.

Soybeans:

Maintaining blossoms and filling pods are
 moisture and nutrient dependent functions.
TASK FORCE 2 is a great supplement to
 maintain pods and boost yield.

Use **TASK FORCE 2** at 1-2 qts/A.
 Apply anytime prior to bloom for faster
 recovery after stress.

SOIL/FOLIAR APPLIED

BOROSOL[®] 10

Guaranteed Analysis

Boron (B) 10.00%

Derived from: Boric Acid

BOROSOL[®] 10 (10% Boron) is a patented soluble polyborate liquid for the prevention and correction of boron deficiencies in crops. The flexibility of **BOROSOL 10** allows it to be mixed with other liquid fertilizers for foliar or soil applications.

FEATURES AND BENEFITS:

- Agronomically superior: plants take up the boron more rapidly and more completely
- Convenient liquid formulation easy to handle, measure, and apply
- Flexible and compatible-mixes well with most plant growth regulators, insecticides, and herbicides
- Right pH - **BOROSOL 10** has a pH of 8.0

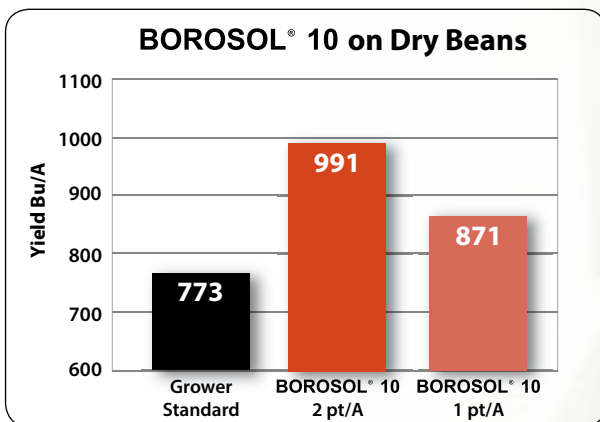
Boron-deficient grape

Note: Advanced stages with interveinal chlorosis and necrosis

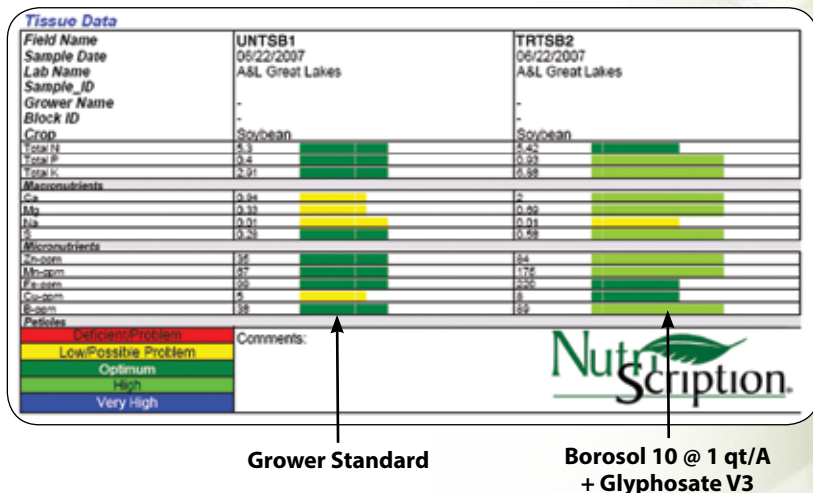


Courtesy: W Gartel

BOROSOL® 10



Source: Kent McKay, NDSU, Minot, ND 2007



In the above tissue report from a soybean field, applying **BOROSOL 10** has influenced the overall plant nutrient levels, not just NPK, but all nutrients.

SOIL APPLIED



Guaranteed Analysis

Iron (Fe).....3.00%
 3.00% Chelated Iron (Fe)

Derived from: Iron EDDHA (Ethylenediaminedi(2-hydroxy-5-sulfophenylacetic) acid)

REBAR® 2 is a liquid source of EDDHA chelated iron in the ortho-ortho isomer and is readily available to plants in all soil conditions. The ortho-ortho isomer of EDDHA is the only effective source of iron in severe alkaline soils and works to prevent and also cure chlorosis in affected crops.

FEATURES AND BENEFITS:

- Highly plant-available even in alkaline soils
- Easy-to-use liquid formulation

APPLICATION INFORMATION:

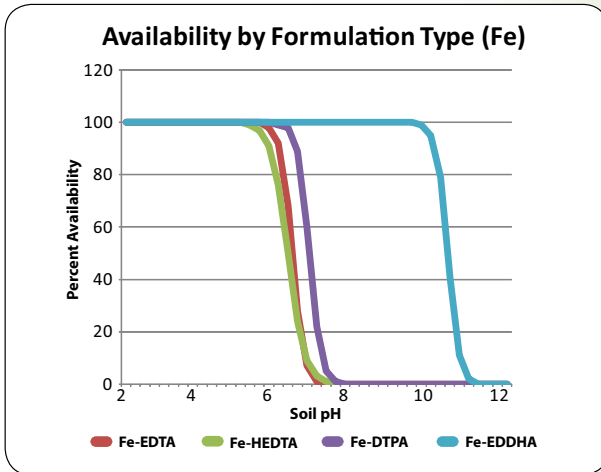
REBAR 2 is recommended as an in-furrow soil applied fertilizer for use on any crop where an iron deficiency exists.

USE RATES AND TIMING

In-Furrow Application: Apply 1 to 8 pts/A.
Refer to label for more specific use rates.

THE POWER OF CHELATION:

REBAR 2 has the widest range of iron availability across pH ranges compared to other forms of iron available.



Liquid Fe EDDHA 3.0%

Weight /Gal Lbs 10.4 4.7 Kg

Application Rate Comparison Dry 6% vs Liquid 3.0%

6% Dry Fe	=	3.0% Liquid Fe	
lbs		pints	quarts
1		2	1
2		4	2
3		6	3
4		8	4
5		10	5
6		12	6
7		14	7
8		16	8
9		18	9
10		20	10
11		22	11
12		24	12

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL APPLIED

ACA[®]

Concentrate



Guaranteed Analysis

Total Nitrogen (N).....	15.00%
15.00% Ammoniacal Nitrogen	
Total Zinc (Zn).....	17.00%

Derived from: Ammonium Acetate, Anhydrous Ammonia and Zinc Oxide.

ACA[®] CONCENTRATE (15-0-0, 17% Zinc) is a premium agricultural crop additive that enhances root growth and plant vigor, helping to overcome plant stress that would otherwise limit attainment of a full yield potential.

FEATURES AND BENEFITS:

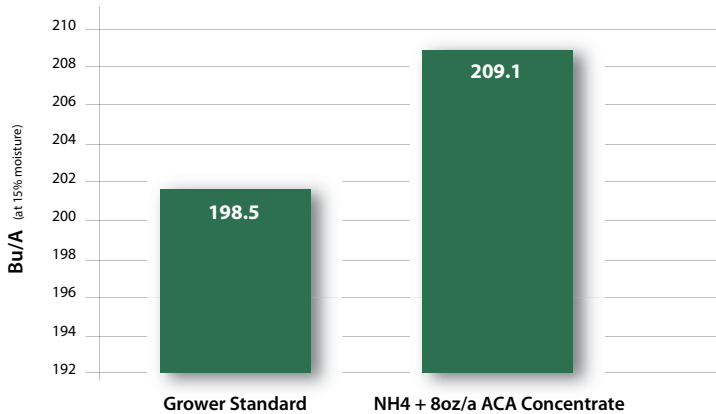
- Enhanced early plant growth and vigor
- More fibrous and extensive root system
- Increased tolerance to environmental stress
- Higher yield potential and/or test weights



Treated corn (*right*) has thicker stalk, more rootmass and hair roots, better vigor.



2014 ACA Concentrate w/NH4 Preplant Applications



* ROI Assumes \$4.14/bu corn

* ANHYDROUS RATE/ACRE	ACA RATE/ACRE	ACA COST/ACRE	INCREASED YIELD NEEDED
120#	5.2 oz	\$2.64	0.88 Bu/A
135#	5.8 oz	\$2.94	0.98 Bu/A
150#	6.4 oz	\$3.25	1.08 Bu/A

* Anhydrous rate is based on actual pounds of nitrogen per acre.

The above formula takes into account \$65/gallon of ACA and corn at \$3.00/bushel.

ACA CONCENTRATE IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL APPLIED

ACA Plus®



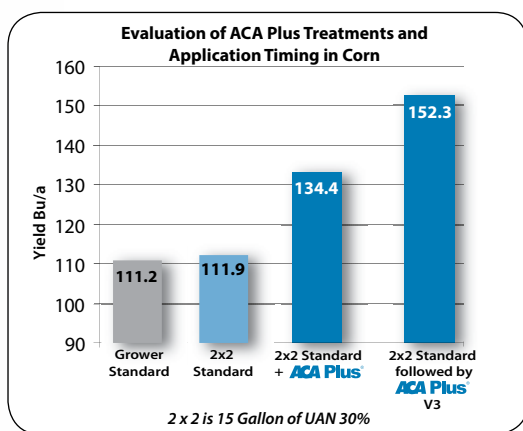
Guaranteed Analysis

Total Nitrogen (N).....	7.00%
7.00% Ammoniacal Nitrogen	
Total Zinc (Zn).....	8.50%
Derived from: Ammonium Acetate, Anhydrous Ammonia, and Zinc Oxide.	
Chlorine (Cl), Maximum	0.01%

ACA PLUS® (7-0-0, 8.5% Zinc) is a plant nutrient that contains **ACA**, a patented agricultural crop additive, in a super soluble, neutral pH formulation. When used as a supplement to a regular fertilizer program, this product may improve vigor, quality, production and stress tolerance in a broad range of crops.

FEATURES AND BENEFITS:

- Enhanced early plant growth and vigor
- More fibrous and extensive root system
- Increased tolerance to environmental stress
- Higher yield potential and/or test weights



Source: Virginia Tech, 2005

ACA Plus[®]**PLANT NUTRITION**

**Standard Program
Check on Sugar beets**



**Standard Program
10-34-0 (3 gal) + ACA Plus (1 qt) on Sugar beets**



ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

What is LHC Technology?

Linear Humus Component Technology (LHC) utilizes the benefits of a spectrum of humic substances to address nutrient availability and soil environmental limitations creating an enhanced approach to plant nutrition.



More for the Plant

- Increased nutrient mineralization and solubility
- Better nutrient uptake promotes root mass
- Reduced root burn through complexing fertilizer salts
- Optimized water holding capacity*

Better for the Soil

- Enhanced CEC in application zone
- Supports beneficial microbes
- Promotes buffering of saline/sodic conditions
- Positively impacts soil structure

Less Environmental Impact

- Better access to existing nutrition
- Sustainable approach to soil tillage
- Optimize land use through productivity
- Natural Petroleum-Free Product

**Water holding capacity varies with use rate*

SOIL/FOLIAR APPLIED



PLANT NUTRITION

BLACKMAX[®] 22

If you feed it, you need it!

Guaranteed Analysis

Soluble Potash (K₂O) 4.00%

Derived from: Potassium Hydroxide

ALSO CONTAINS NON-PLANT FOOD INGREDIENTS:

Humic Acids derived from Leonardite 22.00%

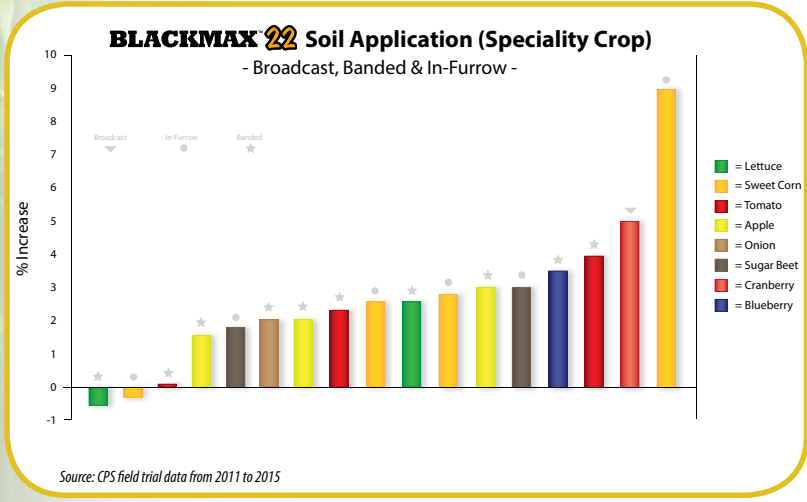
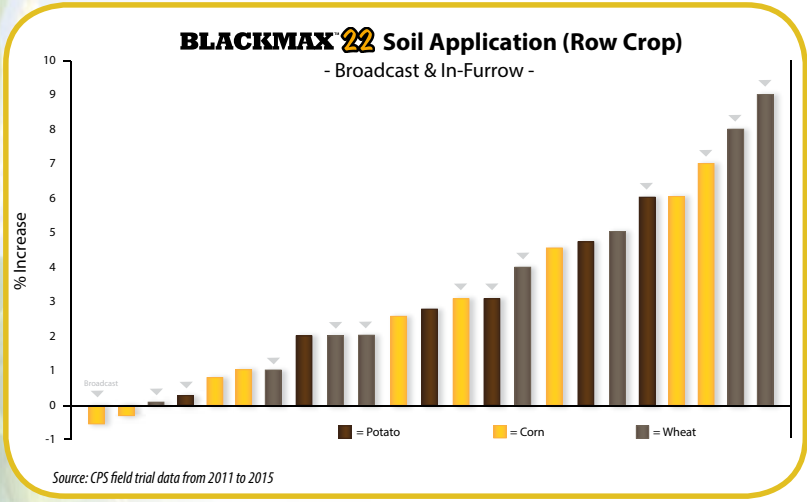
Other Ingredients 78.00%

BLACK MAX[®] 22 (0-0-4) is a nutritional enhancement tool designed to positively impact nutrient availability and soil attributes. When combined with a growers fertilizer program the Linear Humus Components (LHC) in BlackMax 22 can give growers more nutrition for their crops and provide a better soil environment in which to grow - a more sustainable approach to plant nutrition.

FEATURES AND BENEFITS:

- LHC technology to enhance applied nutrient availability and uptake
- Enhanced existing nutrient mineralization and nutrient solubility
- Designed to promote beneficial microbes
- Sound, Efficient, Flexible Formulation

Key Crops	Soil Applied Rate	Foliar Applied Rate
Cereal Grains	0.5 to 4 gal/acre in-furrow or banded	1 to 12 qts/acre per application
Legume Vegetables	0.5 to 4 qts/acre	1 to 12 qts/acre per application
Root and Tuber Vegetables	0.5 to 4 gal/acre in-furrow or banded	1 to 12 qts/acre per application



BLACKMAX 22 IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
 ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

DON'T LET SAVING MONEY ACTUALLY COST YOU MONEY.



BLACKMAX® 22

When crop prices fluctuate, it's tempting to try and save money by NOT using a product like Blackmax® 22. But here's the problem – when prices waver, improving yield and quality becomes your most important strategy. Blackmax® 22's proprietary LHC technology is optimized to promote better soil nutrition, reduce root and tissue burn from fertilizer and improve yield potential year after year.

So don't let "saving" money actually cost you money. Use Blackmax® 22 – because if you feed it, you need it.

Visit www.lovelandproducts.com for more information

SOIL/FOLIAR APPLIED

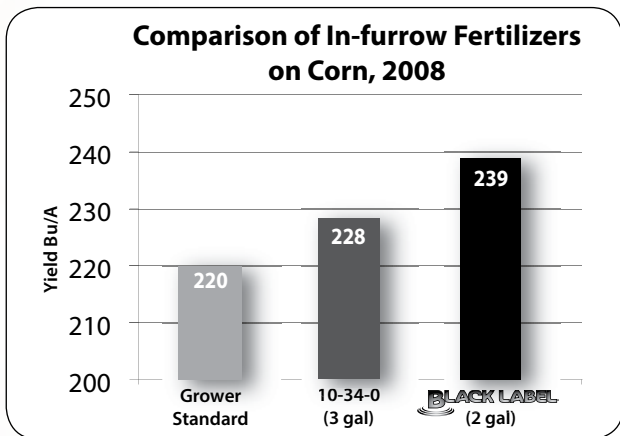


BLACK LABEL®

Guaranteed Analysis

Total Nitrogen (N)	6.00%
5.00% Ammoniacal Nitrogen	
0.30% Nitrate Nitrogen	
0.70% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	22.00%
Derived from: Anhydrous Ammonia, Urea-Ammonium Nitrate, Phosphoric Acid	
ALSO CONTAINS NON-PLANT FOOD INGREDIENT:	
Humic Acid derived from Leonardite	7.40%
Other Ingredients.....	92.60%

BLACK LABEL® (6-22-0) is a patented nitrogen and phosphate formulation designed to protect phosphate tie-up in the soil and help reduce nitrogen loss. Powered by LHC Technology, it is ideal in addressing the nutrient needs of field, row and specialty crops.



Source: John Sawyer, ISU

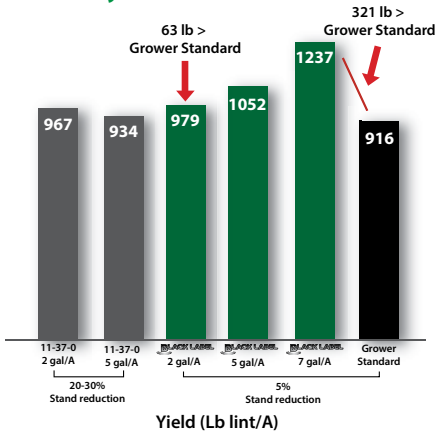
FEATURES AND BENEFITS:

- Excellent crop safety
- Highly efficient and readily plant available
- Excellent phosphate availability
- Excellent application flexibility



Source: Loveland Products Tech Services Agronomist, 2007

Evaluation of Various In-Furrow Starter Products on Cotton Dyna-Gro® 2100 B2RF



Source: Dr. G. Coburn, PME Inc, LA, 2006.

BLACK LABEL IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED



BLACK LABEL[®]

Zn

Phosphate, Done Better

Guaranteed Analysis

Total Nitrogen (N)	6.00%
5.00% Ammoniacal Nitrogen	
0.30% Nitrate Nitrogen	
0.70% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	20.00%
Zinc (Zn)	0.77%
0.77% Water Soluble Zinc	

Derived from: Anhydrous Ammonia, Urea-Ammonium Nitrate, Phosphoric Acid and Zinc Sulfate

ALSO CONTAINS NON-PLANT FOOD INGREDIENT:

Soil Amending Ingredients

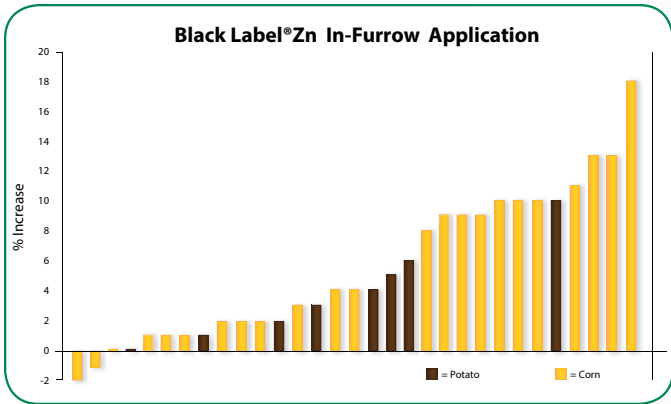
Humic Acids derived from Leonardite ore

Other Ingredients.....

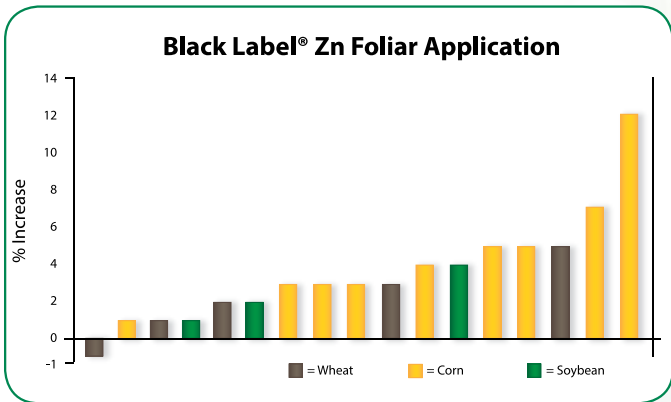
BLACK LABEL[®] Zn (6-20-0 0.77 Zn) is a phosphate fertilizer formulated with Linear Humus Components (LHC) – to provide sound, efficient and immediately available phosphate based nutrition. The LHC technology promotes extended nutrient uptake and supports a better soil environment – key to maximizing a grower's return on their complete nutritional investment.

FEATURES AND BENEFITS:

- Highly available phosphorous (P) and zinc (Zn) to drive early season development
- Enhanced cation exchange column (CEC) of application zone
- LHC technology to enhance total nutrient availability
- Safe, efficient, flexible zinc phosphate formulation



Source: CPS field trial data from 2011 to 2015



Source: CPS field trial data from 2011 to 2015

Key Crops	Soil Applied Rate	Foliar Applied Rate
Cereal Grains	1 to 5 gal/acre in-furrow or 2x2	2 to 8 qts/acre per application
Legume Vegetables	2 to 4 qts/acre	2 to 8 qts/acre per application
Root and Tuber Vegetables	1 to 5 gal/acre in-furrow or 1 to 10 gal/acre 2x2	2 to 8 qts/acre per application

BLACK LABEL ZN IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL APPLIED



***Contains: NBPT (N-(n-butyl) thiophosphoric trianimide.
N-methyl-2-pyrrolidone***

NITRAIN™ reduces volatility by inhibiting the activity of the urease enzyme. Urease is a naturally occurring enzyme in the soil responsible for breaking down urea when moisture and organic matter are present. Up to 40% of nitrogen can be lost to volatilization within hours of application. **NITRAIN** nitrogen stabilizer is “engineered to reduce nitrogen volatilization.”

FEATURES AND BENEFITS:

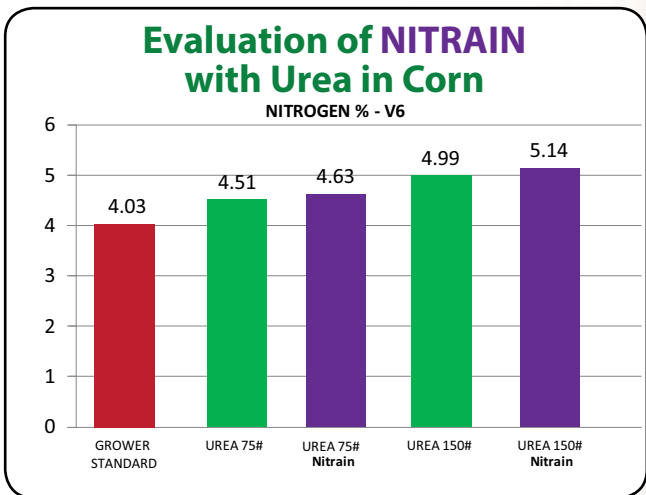
- Prevents the volatilization of both Urea and UAN fertilizer applications
- Increases the efficiency and utilization of nitrogen
- May enhance yield in many different crops

NITRAIN Nitrogen Stabilizer Use Rates
(refer to label for more specific use rates)

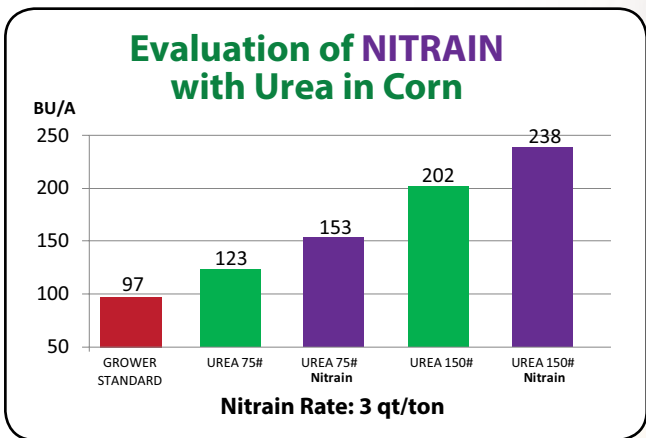
Urea: 3.0 qts/ton

UAN: 1.5 qts/ton

When conditions favoring volatility exist, or when longer control is needed, the rate may be increased by 1 quart/ton.



2015 Loveland Products, Inc. Research Farm



2015 Loveland Products, Inc. Research Farm

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED



*Contains: NBPT (N-(n-butyl) thiophosphoric triamide.
N-methyl-2-pyrrolidone*

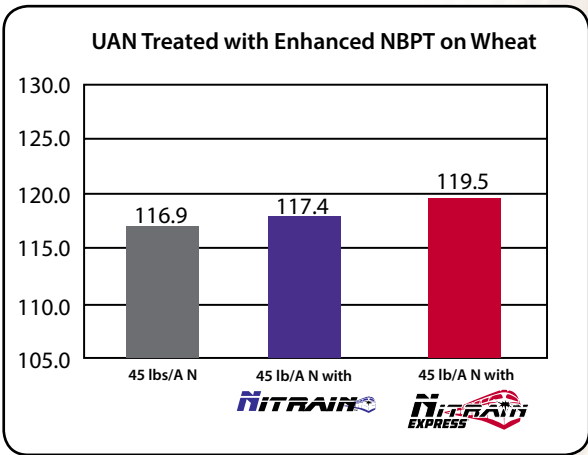
NITRAIN™ EXPRESS is a Loveland Products proprietary product containing a unique mix of **NBPT**, and fertilizer biocatalyst technology similar to that found in **ACCOMPLISH® LM**. **NITRAIN EXPRESS** reduces volatility by inhibiting the activity of the urease enzyme. Urease is a naturally occurring enzyme in the soil responsible for breaking down urea when moisture and organic matter are present. Up to 40% of nitrogen can be lost to volatilization within hours of application.

FEATURES AND BENEFITS:

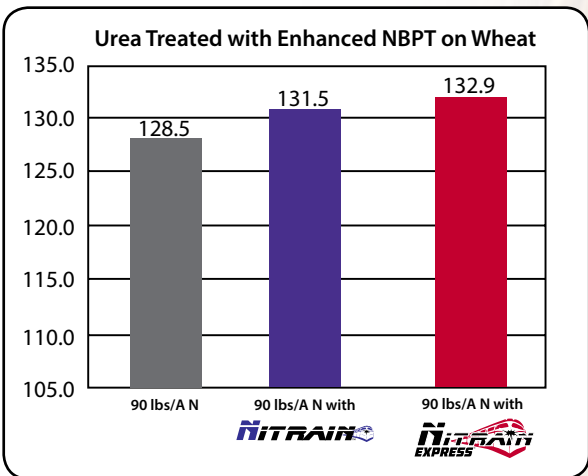
- Prevents the volatilization of both UAN and Urea fertilizer applications
- Increases the efficiency and utilization of nitrogen and other key nutrients
- Maximizes yield in many different crops
- Contains biochemical fertilizer catalyst technology similar to that found in Accomplish LM

APPLICATION RATE RANGE:

- 3 qts/ton of Urea
- 1.5 qts/ton of UAN



Source: Loveland Research Farm, Owensboro, KY (2014-2015)



Source: Loveland Research Farm, Owensboro, KY (2014-2015)

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED

Radiate®

Guaranteed Analysis

ACTIVE INGREDIENTS:

3-Indolebutyric acid (IBA)	0.85%
Cytokinin, as Kinetin	0.15%

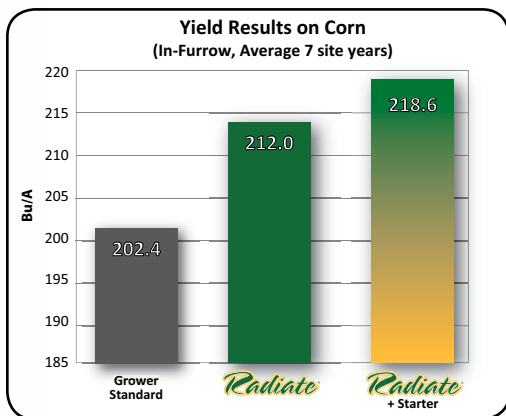
OTHER INGREDIENTS:.....	99.00%
TOTAL.....	100.00%

EPA Reg. No. 34704-909

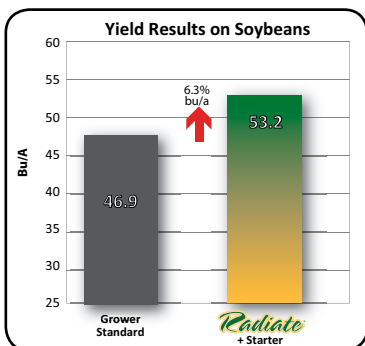
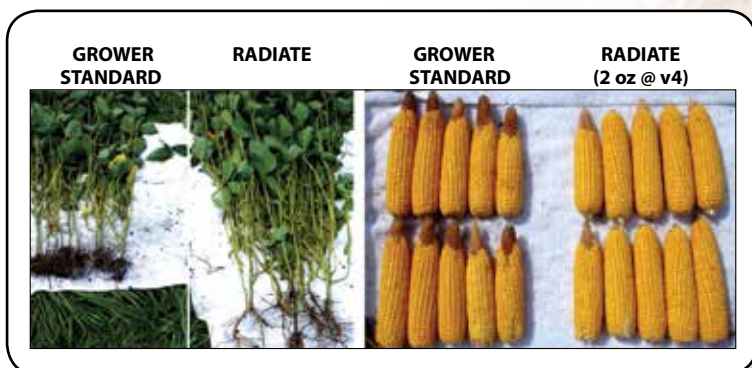
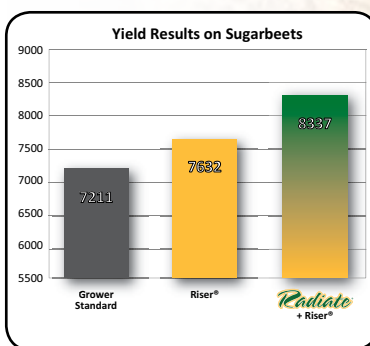
RADIATE® is a patented formulation of IBA & Kinetin, in optimized ratios, to enhance early season vigor and drive maximum root growth. The proven technology in Radiate provides Growers consistent performance across a wide variety of crops.

FEATURES AND BENEFITS:

- Labeled for both in-furrow and foliar applications.
- Promotes root and shoot growth.
- Reduces early season stress.
- Improves early season vigor.
- Compatible with most fertilizers and pesticides.



Loveland Product Research Trials

PLANT NUTRITION

Loveland Product Research Trials

KayJay Ag Services Inc. Hickson, ND


Plant Health Stimulants are active ingredients that have a positive effect on plant health. They are typically applied in low quantities to mimic or enhance a plant's metabolism.

Plant Health Stimulants can include:

- Plant growth hormones
- Systemic acquired resistance (SAR)
- Amino acid complexes

RADIATE IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA
ALWAYS READ AND FOLLOW LABEL DIRECTIONS.



Radiate plant growth regulator strengthens young plants' roots to promote bigger, higher-quality yields, as these results prove.

Radiate is a patented formulation of IBA and Kinetin that gives crops more early-season vigor and helps them to quickly develop longer, stronger root and shoots. Those benefits improve plants' nutrient uptake, early stress resistance and overall health, resulting in better yields and higher-quality crops.

Applied foliar or in-furrow, Radiate makes all the difference across a wide variety of crops and soil types, and it's compatible with most fertilizers and pesticides.

Radiate delivers a combination of the proven plant growth regulators IBA and Kinetin in the optimum ratio. That unique balance

consistently supports maximum root growth and plant performance.

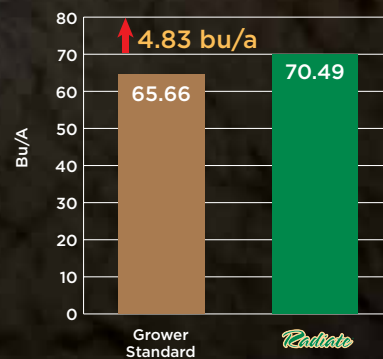
The impressive trials shown here demonstrate the effectiveness of Radiate.



Wheat

Radiate yielded 4.83 bushels higher per acre average than Grower Standard fields.

Yield Results



Cotton

Radiate demonstrated significant increase in cotton compared to untreated control.

Yield Results

Safford, Arizona - Bales/Acre		
Radiate	1.9	↑ + 0.6 Increase +46%
Grower Standard	1.3	
Santa Rosa, Texas - lbs Lint/Acre		
Radiate	1,479	↑ + 354 Increase +31%
Grower Standard	1,125	

Corn

Radiate in combination with glyphosate produced 8.3 more bushels of corn per acre than a crop treated with glyphosate alone.

Labeled for the following applications:



Foliar



In-Furrow

© 2016 Loveland Products Inc. Radiate is a registered trademark of Loveland Products, Inc. Always read and follow label directions. Text the word RADIATE to the number 31313. Carrier message and data rates may apply. More than one message may be required to deliver content. By texting in you agree to receive text messages, telemarketing messages or prerecorded voice calls delivered using an automatic telephone dialing system. Consent is not required for purchase of other products.

This year, let Radiate make all the difference in your crops. See how other growers are finishing the season with stronger results at LovelandProducts.com/Radiate.



SOIL/FOLIAR APPLIED

Validate®

Guaranteed Analysis

Cytokinin, as Kinetin	0.50%
OTHER INGREDIENTS:.....	99.50%
TOTAL.....	100.00%

EPA Reg. No. 34704-910

VALIDATE® is a proven formulation of Cytokinin (as kinetin), an Plant Growth Regulator that produces positive plant growth and development.

FEATURES AND BENEFITS:

- Cell division stimulation
- Nutrient mobilization
- Promotion of lateral branching
- Flower and seed development
- Delayed leaf aging or abscission

LABELED CROPS INCLUDE:

- Corn (sweet, field and popcorn), cotton, peanut, rice, sorghum, and wheat
- Brassica, leafy cucurbit, fruiting, legume, root and tuber root vegetables
- Citrus and pome/stone fruits
- Grape, stawberry
- Tree nuts (including almonds)

Product Recommendation by Growth Stage

TIMING	SEED TREATMENT OR IN-FURROW	EARLY FOLIAR	MIDSEASON FOLIAR	PRE-FLOWER TO FRUIT / POD / BOLL FILL
MONOCOTS <i>(general)</i>	<i>CONSENSUS</i> OR <i>Radiate</i>	<i>Radiate</i>	<i>Radiate</i>	<i>Validate</i>
Corn	<i>Radiate</i>	Glyphosate application <i>Radiate</i>	V5 Fungicide application <i>Radiate</i>	VT Fungicide application <i>Validate</i>
DICOTS <i>(general)</i>	<i>CONSENSUS</i> OR <i>Radiate</i>	<i>Radiate</i>	<i>Radiate</i>	<i>Validate</i>
Soybeans	<i>CONSENSUS</i> OR <i>Radiate</i>	Glyphosate application <i>Radiate</i>	V5 Fungicide application <i>Radiate</i>	R3 Fungicide application <i>Validate</i>
Cotton	<i>CONSENSUS</i> OR <i>Radiate</i>	Glyphosate/thrip application <i>Radiate</i>	Mepiquat application <i>Poltenza</i> OR <i>Radiate</i>	Boll worm application <i>Validate</i>



Plant Health Stimulants are active ingredients that have a positive effect on plant health. They are typically applied in low quantities to mimic or enhance a plant's metabolism.

Plant Health Stimulants can include:

- Plant growth hormones
- Systemic acquired resistance (SAR)
- Amino acid complexes

VALIDATE IS NOT REGISTERED FOR SALE OR USE IN CALIFORNIA

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED



Guaranteed Analysis

Total Nitrogen.....	5.00%
5.00% Ammoniacal Nitrogen	
Available Phosphate (P ₂ O ₅).....	15.00%
Soluble Potash (K ₂ O).....	5.00%
Zinc (Zn).....	1.50%
1.50% Chelated Zinc (Zn)	

Derived from: Ammonium Polyphosphate, Potassium Hydroxide, Potassium Acetate, and Zinc EDTA.

EDTA is ethylenediaminetetraacetic acid.

ALSO CONTAINS NON-PLANT FOOD INGREDIENTS

Microorganisms	<1%
<i>Bacillus licheniformis</i>	1x10 ² cfu/ml*
*colony forming units/milliliter	

Inert Ingredients:

Water-based culture medium	96.50%
2.50% Fulvic and Humic Acids derived from Leonardite.	

LEVITATE® is a Loveland Products' proprietary starter fertilizer formulated with a blend of proven fertilizer biocatalyst – similar to **Accomplish® LM** as well as **ACA® technology**, fulvic acids and EDTA chelated Zinc. For starter fertilizer users, **LEVITATE** is the only starter on the market combining all three fertilizer efficiency technologies to increase nutrient availability and uptake - because growers know the only nutrition that matters is what gets in your crop.

FEATURES AND BENEFITS:

- Critical Zinc for early season growth
- Enhanced nutrient availability and uptake
- Acetate technology to drive root growth
- Low salt, seed safe formulation



LEVITATE TECHNOLOGY:



Acetate

- Increases root hair and shoot growth
- Enhances nutrient efficiency through increased root interception
- Promotes nutrient solubilization



Fertilizer Biocatalyst

- Enhances nutrient efficiency of existing soil nutrition
- Increases water use efficiency through salt mediation
- Improves nutrient mineralization



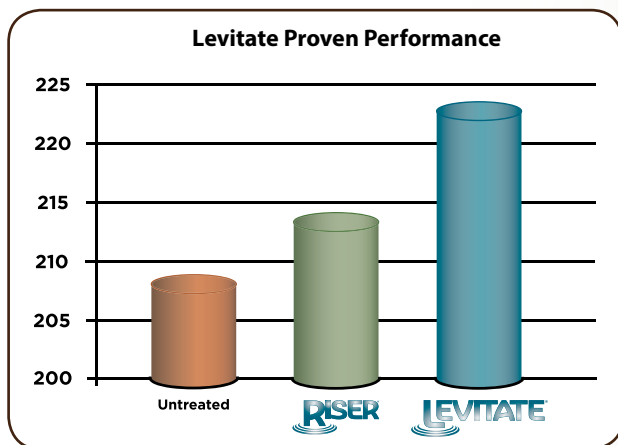
Fully Chelated Zinc

- EDTA chelation for excellent uptake and compatibility
- 4 to 5 times more available than ammoniated zinc
- Zinc is a key component in phosphate utilization



Fulvic Acid

- Chelation and sequestration of soil compounds that bind nutrients in the soil
- Reduces stress from salt in fertilizer
- Enhances nutrient efficiency of applied nutrition



Source: 2015 data collected from over 30 evaluation sites across the corn belt. Risier at 2.5 gallons per acre and Levitate at 2 to 3 gallons per acre.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

SOIL/FOLIAR APPLIED



Guaranteed Analysis

Total Nitrogen (N).....	7.00%
6.00% Ammoniacal Nitrogen	
0.30% Nitrate Nitrogen	
0.70% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	17.00%
Soluable Potash (K ₂ O)	3.00%
Copper (Cu).....	0.07%
0.07% Chelated Copper (Cu)	
Iron (Fe).....	0.20%
0.20% Chelated Iron (Fe)	
Manganese (Mn).....	0.06%
0.06% Chelated Manganese (Mn)	
Zinc (Zn).....	0.95%
0.95% Chelated Zinc (Zn)	

Derived from: Urea Ammonium Nitrate, Ammonium Polyphosphate, Potassium Acetate, Zinc Oxide, Anhydrous Ammonia, Copper EDTA , Iron HEDTA , Manganese EDTA , and Zinc EDTA . EDTA is ethylenediaminetetraacetic acid.

HEDTA is hydroxyethylethylenediaminetriacetic acid.

Riser® (7-17-3 + MICROS) is a low salt, seed safe, highly pure pop-up in-furrow starter fertilizer containing ACA® Technology and micronutrients. These ingredients provide essential nutrients for optimizing seeding vigor, plant health and crop yields.

FEATURES AND BENEFITS:

- Excellent crop safety
- Low salt blend that's seed safe
- High quality pop-up fertilizer
- Increase early season plant vigor
- Increases rootmass



RISER TECHNOLOGY:



Acetate

- Increases root hair and shoot growth
- Enhances nutrient efficiency through increased root interception
- Promotes nutrient solubilization



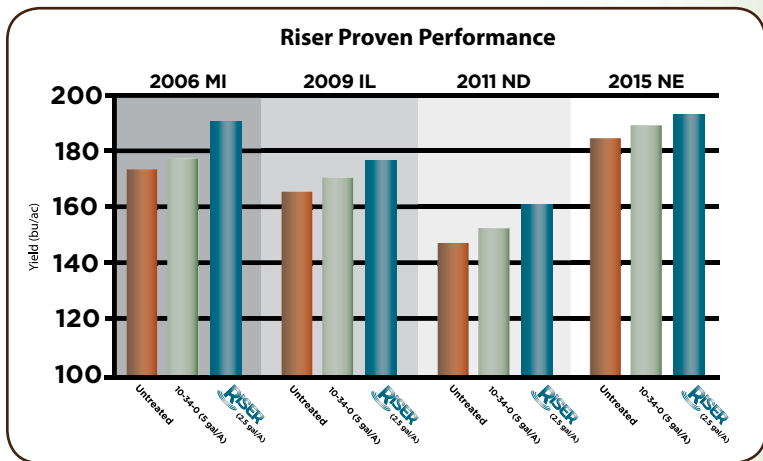
Low Salt/Seed Safe

- Enhanced nutrient efficiency of existing soil nutrition
- Increase water use efficiency through salt mediation
- Improves nutrient mineralization



Chelated Micros

- EDTA chelation for excellent uptake and compatibility
- 4 to 5 times more available than ammoniated zinc
- Zinc is a key component in phosphate utilization



Source: Loveland Products Tech Service Agronomist

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.



REFERENCE GUIDE

PROPER TANK MIXING PROCEDURES

Every year when application season rolls around, the number of customer calls concerning tank mix compatibility problems increases. In most cases these issues can be traced to simple product management practices that will eliminate most concerns. The most common issues are:

- Incorrect product mixing order.
- Incomplete mixing of product prior to adding a second product.
- Lack of agitation of product: inadequate bulk storage tank or mini-bulk tank recirculation before use, package product not shaken well, no agitation action in spray tank.
- Spray tank contamination or not clean.
- Product sitting overnight in the spray tank.

Other factors that can make mixing more difficult are cold temperatures of the carrier (water, liquid fertilizer) that is common during early spring seasons. Under these conditions, it is important to maintain adequate agitation to ensure proper suspension of the product. Lack of carrier volume may cause problems while mixing products.

OTHER TANK MIX GUIDELINES

- If a known product compatibility issue exists or the water or fertilizer carrier is cold, a compatibility agent may be used to help with mixing problems. COMP-AIDE or E-Z Mix work well.
- UNFOAMER® may be used if excessive foam is a problem. Surfactant loaded glyphosate products or organo-silicone surfactant products may cause excessive foaming.

MIXING WITH GLYPHOSATE OR GLUFOSINATE FORMULATIONS

The following guidelines can be utilized throughout the season to avoid tank mixing problems:

- Fill the spray tank half full with carrier (water or fertilizer). Make sure the agitation system is engaged and working properly.
- If glyphosate or glufosinate is to be mixed, a water conditioning agent should be added to the spray tank first, such as WeatherGard Complete or Choice® Weather Master.

FORMULATION ABBREVIATIONS

- DF – Dry Flowable
- EC – Emulsifiable Concentrate
- EW – Emulsion in Water
- F – Flowable liquid
- ME – Micro-encapsulated
- OD – Oil Dispersion
- S – Solution
- SC – Suspension Concentrate
- SG – Soluble Granule
- SP – Soluble Powder
- WDG – Water Dispersible Granule
- WSP – Water Soluble Packet

LOVELAND PRODUCTS MIXING ORDER EXAMPLES

EXAMPLE:

Crop – Corn

APPLICATION TIMING: Post-emerge @ V5

PRODUCTS OF CHOICE: Makaze Yield Pro®, Satori®, Black Label® ZN, WeatherGard Complete

MIXING ORDER:

1. Fill spray tank $\frac{1}{4}$ to $\frac{1}{2}$ full of carrier
2. Add WeatherGard Complete
3. Use proper agitation
4. Add Makaze Yield Pro glyphosate
5. Add Satori fungicide
6. Add Black Label ZN last
7. Fill remainder of spray tank with remainder of needed carrier and continue agitation
8. Spray field

EXAMPLE: **Crop – Soybean**

APPLICATION TIMING: Post emerge @ R3

PRODUCTS OF CHOICE: Satori, Swagger®, Re-nforce® K, Black Label ZN, Franchise®

MIXING ORDER:

1. Fill spray tank $\frac{1}{4}$ to $\frac{1}{2}$ full of carrier
2. Use proper agitation
3. Add Satori fungicide
4. Add Swagger insecticide
5. Add Franchise adjuvant
6. Add Black Label ZN
7. Add Reinforce K
8. Fill remainder of spray tank with remainder of needed carrier and continue agitation
9. Spray field

EXAMPLE: **Crop – Wheat**

APPLICATION TIMING: Post-emerge @ 4 leaf to tillering

PRODUCTS OF CHOICE: Hat Trick®, Fitness®, Tombstone™ Helios®/Warhawk®, LI700®

MIXING ORDER:

1. Fill spray tank $\frac{1}{4}$ to $\frac{1}{2}$ full of carrier
2. Use proper agitation
3. Add Hat Trick herbicide
4. Add Fitness fungicide
5. Add Tombstone Helios/Warhawk
6. Add LI700
7. Fill remainder of spray tank with remainder of needed carrier and continue agitation.
8. Spray field

WALES/DALES

MIXING ORDER FOR CHEMICAL FORMULATIONS

Pesticides should be added to the tank using the WALES or DALES method to help avoid mixing issues.

- Fill spray tank $\frac{1}{4}$ to $\frac{1}{2}$ full with carrier. Be sure agitation system is in working order.
- Add water conditioner and any compatibility agents if needed.

W or D

Dry formulations should be added to the tank first such as: wettable powders (WP/W), water dispersible granules (WDG), water soluble packets (WSP), dry flowable (DF). Be sure dry products are thoroughly dissolved prior to adding other products.

A

Agitation should be continuous and provide enough action to “roll” the surface of the carrier.

L

Add liquid (L), flowable (F), soluble concentrate (SC), formulations next.

E

Emulsifiable Concentrates (EC) should be added next. Micro-encapsulated (ME) formulations should be added after the EC product.

S

Add surfactants and other adjuvants last. This would include NIS, crop oils, MSO, drift control agents, etc. Final step is to fill the tank with the remainder of the needed carrier and continue agitation.

- When adding a nutritional product, add to the tank last.
- Always do a jar test if there are any concerns about product mixes.

NOZZLE OUTPUTS

(20-INCH NOZZLE SPACING*)

Output	Ground speed, miles per hour						
	3	4	5	6	7	8	
			5 gal per acre				
Gal. per minute	.05	.067	.084	.101	.118	.135	
Ounces per minute	6.4	8.6	10.8	12.9	15.1	17.2	
			6 gal per acre				
Gal. per minute	.06	.081	.101	.121	.141	.162	
Ounces per minute	7.8	10.3	12.9	15.5	18.1	20.6	
			7 gal per acre				
Gal. per minute	.071	.094	.118	.141	.165	.189	
Ounces per minute	9.0	12.1	15.1	18.1	21.1	24.2	
			8 gal per acre				
Gal. per minute	.081	.108	.135	.162	.189	.216	
Ounces per minute	10.3	13.8	17.2	20.7	24.1	27.6	
			9 gal per acre				
Gal. per minute	.091	.121	.152	.182	.212	.242	
Ounces per minute	11.6	15.5	19.4	23.3	27.1	31.0	
			10 gal per acre				
Gal. per minute	.101	.135	.168	.202	.236	.269	
Ounces per minute	12.9	17.2	21.5	25.9	30.1	34.4	
			15 gal per acre				
Gal. per minute	.152	.202	.253	.303	.354	.404	
Ounces per minute	19.4	25.9	32.3	38.8	45.2	51.8	
			20 gal per acre				
Gal. per minute	.202	.269	.337	.404	.472	.538	
Ounces per minute	25.9	34.5	43.1	51.8	60.2	69.0	

* Data also applies if every other outlet is plugged and two nozzles are used per drop, as is often the case in post-emergence herbicide application. The table may be used to:

1. Determine gallonage per acre at given ground speed and nozzle output.
2. Select proper ground speed when operating at a given nozzle pressure and output.
3. Select new nozzles when range of gal. per acre and ground speed is known.

AIRCRAFT CALIBRATION

Acres covered per minute

	Swath width in feet									
	30	35	40	45	50	75	100	200	300	500
75	4.5	5.2	6.0	6.7	7.5	11.2	15.0	30.0	45.0	75.0
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0	48.0	80.0
85	5.1	5.9	6.8	7.6	8.5	12.7	17.0	34.0	51.0	85.0
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0	54.0	90.0
95	5.7	6.6	7.6	8.5	9.5	14.2	19.0	38.0	57.0	95.0
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0	60.0	100.0
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0	66.0	110.0
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0	72.0	120.0
130	7.8	9.1	10.4	11.7	13.0	19.5	26.0	52.0	78.0	130.0
140	8.4	9.8	11.2	12.6	14.0	21.0	28.0	56.0	84.0	140.0
150	9.0	10.5	12.0	13.5	15.0	22.5	30.0	60.0	90.0	150.0

The rate of application in gallons or pounds per minute is calculated by multiplying the acres per minute by the number of gallons or pounds per acre to be applied. Take for example a 100-mile-per-hour aircraft that has a 50-foot effective swath. The chart indicates that the plane has a coverage of 10 acres per minute. If spray is to be applied at a rate of 2 gallons per acre, the unit should be calibrated to dispense 20 gallons per minute (2 X 10 = 20). If 7.5 pounds of dry material is to be applied per acre, the unit should be calibrated to dispense 75 pounds per minute (10 X 7.5 = 75).

The basic formula for calculating acres per minute is:

$$\frac{\text{swath width} \times 2 \times \text{miles per hour}}{1,000}$$

COMPUTING PLANT POPULATIONS AND YIELDS

Row Width	Length of Row in 1/1000 Acre
40 inches	13-ft., 1-in.
38 inches	13-ft., 9-in.
36 inches	14-ft., 6 in.
30 inches	17-ft., 5-in.
20 inches	26-ft., 2-in.
15 inches	34-ft., 10-in.

Determining Plant Population*

1. Measure off 1/1000 acre row.
2. Count number of plants; then multiply by 1000 to determine plants per acre.

Determining Yields*

1. Harvest grain from 1/1000 acre row.
2. Weigh harvested grain then multiply by 1000 to get pounds of grain per acre.
3. Determine moisture content then divide pounds per acre by pounds per bushel for adjusted moisture.

* Average three or more 1/1000 acre rows for more accurate estimate of field populations and yields.