The Vital Earth News

Agricultural Edition

Volume XV, Number 1 | Vital Earth Resources • Gladewater, Texas | Winter, 2009

Break Up Hardpan, Save On Fertilizer!

A Simple Way to Economize On Fertilizers

By Charles B. Elkins and Kim Van Sickle

[From Solutions*, July-August, 1984, with minor editing.]*

Soil compaction in the form of plowpans affects crop production on large areas of tilled soils throughout the world. This dense zone of soil that forms just below the plow layer restricts root growth and water infiltration into the subsoil. When root growth in the subsoil is reduced or prevented, a shallow root system greatly increases the chances of crop yields being reduced by drought stress.

We have conducted studies at Auburn to determine characteristics that make it possible for grass roots to grow through a compacted layer of soil. Results have shown significant improvement in cotton yields that followed.

Root Behavior

On most agricultural soils, a crop with its root system restricted to the plow layer has an available soil water reserve that will last only a few days to a week following a thorough wetting. However, a root system 4 or 5 feed deep has an available soil water storage capacity that should meet the needs of a crop for 2 to 4 weeks.

A shallow root system also results in less efficient use of certain fertilizer nutrients. Soluble nutrients such as nitrates, potassium, boron and sulfur, which move readily with soil water, may leach below a root system restricted by a plowpan. Root systems extending into the subsoil may eliminate the need of applying boron and sulfur and take advantage of the high potassium-supplying capacity of many soils. Because of cost and possible groundwater pollution, a deep root system can pay off by improving recovery of nitrate fertilizer.

A shallow root system also results in less efficient use of certain fertilizer nutrients.

Dr. F. Leslie Long, formerly with the USDA's Agricultural Research Service, conducted cooperative research with the Alabama Agricultural Experiment

Heavy machinery traffic greatly compacts soil, especially when it is wet.

The effects of machine compaction can be clearly noted when the profile is exposed by excavation.

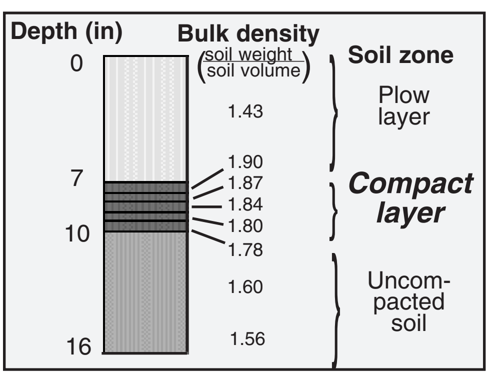
See Improve Soil Biology, page 2

Soil Biology the Key to Soil Structure

By Paul W. Syltie, Ph.D.

Structure is so basic to soils that we oftentimes forget about its importance. Yet, its influence on yield potential, erosion, and rooting is profound and most important at a time when crop production must be maximized.

The factors that influence the development of soil structure are exceedingly complex, and include the parent material, climate, soluble salts, migration of clay, iron oxides, and carbonates, organic matter, and microbial activity, as well as the effects of cultivation. The processes by which soil structural units are formed are (1) wetting and drying, (2) freezing and thawing, (3) root activity, (4) soil animal activity (ants, earthworms, mites, etc.), (5) modifying effects of adsorbed cations, (6) soil tillage, and, most importantly, (7) organic matter decay and microbial activity.



Any activity that develops lines of weakness in the bulk soil mass will produce structural units of various sorts such as granular, crumb, blocky, platy, columnar, or prismatic. A compacted, massive type of structure at plow depth, caused by compacting tractor wheels and machinery, can produce bulk densities as shown in the figure on the left.

While it is impossible to separate these various causes of structural genesis from one another, the overriding effect

See Only 0.02% of Polysaccharide, page 3

Plants Roots Can Break Up Hardpan

Continued from page 1

Station, showing that a deep, well-developed corn or sorghum root system will take up twice the normally recommended rate of nitrogen

Saturation of the plow layer creates an anaerobic condition that is detrimental to root growth and conducive to volatile loss of nitrogen by denitrification. Dr. Morris Huck, ARS, Auburn University, has shown that a few hours without oxygen will kill the growing tip of some crop plants. This pruning of root tips produces a highly branched root system with reduced capability for deep penetration. Large quantities of nitrates can be lost when saturation of the plow layer excludes oxygen and the roots of a growing crop supply energy to the microbes that carry out the denitrification process.

Saturation of the plow layer also makes it vulnerable to erosion. Gullies frequently are observed in tilled fields where topsoil has been eroded down to a plowpan. Runoff of water from additional rainfall, which cannot infiltrate into a soil because of a plowpan, not only increases erosion but also often results in loss of water needed to replenish subsoil water.

> **... a deep, well-developed corn or sorghum root system will take up twice the normally recommended rate of nitrogen.**

Characteristics of Plowpans

Texture. The texture of plowpans varies widely from sand to clay and may be similar to either the topsoil or subsoil, depending on thickness of topsoil and depth of plowing. On highly-eroded soils, texture of the plowpan will usually be the same as the upper subsoil

Density. Density of plowpans may vary from about 1.5 in clayey soils to near 2.0 g/cc in sandy soils. As a soil is compacted to higher densities, solid soil material occupies what was previously pore space. Not only is total pore space reduced when a soil is compacted, but pore size also is reduced. It is primarily the absence of large pores that slows the saturated movement of water through a plowpan.

Plant root growth in soils must take place through existing pores or the root must displace soil, creating a pore at least as large as the root. Often it is a combination of two processes. When a root displaces soil, root forces must overcome the resistance of soil strength. Soil strength increases as a soil dries. In sandy soils, the strength of a very dense plowpan may be great enough to prevent penetration of roots of common crops at all water contents. Less dense plowpans or plowpans containing more clay may have low strength when wet, but water-filled pores prevent oxygen from moving into the plowpan at levels needed for root growth. If large pores are present, water drains from them, allowing air to move into the soil. Normal root growth can proceed and volatile loss of nitrogen is reduced.

Modifying Plowpans

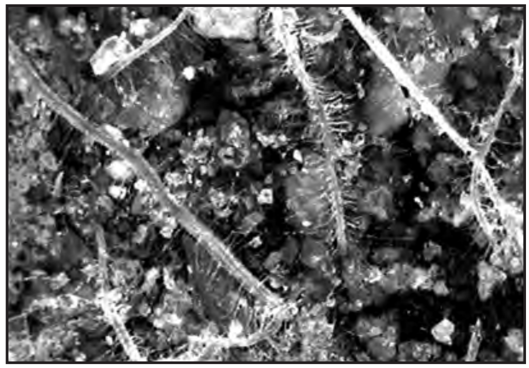
Usually we think of subsoiling or other forms of deep tillage to reduce the damaging effects of plowpans on crop production. Disadvantages of deep tillage are high power and time requirements. On highly compactible soils, the effects of tillage are short-lived, so the tillage must be repeated each year. In some instances, there may be undesirable mixing of soil horizons. An alternative to tillage may be modification of plowpans by plant roots.

Ideally, we would like to have crop plants with roots that can grow through plowpans. Preliminary results at Auburn University indicate that root systems of soybeans and cow peas very among varieties. They also show that roots of some varieties grow in dense soils better than others. Genetic diversity for root characteristics probably exists in all plants, but very little work has been performed to breed for specific root characteristics in crop plants. This is because the root system is out of sight and difficult to observe and measure. There is also very little knowledge regarding characteristics that a root must have to grow well in dense soils.

Roots That Penetrate

Some perennials such as alfalfa, kudzu, lespedeza, certain grasses, and some annual vetches seem to have the ability to develop deep root systems on plowpan soils. In the case of perennials, their ability to penetrate plowpans may be because of their continued growth for an extended time and over wide ranges of soil water and under other environmental conditions. Annual crops have a limited period of time in which to penetrate a plowpan, and this may be in the summer when plowpans dry out and attain maximum strength.

Pensacola bahiagrass roots readily penetrate compacted soil. This is of benefit to the bahiagrass plant, since it can develop a deep root system that uses subsoil water and nutrients. The bahiagrass root system also establishes macropores through the plowpan that make it possible for crops grown after bahiagrass to penetrate the plowpan.



These wheat roots must overcome the physical resistance of the soil in an atmosphere containing enough oxygen to be able to grow

An experiment was conducted in central Alabama to determine if bahiagrass would improve cotton production on a plowpan soil. In this experiment, cotton was conventionally tilled on continuous cotton plots and on plots where a 3-year old sod was turned under in 1969, a 4-year-old sod was turned under in 1970, and a 5-year-old sod turned under in 1971.

Cotton yield increased 38 to 180 percent by growing cotton after 3-, 4- and 5-year-old bahiagrass sod. A 41 percent yield increase was obtained in 1972 by chiseling 14 inches deep, compared to a 112 to 180 percent increase from the sod

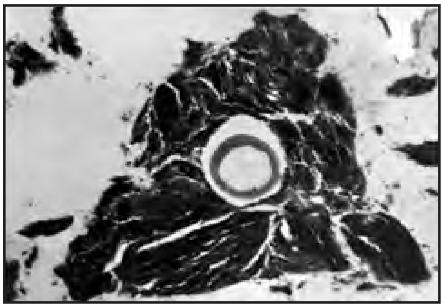
See Macropores Improve Ni, page 7

Only 0.02% of Polysaccharide Is Needed!

Continued from page 1

of soil fungi, bacteria, algae, and other microbes has increasingly been shown to be the most important of all the forces producing a stable soil structure. Especially in the root zone, where root exudates feed a teeming population of microbes, the effects on structure are the greatest, although microbial effects can be pronounced throughout the soil mass, especially if organic materials such as manures, crop residues, and the roots of precious crops lie waiting to be decomposed by this digesting army.

Bacterial populations may be as high as 10^9 (1 billion!) cells per cc of soil, mainly in the rhizospheres (root zones) of plants, but also clustered along cell wall

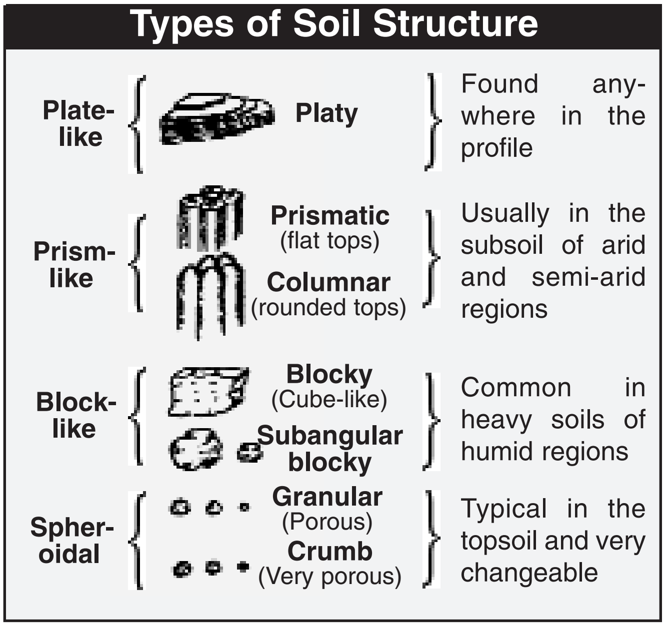


This soil structural unit contains a polysaccharide core, protected from consumption by bacteria..

fragments. The bacteria are small, but greater than 0.3 micrometers in diameter, too large to enter the tiny crevices between clay platelets where polysaccharide exudates may be protected. The clay particles can be disturbed by soil animals and tillage tools, however, releasing the stored organic compounds which help stabilize the structural units, and make them accessible to bacteria.

During the drying of soils, polysaccharides will concentrate in crevices between adjacent clay platelets; these units will bond with one another to form strong, box-like "cardhouse" structures which are resistant to dispersion or collapse. A small amount of these polysaccharide threads — only 0.02 to 0.2% of the soil mass — will markedly stabilize clay aggregates (R. C. Foster, Polysaccharides in soil fabrics, *Science* 214, November 6, 1981).

More recently, a host of studies have shown how various fungal and bacterial species can form and stabilize soil aggregates. For instance, in eastern Montana a saprophytic basidiomycete fungal species, which produces large amounts of non water-soluble extracellular material that binds soil particles into aggregates, was shown to markedly increase the stability of soil aggregates (T. Caesar-TonThat and V. Cochran, Role of a saprophytic basidiomycete soil fungus in aggregate stabilization, *Sustaining the Global Farm*, Purdue University Symposium, 1999).



It behooves farmers to be aware of the great value in adding crop residues and other fresh organic matter on a regular basis to build and stabilize the critically important structural units of soils. It is these units which permit air and water to move throughout the soil mass, and enable roots to grow rapidly through uncompacted zones. By maintaining excellent structure, crop yields can be expected to remain high, and the valuable fertility resources within the soil, and which are added as fertilizers and organic materials, can be utilized to their maximum efficiency. ❒

Has Clothianidin Killed Our Bees?

[From Organic Consumers Association*, August 25, 2008.]*

The German Coalition Against Bayer Dangers has brought a charge against Werner Wenning, chairman of the Bayer Board of Management. The group accuses Bayer of marketing dangerous pesticides and thereby causing the mass death of bees all over the world.

> **"Clothianidin has the potential for toxic exposure to honey bees."**
> **EPA Fact Sheet**

The Coalition introduced the charge in cooperation with German beekeepers who lost thousands of hives after poisoning by the pesticide clothianidin in 2008.

Since 1990, Bayer has been producing the insecticide imidacloprid, a best-selling product that is exported to more than 120 countries. When patent protection for imidacloprid expired in most countries in 2003, Bayer brought the similarly functioning Clothianidin onto the market. Both substances can get into pollen and nectar, and can damage bees.

The marketing of Imidacloprid and Clothianidin coincided with the occurrence of large-scale bee deaths in many

European and American countries. Up to 70% of all hives have been affected.

The German Coalition Against Bayer Dangers suspects that Bayer submitted flawed studies to play down the risks of residues in treated plants, a suspicion that was later confirmed by the Canadian Pest Management Regulatory Agency. ❒

15-Minute Soils Course

Lesson 28:

Manganese (Mn), a Metal of Many Uses

These soybeans show marked chlorosis of the newly formed leaves, which can be from a deficiency of Cu, Fe, Zn, or in this case Mn.

Manganese is an abundant element, the twelfth most common in the earth's crust (0.1%). Typical topsoils contain from 0.01 to 0.5% MnO, and this element is essential for plant growth, as it is for the function of cells of all living organisms. Its available form is Mn^{++}.

25	54.938
Manganese	
1244	1962
Mn	

The pure element is a silvery, brittle metal. Combined forms are found all across the globe. In nodules on the ocean floor there are over 10^{12} metric tons of it, found in close association with oxides of iron, cobalt, nickel, and copper. Manganese is more electropositive then its near neighbors (iron and cobalt) on the Periodic Table, so it is more reactive than them.

Used in metals to increase strength, hardness, and wear resistance, manganese in plant cells acts primarily as an enzyme metallic activator. Its known functions are given in the list below.

Functions of Mn in Plants

1. **Assimilate carbon dioxide in photosynthesis**
2. **Aid in the synthesis of chlorophyll, and in nitrate assimilation**
3. **Activate fat-forming enzymes**
4. **Function in the formation of riboflavin, ascorbic acid, and carotene**
5. **Function in electron transport during photosynthesis**
6. **Involved in the Hill Reaction, where water is split during photosynthesis**

Effects on Availability

With manganese being so critical for plant enzyme systems, it is valuable to understand how its availability to plants is affected.

* **Soil pH.** High soil pH reduces Mn availability while low pH increases it, even to toxic levels.

* **Organic matter.** Organic matter can tie up Mn, making it deficient in high organic soils.

* **Soil Moisture.** Short-term water logging can change Mn^{++} to Mn^{+}, which is unavailable to plants. Yet, long-term waterlogging can increase Mn availability. Drying of soils may increase and then reduce Mn availability.

* **Mn:Fe balance.** High Fe levels will reduce Mn uptake, since Fe is similar to Mn.

* **Mn:P and Mn:Zn balance.** Results are conflicting

* **Mn:Si balance.** Si applications can alter the distribution of Mn in leaf tissue so that high Mn levels are not as toxic.

* **N stress.** Low N availability can reduce Mn uptake.

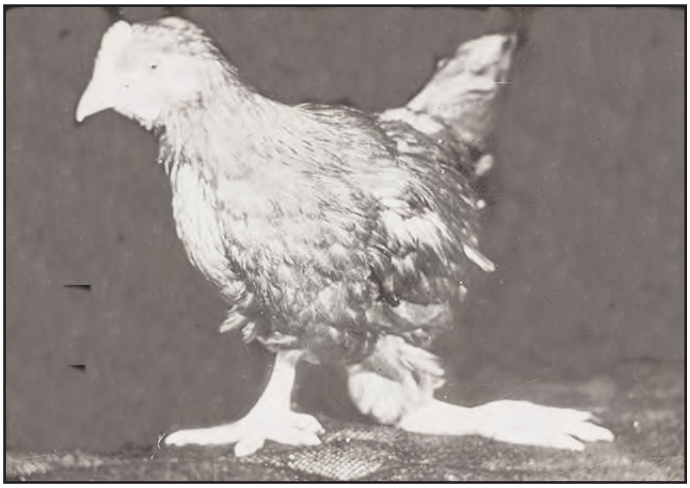
* **Mn:S balance.** As S content drops, so does the Mn content of plant tissues.

* **Mn:anion balance.** High levels of fertilizers containing Cl^-, NO_3, or SO_4^{-2} can enhance Mn uptake.

Deficiencies and Toxicities

As an immobile element in plants, deficiency

15-Minute Soils Course



In chickens, a manganese deficiency can manifest itself by "slipped tendon" on the legs because of imperfect cartilage formation.

symptoms occur on youngest leaves first, usually as interveinal chlorosis or as a series of brownish-black specks. These deficiencies are noted in high-pH and naturally deficient soils. Toxicities are common in low-pH soils (below 5.5), and include chlorosis and necrotic spots, "measles" on leaves and stems, and stunted roots.

A maple leaf shows distinct interveinal chlorosis, highly typical of manganese deficiency.

Correcting Mn Toxicities and Deficiencies

Liming will usually correct an Mn toxicity, while deficiencies can be improved by applying manganese sulfate, oxide, or chelate (EDTA), at 1 to 5 lb/acre of actual Mn. Foliar sprays are effective, at 1 to 2 lb/acre of Mn, but should be made more often than for soil applications. However, these materials should not be broadcast but rather banded, since Mn^{++} can quickly be converted to unavailable forms. Paradoxically, Mn-chelate can actually **increase** a deficiency because Fe in the soil has a greater affinity for the EDTA than does Mn, will kick off the Mn, and be taken up as Fe-EDTA instead of the Mn.

The encouragement of higher organic matter contents of the soil and greater microorganism activity is a sound approach to improving the proper level of available Mn in plants, and for the proper level of all nutrients in soils.

Crops That Respond Well to Manganese

Alfalfa	Beets
Cauliflower	Citrus
Cotton	Beans
Lettuce	Onions
Potatoes	Small grains
Sorghum	Soybeans
Spinach	Sweet corn
Tobacco	

See How Much You Learned

1. Manganese is essential for plant growth. T or F
2. Manganese functions in plants as an _________activator.
3. The best way to correct an excess of Mn in acid soils is to: a. Apply a lot of nitrate fertilizer; b. Lime as recommended; c. Add more Mn
4. Organic matter maintenance is a good practice for supplying Mn to crops. T or F
5. Manganese functions in plants to: a. synthesize chlorophyll; b. aid in splitting water during photosynthesis; c. helps form some vitamins; d. all of these three
6. The available form of manganese is ________, while the unavailable forms are Mn^{+}, and Mn^{+4}.
7. A typical Mn fertilizer rate may be 2 lb/acre of actual Mn. T or F

Answers: 1. T; 2. enzyme; 3. b; 4. T; 5. d; 6. Mn^{++}; 7. T.

Corn Is Great, But Not As a Sweetener!

High Fructose Corn Sugar Is a Nemesis to Health

By Paul W. Syltie, Ph.D

Corn is a crop.of many uses:feed for cattle, food for humans, starch for strengthening fabric and binding books, and for converting into sugars for ethanol production, to name a few. Yet, for all the good it does for us, corn starch processed into fructose for human consumption is not a good idea.

Despite what The Corn Refiners Association claims, that "Research confirms that high fructose corn syrup [HFCS] is safe and no different from other common sweeteners like table sugar and honey", are these claims true? Why then is The Corn Refiners Association embarking on a strong public relations blitz to try and quell fears that consuming HFCS is without significant danger?

The Truth Arrives

The truth of the matter is that HFCS is indeed dangerous, and should be avoided. Since 2004, research findings have shown that the skyrocketing consumption of HFCS, since its introduction into foods in the 1970s, increased to about 45 pounds per person in 1999. That consumption dropped to 40 pounds by 2007, in part because of news concerning its great harm to health. More calories are consumed in the United States from HFCS than from any other source. Thus, with per capita annual consumption dropping, the corn refiners are upset about lost revenues and are fighting back with ads to try and change perceptions about this dangerous product. The Corn Refiners Association spent $20 to $30 million in ads to try and rehabilitate its reputation.

Elevated insulin levels are the foundation of nearly every chronic disease.

What High Fructose Corn Syrup Does to the Body

Notice the accompanying box for the diseases associated with the consumption of HFCS. The use of refined sugar (sucrose) is itself harmful to the body, and is a cause for many diseases. This issue was addressed in the summer, 2005, issue of *The Vital Earth News*: "76 Ways Sugar Can Ruin Your Health."

DISEASES INDUCED BY HFCS

- CANCER
- DIABETES
- HEART DISEASE
- PREMATURE AGING
- ARTHRITIS
- OSTEOPOROSIS

Sucrose is a molecule of combined glucose and fructose that must be cleaved, and is metabolized in the intestine; the glucose is then delivered to the blood and serves as fuel for body cells. The fructose in HFCS, on the other hand, is delivered to the liver and is metabolized into triglycerides and adipose (fat) tissue, not blood glucose. Not only that, fructose does not stimulate insulin secretion of the pancreas, which would help burn the compound. Fructose also does not enhance the production of leptin, a hormone thought to regulate the appetite. Thus, fructose does not allow the body to tell itself to stop consuming calories. The link is readily seen between our epidemic of obesity and the high consumption of products containing corn syrup.

Fructose and Diabetes

Recent research has found that soft drinks sweetened with HFCS contain high levels of reactive compounds that trigger cell and tissue damage which cause diabetes. These reactive compounds are carbonyls, that were found in "astonishingly high" levels in all soft drinks sampled because the fructose and glucose are "unbound", not chemically stable like the attached glucose and fructose of sucrose.

Like white sugar, fructose contains no enzymes, vitamins, or minerals that are needed to digest them. Rather, the body borrows these components from other tissues of the body. Whole fruit, on the other hand, which contain fructose, also possess a significant complement of these minerals, vitamins, and enzymes necessary to digest them. Besides, unbound fructose can interfere with your heart's use of minerals such as magnesium, copper, and chromium.

The Solution: Avoid Fructose!

Not only should you avoid sodas, many of which are laced with HFCS, but also avoid many processed foods and fruit juices. An average soda has eight teaspoons of fructose! Switch to pure water and whole foods. Avoid the risk of getting diabetes, which does devastation throughout the body in many ways, and which is epidemic today in America.

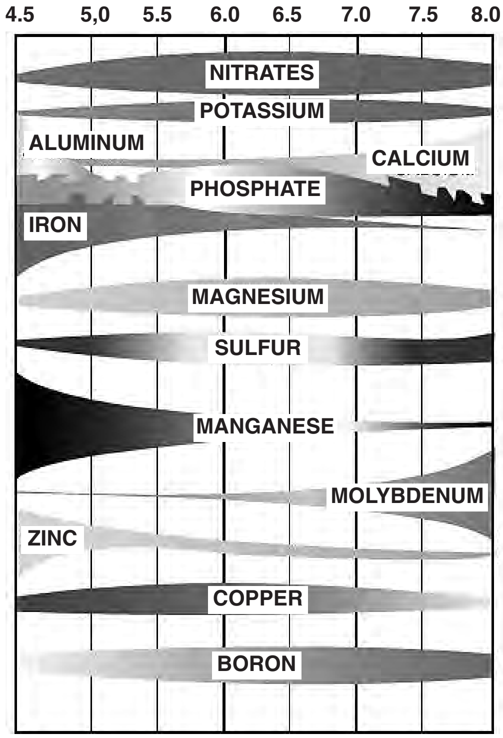
High fructose corn syrup is worse than smoking and white sugar, but not as bad as artificial sweeteners like aspartame. Avoid them all and experience better energy and more abundant life! ❐

TRAITS OF SUCCESSFUL LEADERS

1. **They observe with application.** They observe and absorb. They look at everything like it is the first and last time they will ever see it.
2. **They know how to listen** ... really listen! Listening is *wanting* to hear.
3. **They take copious notes.** They capture ideas as their senses alertly respond to react to them.
4. **They welcome ideas**, urging others to bring their best thinking on a subject. They are open, responsive, sensitive, aware, and encouraging.
5. **They value time highly.** They use it skillfully.
6. **They set regular goals**, and expend their energy to reach these goals.
7. **They try to understand first.** Then, and only then, do they judge.
8. **They always anticipate achievement** and they build on their strengths.
9. **They know how to ask clear, courteous, and incisive questions** ... the creative acts of intelligence.
10. **They know how to organize their approach** to challenges and how to immediately focus their total mind power on the relevant.

Bits and Pieces, May 30, 1991..

Soil Acidity Affects Nutrient Availability



By Paul W. Syltie, Ph.D.

Why is soil pH so important? The major reason is that soil nutrient availability is greatly affected by soil pH, for two major reasons:

(1) The oxidation state of the element is directly related to soil pH. This oxidation state determines its solubility, and thus its ease of being brought into the soil solution and taken up by roots, or converted to available forms by soil microbes.

(2) Soil microbial activity is directly related to soil pH, and, as we have learned in many newsletter articles, soil microbes are critical in making nutrients available to plant roots. Certain microbes are more active at particular pH levels, but in general the more valuable bacteria, fungi, actinomycetes, protozoa, nematodes, and earthworms are active in the range that makes nutrients most available: about 6.0 to 7.2.

Low pH levels limit phosphorus, sulfur, and nitrogen availability, in particular, but all of the nutrients, except manganese and iron, tend to be more limited. Likewise, for pHs above about 7.5 most elements become less available except calcium and molybdenum.

It is wise to remember that most modern agricultural practices make the soil more acidic. Thus, it is very important to check the proper balance of calcium and magnesium from time to time using accurate soil testing as a guide. ❒

Morale is when your heart and hands keep working, and your mind says it can't be done.

Bits and Pieces, November, 1973.

Macropores Improve Nitrogen Utilization

Continued from page 2

effect. Cotton roots grew more than 6 feet deep when cotton followed bahiagrass, but less than a foot deep on continuous cotton plots. ***Chemical and physical studies of the soil on these plots identified only one soil characteristic that could explain the sod effect on cotton root growth and yield. This was an eightfold increase in macropores extending through the plowpan that were larger than 1 mm in diameter.*** This increase in large pores improved water movement through and oxygen movement into the plowpan. Cotton roots intercepting these pores could grow through them into the underlying subsoil. Root growth was also probably improved in the bulk soil of the plowpan because of increased oxygen when the plowpan was wet and weak. Beneficial effects of the bahiagrass continued for several years.

Soil water measurements showed that the deep-rooted cotton following bahiagrass extracted water from deep in the subsoil. The continuous cotton with its roots restricted by the plowpan used water primarily from the plow layer. Soil solution samples from a depth of 5.5 feet on plots where cotton followed bahiagrass contained one-half to one-fourth the nitrate of soil solution from the same depth on continuous cotton plots, showing that deep-rooted cotton made more efficient use of nitrogen fertilizer. ❒

Statement of Purpose

Vital Earth Resources is a for-profit private corporation dedicated to the development, production, and sale of top-quality, ecologically sound horticultural and agricultural products. *The Vital Earth News* is a periodic publication of Vital Earth Resources to inform customers and other interested parties about our products and programs, and to educate our readership on critical issues facing growers today and in the future. If you would like to receive future issues of this newsletter or product information, simply fill out the form on the right and mail it to us.

***Yes!* Send me a subscription to *The Vital Earth News* and/or product information!**

- ❑ *The Vital Earth News Agricultural Edition* (two issues per year)
- ❑ Carl Pool water soluble fertilizers
- ❑ Potting soils, mulches, and compost
- ❑ Vitazyme, Aqua-Min, and Odor-X
- ❑ I am a ( ) farmer or grower, ( ) retailer, ( ) other interested party.

Name ______________________________________

Address ____________________________________

City/State/Zip _______________________________

Telephone and/or fax (optional) ______________________

Mail to: **Vital Earth Resources, P.O. Box 1148, Gladewater, Texas 75647**

Vitazyme **produced outstanding yield increases in Ukraine in 2008. For canola near Vinnytsia, a fall and a spring application at 1 liter/ha each time increased the yield by 18%. A single fall application produced a 9% increase. Spring barley, winter wheat, and potatoes gave consistent 9 to 13% yield increases.**

This lush canola crop in Ukraine had two Vitazyme treatments, an 18% yield increase.