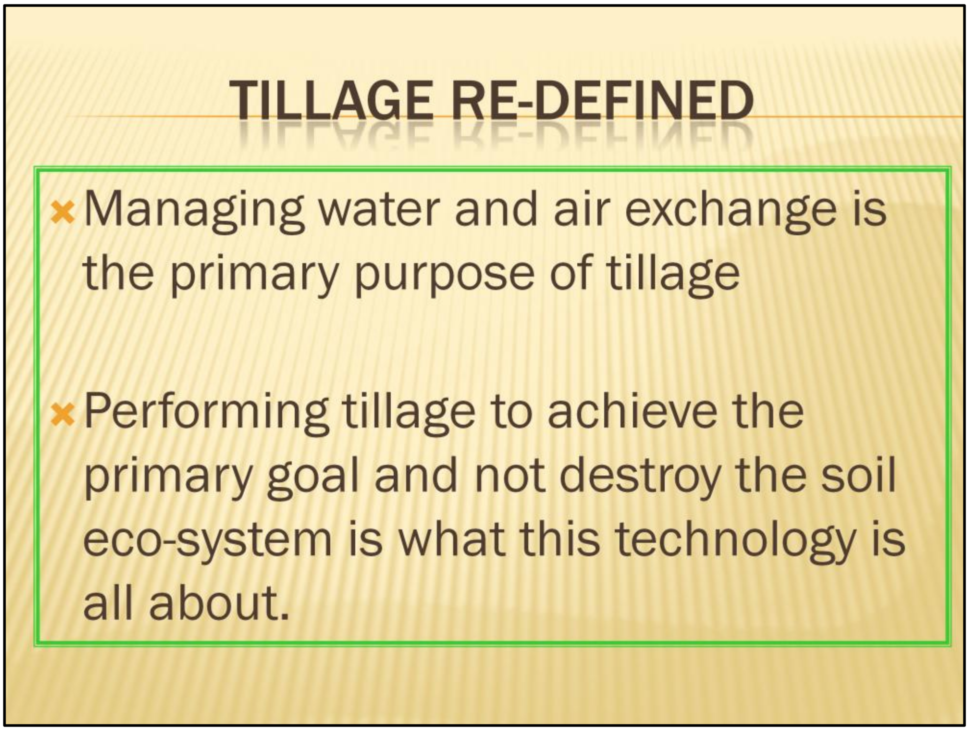


The content of this presentation is designed to bring some of the latest successs to light that were documented during the Drought of 2012. Most of the observations were made in the mid-west but they also included the Mason Farm in northern NY as well which was included in the drought stricken area of the country.

This slide is to serve as a reminder that the particular nature of the vertical tine tillage that has produced the results to be presented operates under these tenets. It is very simple to get water and air to relate to each other using several different forms of tillage. What is uncommon is for a tillage practice to achieve #1 AND achieve #2. Let alone, actually improve soil health or rhizosphere functions.

Robust soil kills fungi

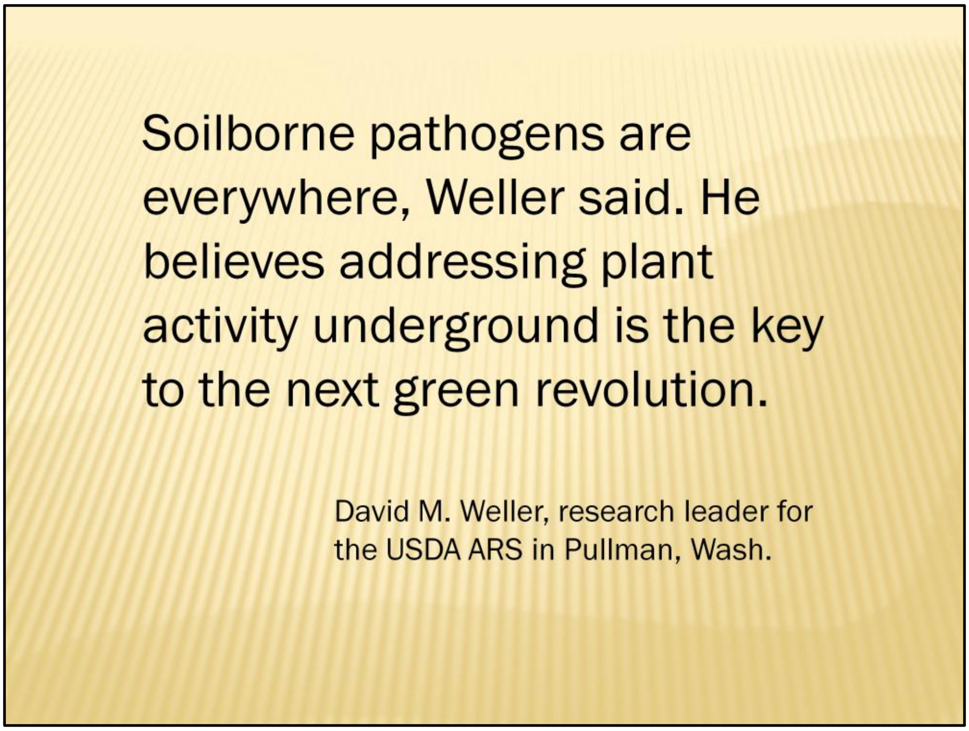
Updated: Thursday, February 28, 2013 9:58 AM

Beneficial organisms create natural antibiotics to fight pathogenic fungus

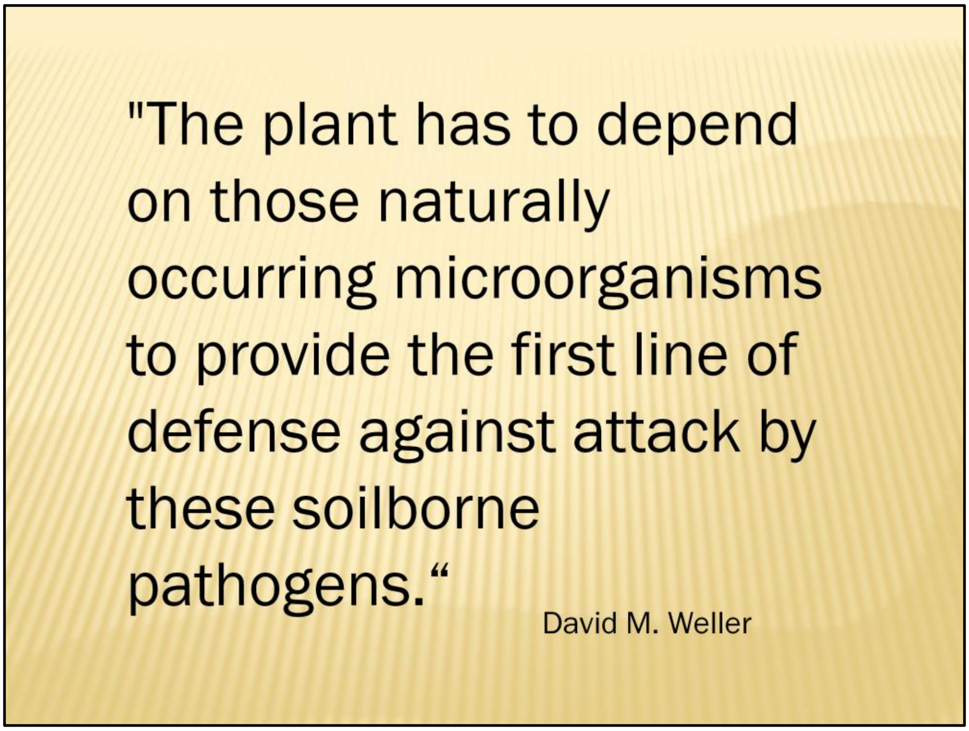
By MATTHEW WEAVER

Capital Press

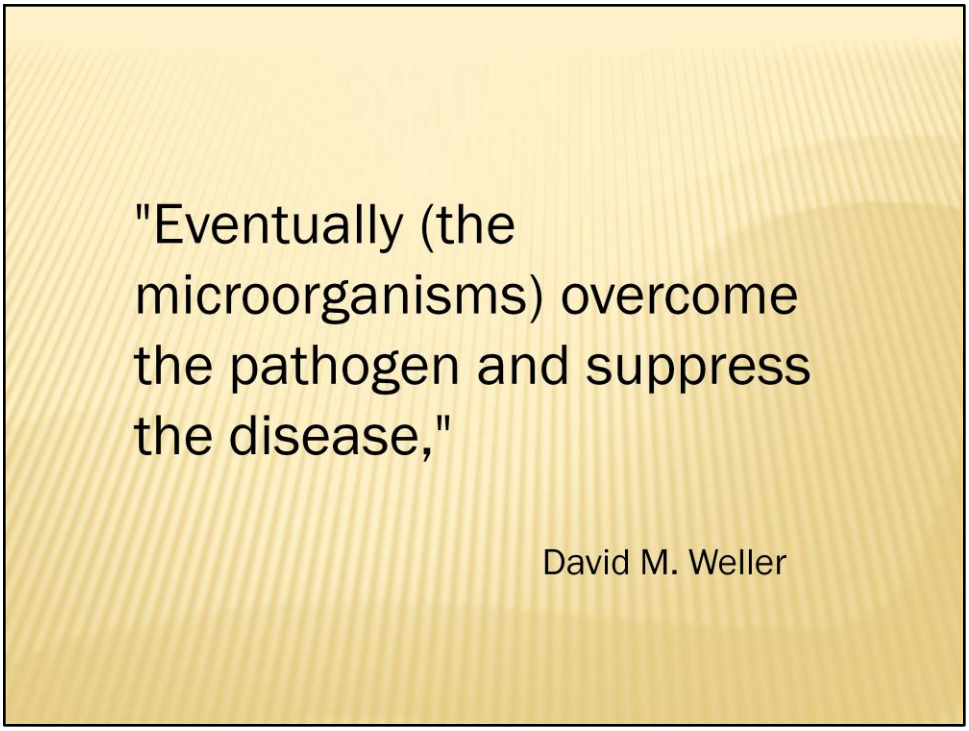
This article appeared to affirm what can happen in a healthy soil rhizosphere on the eve of the meeting where this slide series was presented.



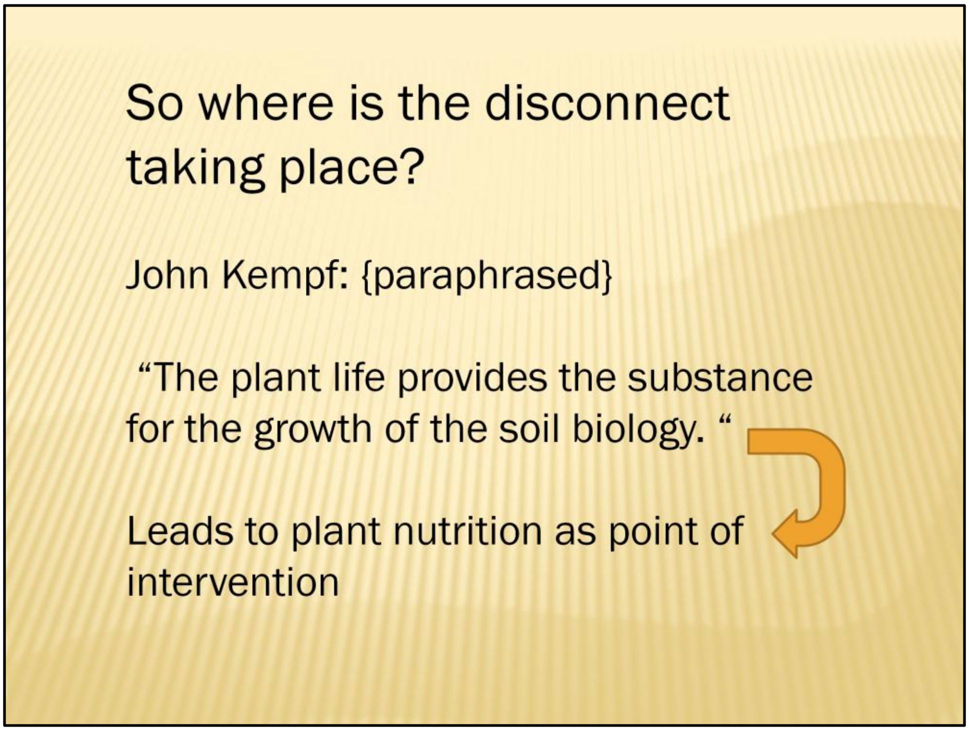
Plant activity underground is beginning to take on the specter of meaning more than a plant just producing root mass. There a host of things which transpire in the soil in immediate proximity to the root system. By inference, Weller, is saying these things which are essential to crop performance, have little or nothing to do with what has historically come in a fertilizer bag.



So the basic premise is that a healthy plant is a high producing AND profitable plant. Just supplying N-P-K, etc. is not sufficient to keep the plant healthy and prospering.



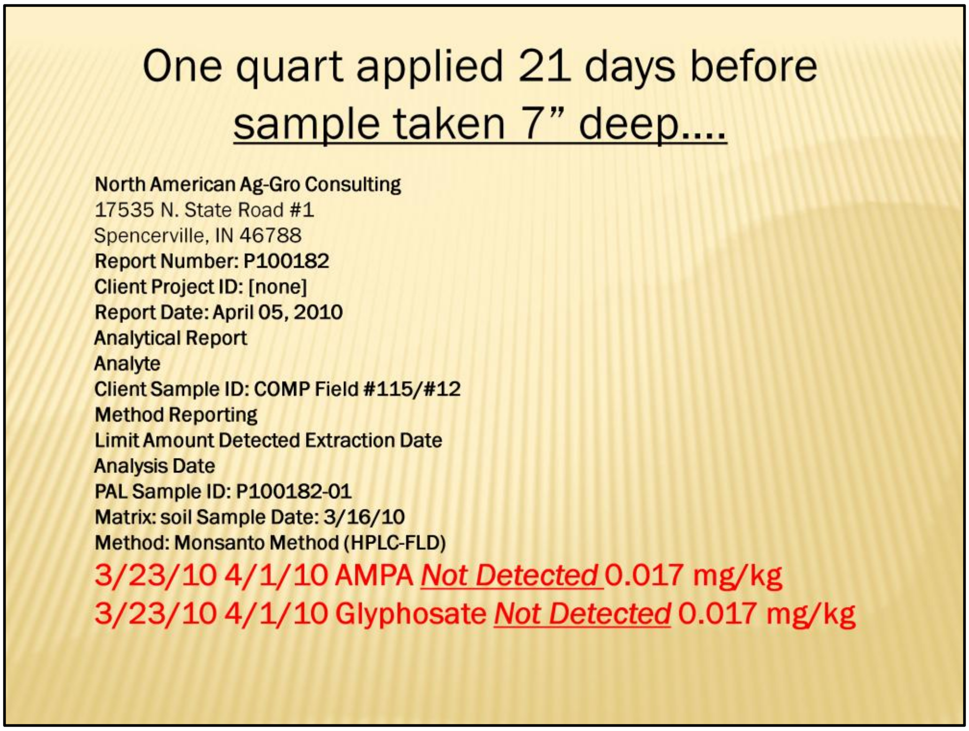
The obvious contrast would be that if the good guys don't win then the plant is going to cost money to be rescued or the crop maybe unfit for consumption.



This is an increasingly common approach to breaking into the paradigm in a different place than is normally used in crop production generally. John attempts to improve the performance of the sugar factory or plant in order to raise the plane of nutrition to the soil life or rhizoshpere. This can be profitable but can also prove to be risky because of the cost associated with the nutritional supports that are often required.

What we are going to look at next is some evidence that this or other high input NPK type approaches may not be necessary to enhance rhizosphere performance.

The example we are going to look at is the case of decomposing glyphosate and its primary metabolite AMPA in soil. This has proven to be one of the most persistent chemicals ever used in production agriculture so tracking its rate of disappearance is very telling.

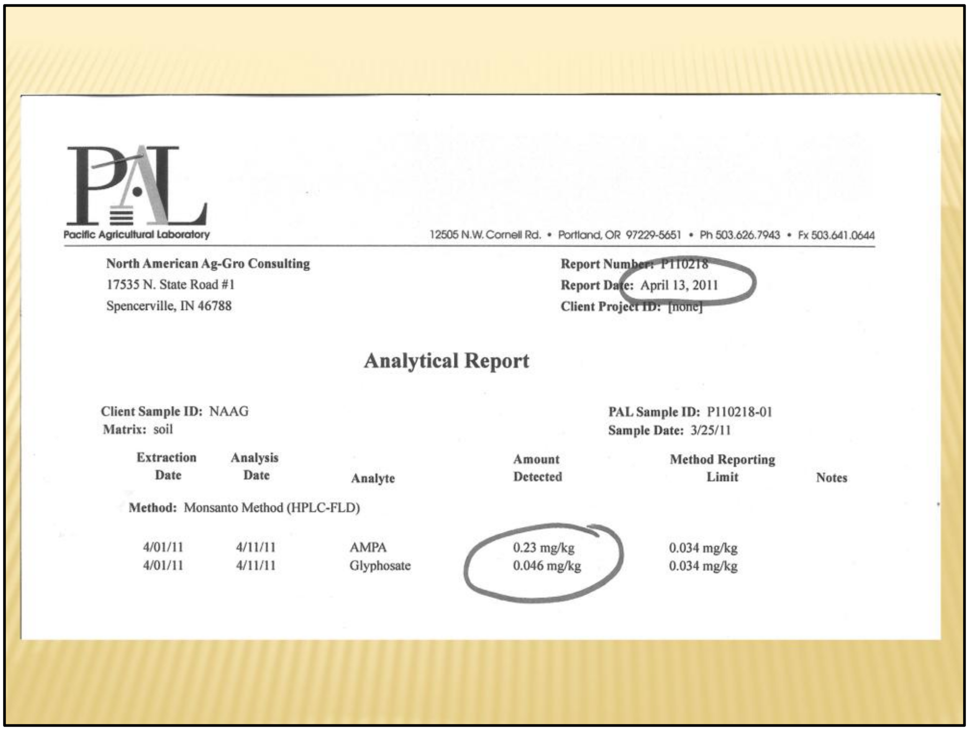


This was the first brush with glyphosate residue testing on the Mason Farm in upstate NY. The Round-Up chemical was applied in early October 2009 to a 6 year old mixed hay stand. This has been the practice since the mid 80's on any field that will be planted to corn the coming crop year.

The operator took seven inch soil cores of this field at the end of the third week of October. The samples were then frozen and kept in this condition continuously until I picked them up in mid March of 2010. When the samples were analyzed at Perry Ag. Labs, the unused portions of the specimens from the field were forwarded to Pacific Ag. Labs in Portland, Oregon for glyphosate and AMPA extraction.

These detection levels of 17 ppb are the lowest by any lab found to date. The application rate would result in a soil content of 500 ppb if all of the chemical was in the soil. Of course it is not all in the soil within 21 days. At most there would likely be 125 ppb in the soil from the chemical being exuded from the plant roots or about 25% of the total applied to the plants. This is assuming none of the chemical actually was applied directly to the bare soil.

So the fact that this soil was able to produce a disappearance rate of this magnitude is remarkable if not unprecedented. At $345/ea. I don't run a lot of these samples.



PAL

Pacific Agricultural Laboratory

12505 N.W. Cornell Rd. • Portland, OR 97229-5651 • Ph 503.626.7943 • Fx 503.641.0644

North American Ag-Gro Consulting
17535 N. State Road #1
Spencerville, IN 46788

Report Number: P110218
Report Date: April 13, 2011
Client Project ID: [none]

Analytical Report

Client Sample ID: NAAG
Matrix: soil

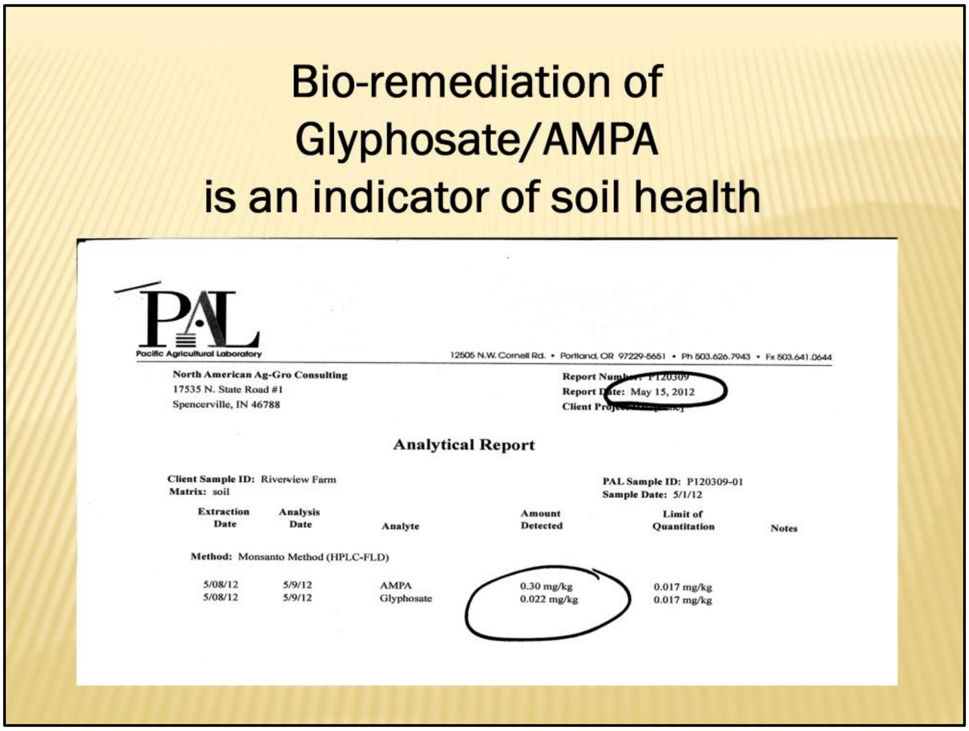
PAL Sample ID: P110218-01
Sample Date: 3/25/11

Extraction Date	Analysis Date	Analyte	Amount Detected	Method Reporting Limit	Notes
Method: Monsanto Method (HPLC-FLD)					
4/01/11	4/11/11	AMPA	0.23 mg/kg	0.034 mg/kg	
4/01/11	4/11/11	Glyphosate	0.046 mg/kg	0.034 mg/kg	

Here is another Pacific Labs report on another field at Masons which was sampled in the early spring of 2011. This field had had glyphosate applied in the fall burndown as in the previous field we just looked at. This field had an additional quart applied to the standing corn crop two consecutive years for additional weed control.

When this sample was taken after the application of a total of three quarts over a period of twenty–two (22) months and an additional 7 months of residence time. The amount of the chemical that actually made it into the soil is difficult to measure. Two manure applications of 10,000 gallons each were applied to the field. The glyphosate content was measured in the manure. It was a very small amount. The burn-down in the fall of ’08 might have contributed 125 ppb. The subsequent applications of one quart in ‘08 and ‘09 may have contributed as much as 2 or 3 times that amount given the largely bare soil conditions when the chemical was applied in the growing corn crops.

This could mean that the soil had received by the time of the sampling as much as 625 ppb or more of the glyphosate chemical. The report shows 230 ppb of AMPA and 46 ppb Glyphosate. Another variable entered into the picture. A tandem disc was used to till the manure into the top three to four inches of the soil both years.



This same field was retested 13 months later, a full year after it was planted to alfalfa. The level of AMPA found was 300 ppb and 22 ppb of Glyphosate. So the amount of Glyphosate was about half of what was found a year earlier and the AMPA was somewhat higher. The total chelating potential from the two sources in the soil was virtually unchanged during this one year period.

GLYPHOSATE BIO-REMEDIATION RIVERHAVEN FARM

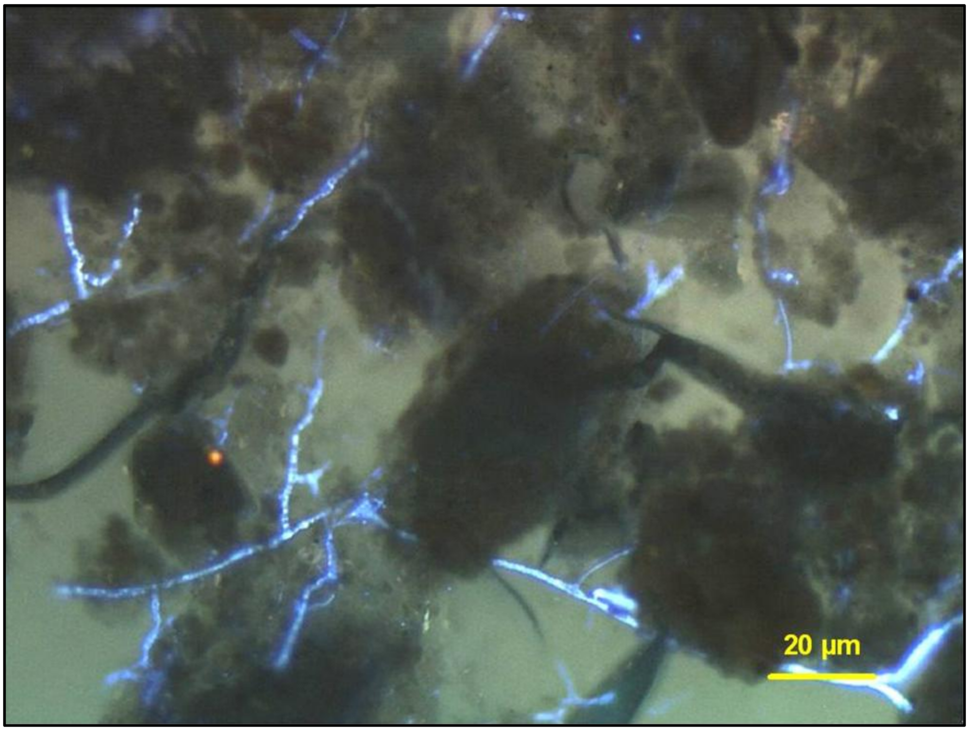
Sampled in May, 3 inches deep

	AMPA		GLY
2011	0.23	ppm	0.046
2012	0.3	ppm	0.022
2013	.41	ppm	0.030

One quart applied each time: 9/08; 06/09; 06/10
Seeded 04/11

A change in sampling procedure was required for 2013. The core taken was only 3 inches deep. These results definitely have implications for where the chemical residues are located in the soil profile. The annual sampling in 2014 will be done at the original depth of 7 inches.

There is another implication in seeing the test results for three inches of depth… Stay tuned



What is this and what is it doing at this point in a discussion of glyphosate and AMPA degradation? This a pictures taken thru a microscope of soil fungus. The reason this picture is here is because of a comment made by a man who examined these soils under his microscope. This picture is not of those soils.

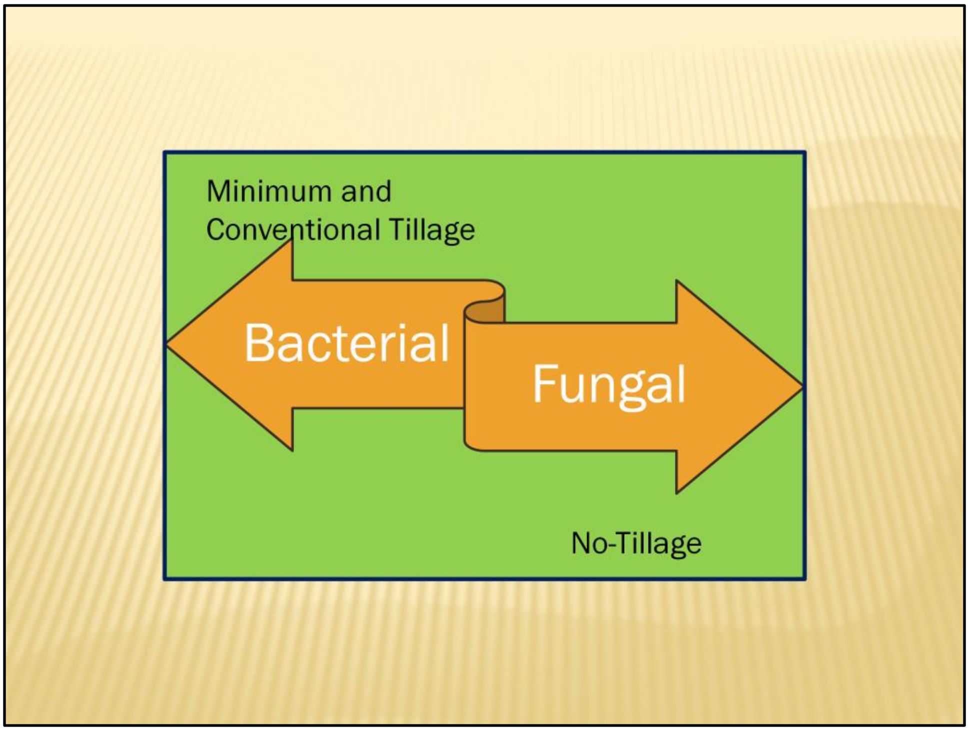
The microscopic examination of the Mason soils that I asked for was part of an effort to determine what life forms might be dominating in this soil which had resulted in record disappearance rates in the first testing round i.e. nothing detectible in less than 30 days.

The phone report was "I can tell you that bacteria have nothing to do with the disappearance of the glyphosate and AMPA in the Mason soil." When I asked for an interpretation of the comment, the reply was "I can't find any bacteria in the soil sample."

Another sample of soil was sent from the Mason Farm (that had been disced) to Dr. Haim Gunner for bio-assay of the rhizosphere. The report came back as follows:

> "Total bacterial counts: 10^6-10^8 cfu per g
>
> Total fungal counts: 10^5 cfu per g
>
> These are counts typical of agricultural soils and do not show dominance of fungi."

The plot continues to thicken…..

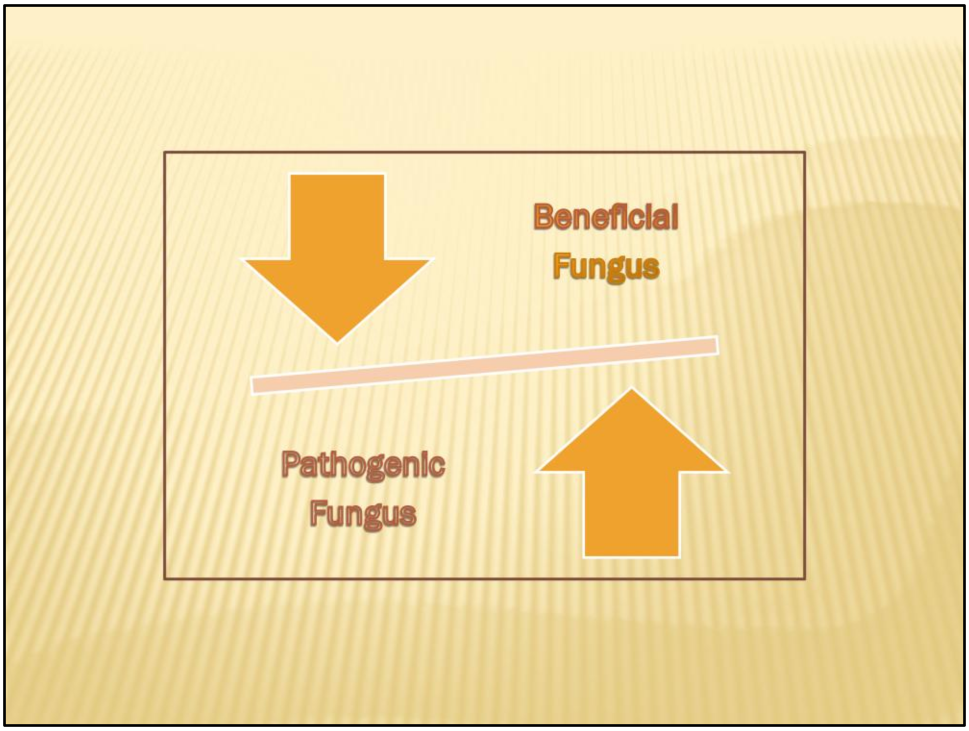


Here is a well understood axiom that relates to the Mason soil story line.

The only form of tillage performed on the Mason farm soils never included mixing above ground atmosphere with soil from 1985 until the tandem discing began on manured acres in 2010.

In the first bio-assay it was determined that the Mason soils were exclusively a fungal rhizosphere. In the second assay with Dr. Gunner the soil rhizosphere was more "typical" with a strong showing of soil bacteria present.

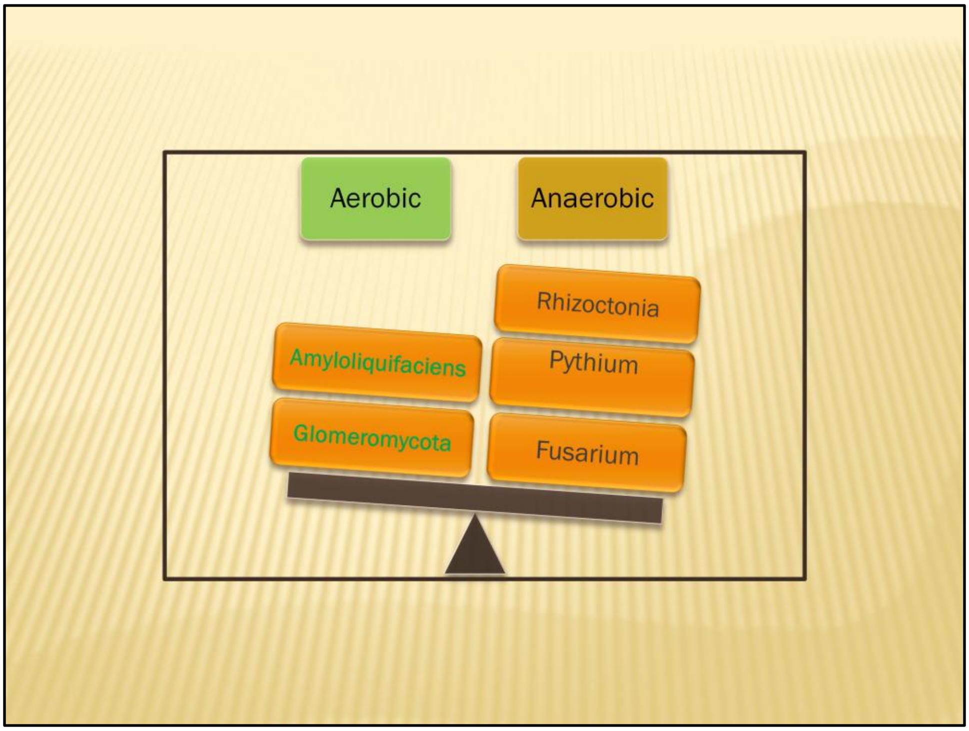
The axiom is well established that "more" oxygenation and addition of N2 to soil results in fewer fungi and more bacterial forms.



Before getting further into what is possibly moving and shaking in this glyphosate/AMPA disappearance rate story, let's review some basics of soil rhizosphere development.

First of all there is a constant battle taking place between beneficial and pathogenic fungi. This even extends to the control of some pathogenic nematode populations where the hyphae of the beneficials can entrap the parasitic nematodes.

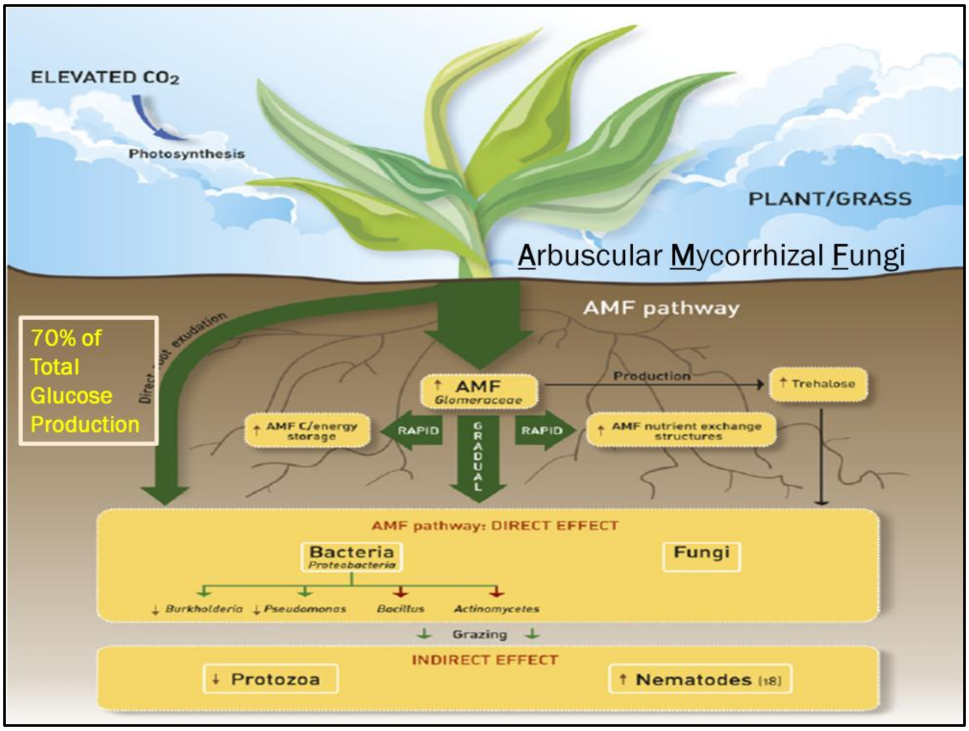
Also we know that anaerobic or waterlogged soil conditions for prolonged periods cause the inordinate growth of pathogenic fungi. The absence of an oxygen limited soil atmosphere produced the expansion of beneficial fungal populations.



These are just a few of the names of some of these good and bad fungi. Most of us recognize the names of the bad guys more readily than we do the names of the beneficials. Wonder why!

We know a little about the beneficials but surprisingly little.

The amyloliquifaciens in certain strains happen to be very effective bio-controls of the Fusarium. The cell wall of Fusarium is a favorite food source for the amyloliquifaciens. How convenient!!!

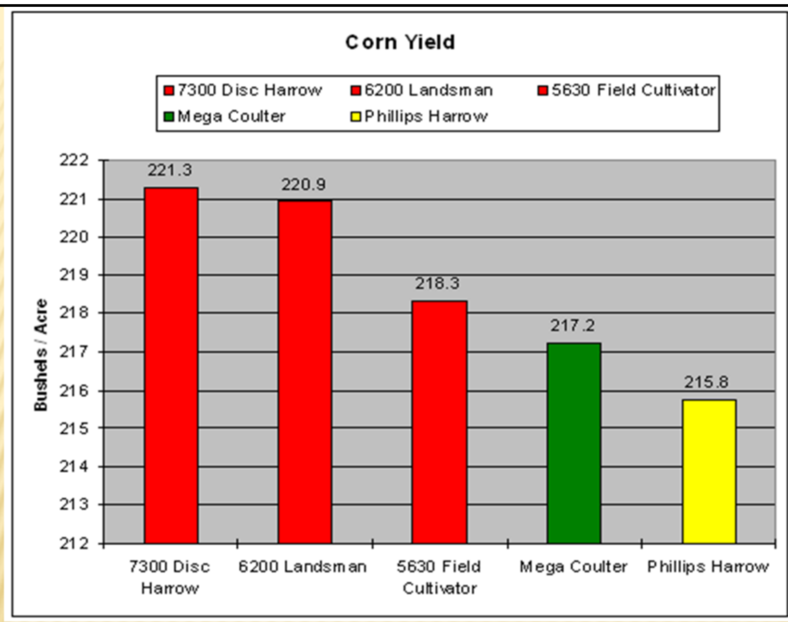


We could spend hours talking about this complex soil food web diagram but we can't today. Neither am I going to presume to know enough about it to make it worth our time or effort. I very instructive 45 minutes on this subject can be had here- http://vimeo.com/42140886

For our purposes today, let's simply be reminded of the complexity and inter-dependent relationship that are existing in our soils. The plants' role of supplying carbon in the form of sugars to energize the fungi and bacteria is just the beginning of the "grazing" and regeneration of various substrates necessary for normal plant development . Imagine for a minute taking a smooth running fungal machine that has developed over many years and suddenly destroy this community with no substitute community to stand in to assume responsibility for the operations performed by fungi. The fact is many fungal functions are impossible for bacteria to perform such as searching out limited water resources for the plant root system.

Most often we have considered the impact of tillage as a result of doing LESS tillage. Certainly this is a truism when a grower decides he is going to stop doing tillage. As far back as 50 years ago soil scientists agreed that extra nitrogen needed to be applied when “normal” tillage was reduced. This was necessary because the “normal mineralization rate” of humus was disrupted when only limited amounts of Oxygen were introduced into the soil such as is the case with “no-till”.

We are going to look at a situation where the reverse has happened. The Mason tillage operation has resulted in a huge fungal community that does not use nor require the usual bacterial population to supply the plants with the nutrition that they need to perform well (in fact, significantly above average.) The Masons average corn silage yield since the mid 80’s has been 24 ton/acre. The record low was in 1999 when they received no additional rainfall for the crop after June 10th. That year the crop averaged 19.5 tons per acre. The soils in the area averaged 9 tons that year.



This is a study which is really a better measure of the mineralization rate of humus than probably anything else. The amount of nitrogen contributed by the humus oxidative process relates pretty well to the form of tillage used AND to the bushels.

Back to the Mason experiences of 2012 and the discing operation on corn fields receiving manure. In the absence of rainfall, you have guessed the results… It was a train wreck.

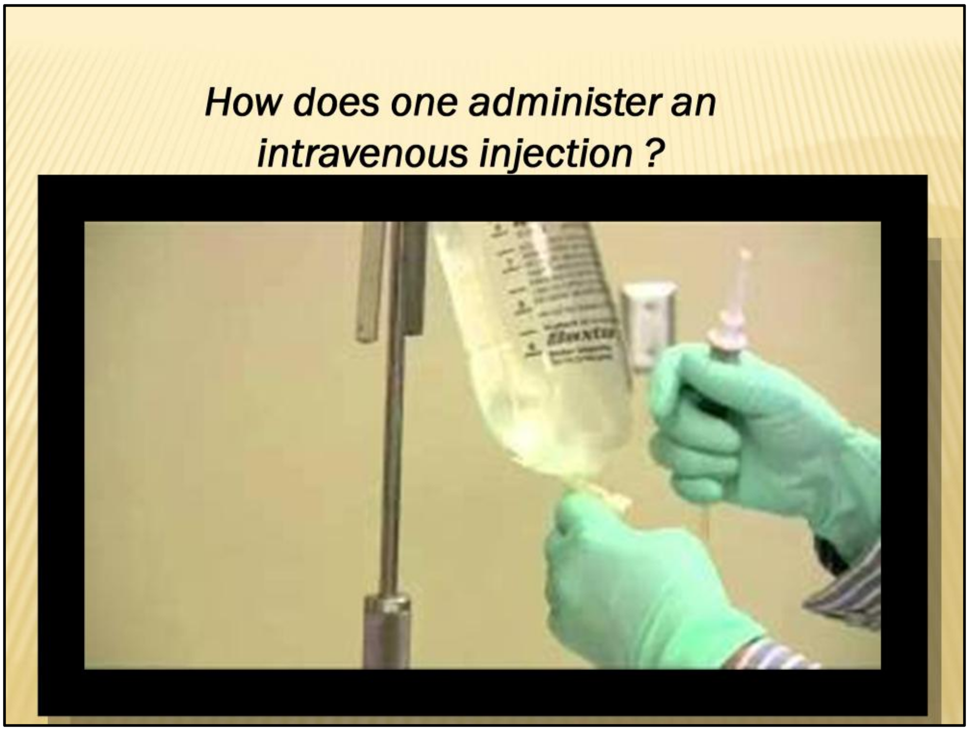
This is what I found as I collected soil samples in late April. This was a October Round-Up sprayed hayfield that had received a 10 gpa application of dairy manure and a single disking.

No one including myself could have predicted how significant this situation was going to become in the next six months. First problem was that the field would have to be disked again and again to create a suitable seedbed.

I was told that corn plants could be pulled from soil anytime during the growing season with a single hand. This was unheard of for over 27 years.

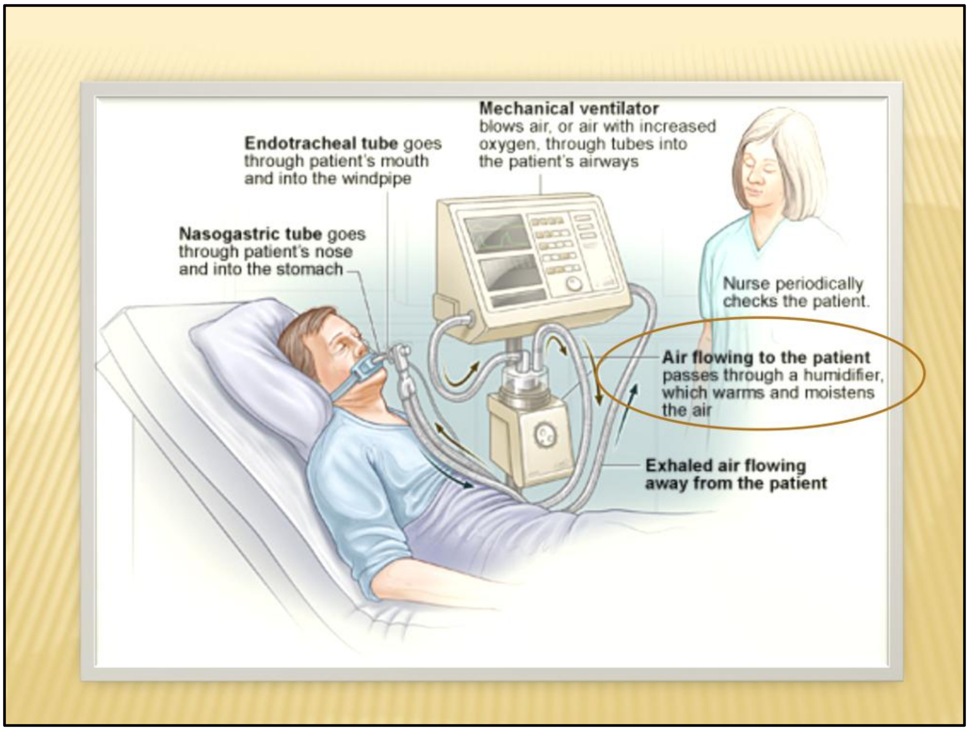
The invisible damage to the fungal community was much worse than the mechanical problems associated with the disking operation.

Unfortunately, I don’t have picture from the growing season, but Todd Mason said the corn never developed good color and was firing by pollination. He had become accustomed to seeing plants holding 180 to 100 ba corn at 24% grain moisture with no firing using only 20#N/acre applied N.



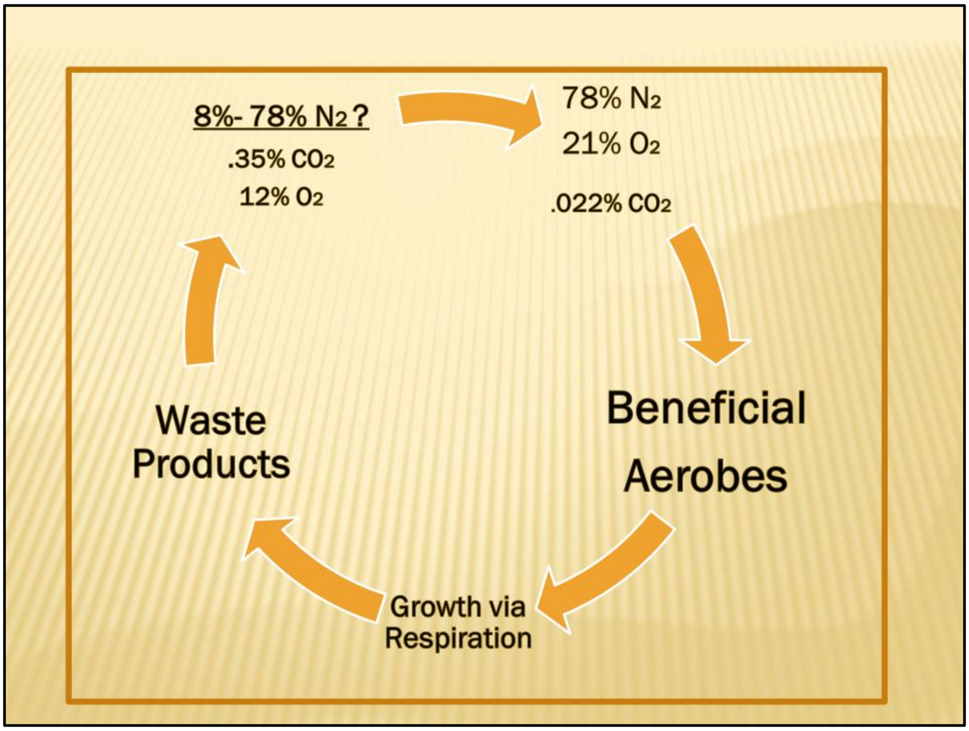
To help us understand the rhizosphere carnage which took place with the disking operation (which was felt needful because manure odor near a busy State Highway), let’s think about giving someone an intravenous injection.

Perhaps we know someone who has experienced this or even had it happen to us. It’s not a pretty sight when too much of a powerful substance is placed directly into the human body.



Perhaps more analogous to the soil getting a disking after years of no disking or other form of tillage which has the ability to massively impact the total amount of soil oxygen and elemental nitrogen gas, would be the ventilation pump used in adjusting oxygen levels in human blood.

The effects of improper adjustment can be devastating.



Taking a close look at the soil atmosphere changes, it is obvious that massive shifts in concentrations of gases occurs through the influence of the rhizosphere. Typical oxygen reduction recorded in the scientific literature is 50%, down from 21-22% incoming to 12% or less in emission. Increases in carbon dioxide emission are much greater by a factor of over 10 times.

This is much appreciated by all of the plants who will use this to create more sugars to support this invisible world of the rhizosphere producing these changes. So much for soil carbon emissions being a problem for the climate. Have you ever heard such heresy, Al?

Interestingly in the literature, the amount of nitrogen recorded in soil gas emissions varies from 7% to as much as 78%. How can this be? Obviously, some soils are doing nothing with microbes to take N2 from the soil air and convert it to amine forms or living protoplasm.

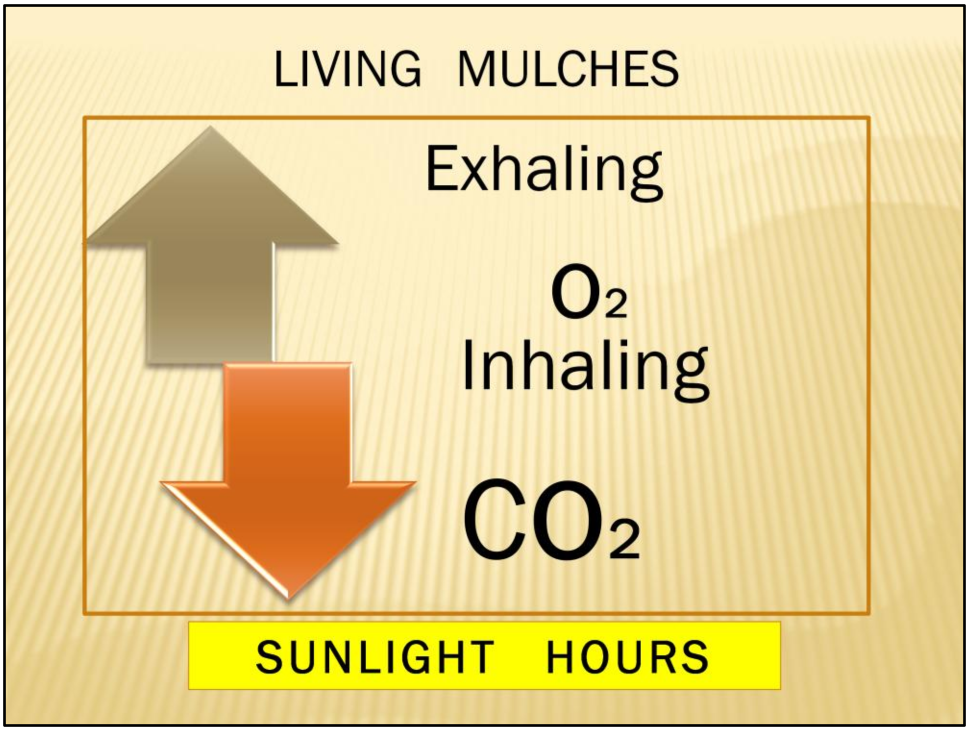
Which leads me to mention a study done at Iowa back in the early 80's where various soil microbial populations were quantified prior to traditional primary and secondary tillage operations were performed. Following the tillage the soil was analyzed again. The first populations to disappear were the naturally occurring nitrogen fixers, nitrosamonas, blue-green algae, azotobacter, and rhizobium.

Here is a stark contrast from the year of the drought, 1012. Mark Conrad took off the first cutting on this 5+ year old hayfield and then tilled without killing the sod. In fact he tried to kill it twice using Round-Up and Liberty. Obviously he was successful!!!

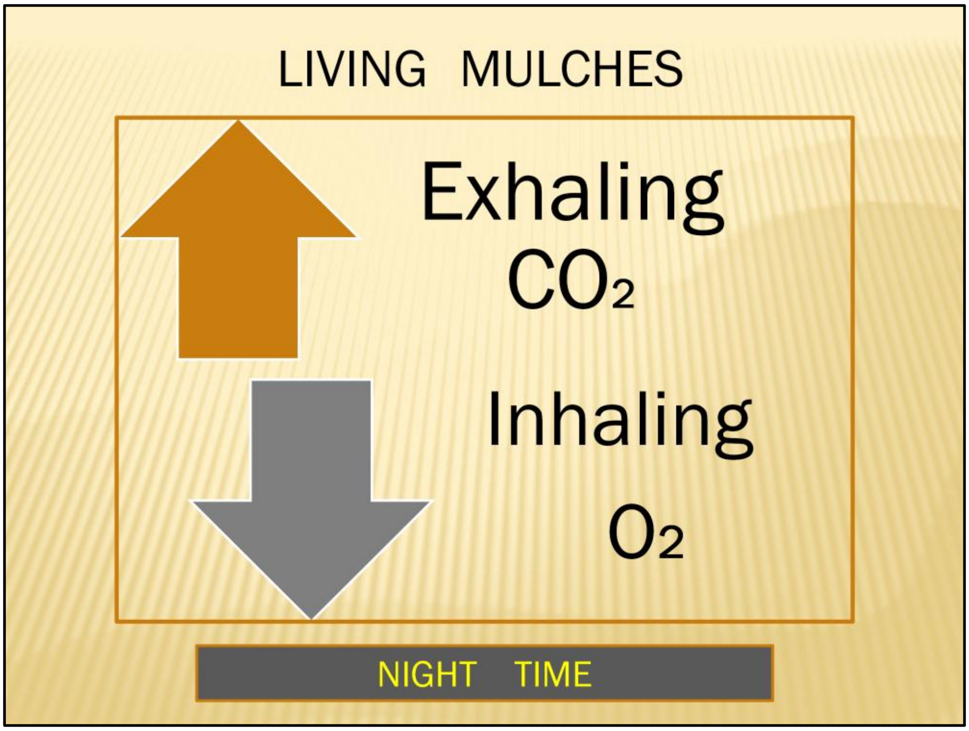
This soil system had developed to produce nitrogen on legume root systems for several years using rhizobium. The tillage did nothing to destroy this although there probably was some scavenging by nitrifiers such as nitrobacter and nitrosamonas.

Obviously there was lack of nutrition to bring forth fruiting in the alfalfa even under the abnormal amount of shading that took place with the corn.

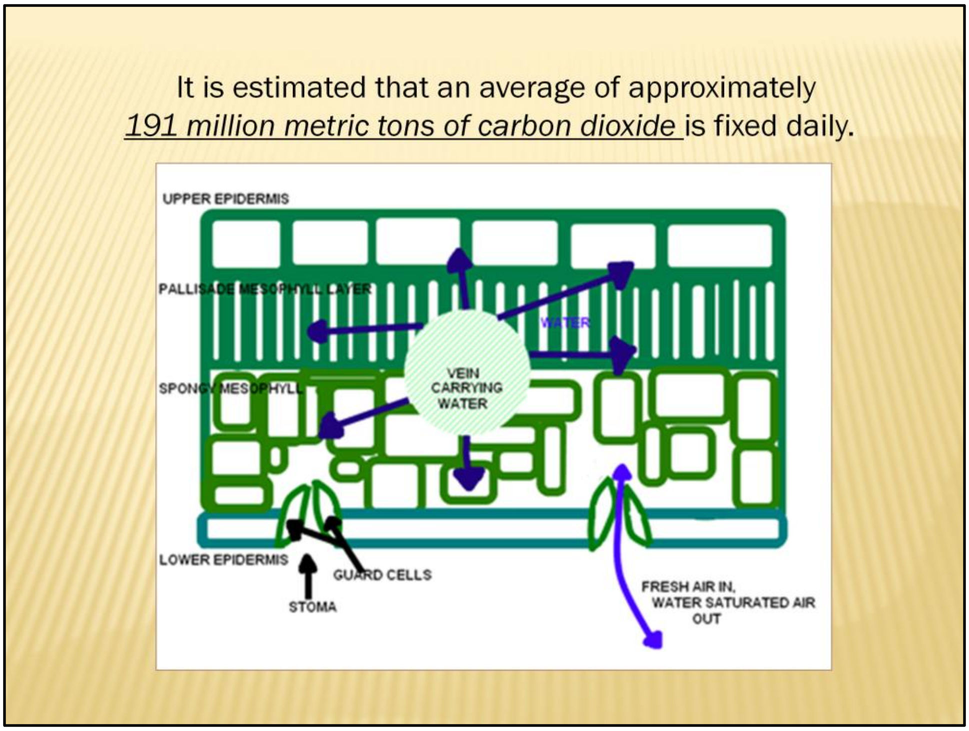
Obviously the orchard grass recovered too from the chemical attempts to kill the sod. The alfalfa (obviously missing) went off in the corn silage. This field went without precipitation for over 9 weeks. Not a great yield of silage but consider that this was the second forage crop harvested that season.



It may be beneficial to review some general science on photosynthesis in light of gaining additional insight into the usefulness of the living mulch in any crop such as corn. During daylight hours the sun's energy is harnessed in the chloroplast to harness Phosphate and calcium and CO2 to create glucose and sucrose. The result of this is the emission of Oxygen from the plant leaf tissue.

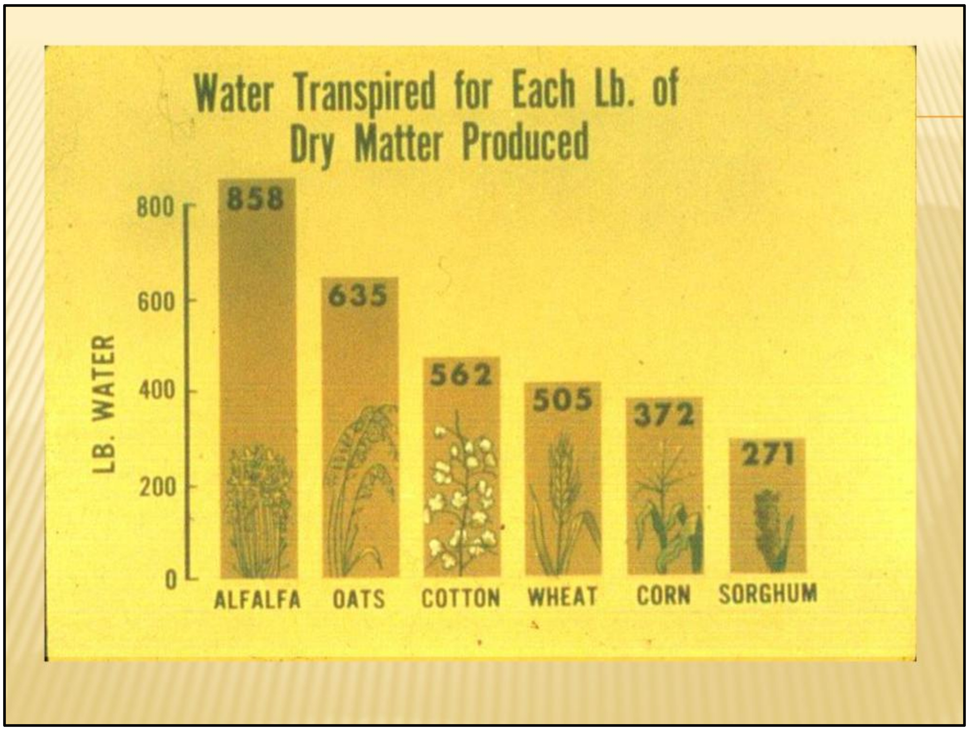


Then at night the plant uses Oxygen and releases CO2 to the atmosphere. This is an obvious provision for making carbon available for the upcoming day so that more sugars can be produced by the plant.



With this carbon being fixed by vegetation on a daily basis, how much does the burning of fossil fuel actually contribute to the dangerous increase in carbon dioxide in our atmosphere? The reason this slide is in here is because it serves to remind us that air leaving plant stomata also carry moisture out of the plant.

Corn and several other plants have a unique ability to take in water with atmosphere. Corn can take up to 80% of it total water requirement through normal respiration.



This chart helps to see the amount of water various plants release in transpiration losses. Obviously broadleaf plants release more than grass family plants. In the case of corn grown in a legume living mulch such as alfalfa, it is possible for the corn to thrive on the transpiration losses of the alfalfa.

Corn only requires about 1/3 of the moisture the alfalfa transpires into the corn crop. If it can extract only 30% of it needs from the air moisture it will not suffer a moisture deficiency.

Of course the corn plant is also benefiting from CO2 production of the living mulch as well. Bare soils that get hot and dry stop producing CO2 and so the corn is actually looking for more CO2 in drought and heat stress conditions.

The drought of 2012 took this concept to the limits never before recorded.

As the humidity increases, the higher water content of the air decreases the rate of water loss from the leaf because the water pressure gradient no longer favors evaporation from the leaf surface.

This is an interesting twist on this whole moisture and transpiration loss controversy. Substituting the alfalfa living mulch in this picture makes for interesting reading. As the Alfalfa mulch is producing higher humidity in the corn crop because of its high transpiration rate it actually reduces the transpiration losses of the corn.

So the presence of the alfalfa does two things to REDUCE drought stress potential. It supplies moisture to the air so the corn can extract it AND it effectively reduces transpiration loss of the corm plant by placing the corn plant in a higher humidity atmosphere.

This is what it looked like in 2012 in a clover living mulch field during the early stages of the drought. By now the grower had elected to chemically terminate the clover. The clover had been harvested as baleage and yielded close to 2.0 tons of dry hay equivalent.

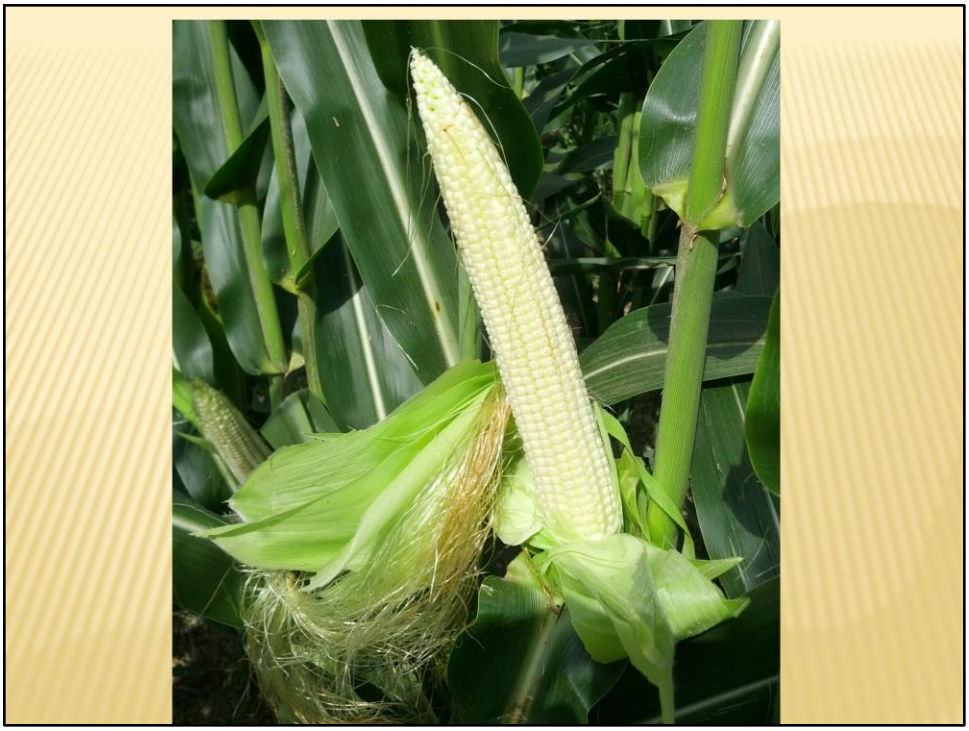
The grower then postponed planting of the corn crop for three weeks following removal of the clover as a forage. This proved to be a bad choice when it refused to rain for the 12 weeks following the hay harvest. There was a .8” rain event which preceded tillage and planting by two days. That was it for 12 weeks. The clover was using massive amounts of soil moisture in its regrowth efforts.

Some of the corn plants lost all of the leaf tissue from the prolonged drought stress but refused to die. The growing point was still viable.

This was a typical root found under the clover which was 16 months of age. The crop had been established as a frost seeding in wheat in the spring of 2011.

The stand finally began to emerge planted slightly over two inches deep.

Once again the herbicide failed to totally control all of the living mulch. No residual herbicide was applied so small patches of foxtail did appear after rainfall began to occur in mid August.



When the crop began to develop it was like a mad bull coming out of the barn door. The crop was sidedressed with 60# of N/acre. It was a struggle to leave the crop for several weeks but everyone realized planting something else was futile because it wouldn't have germinated.

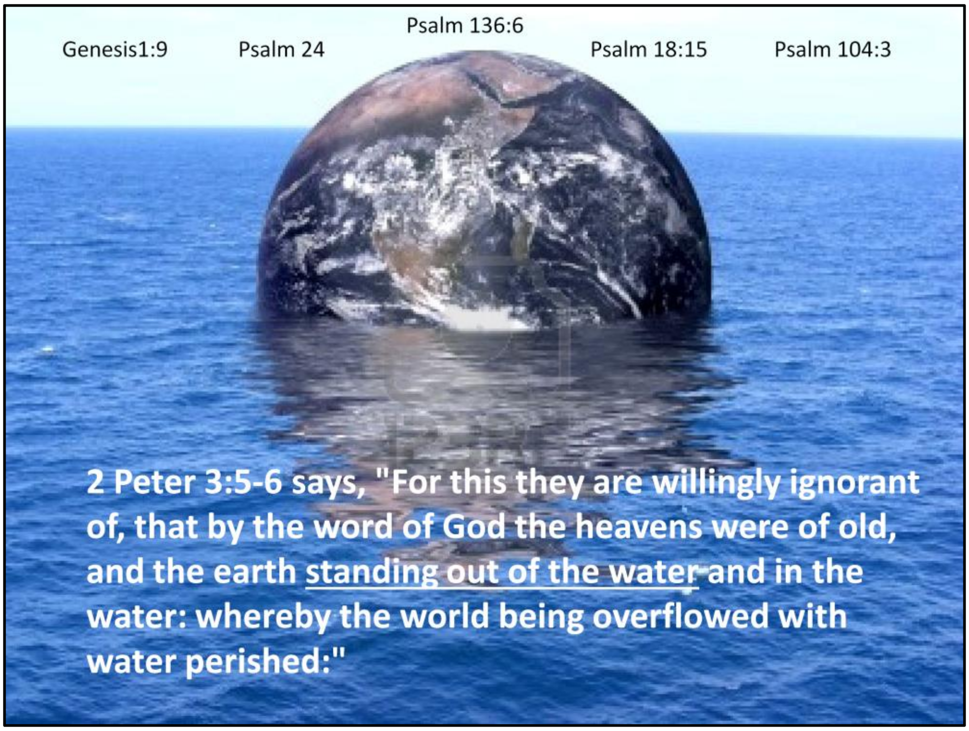
Some areas in the field with harvestable populations here over 30K showed up to 170 ba. Unfortunately, unaddressed traffic areas where the corn could not develop a root system capable of going the distance under the stresses had suffered plant losses and the field averaged slightly over 100 ba.

When the crop year was fully expensed and credited the 100 acre experiment netted over $1100.00/acre. It ranked at or near the top of any field on the 3000 acre operation in 2012.

Gas exchange and transpiration in plants are very dynamic and interrelated processes. A thorough knowledge of both processes and of the interaction between them could one day lead to increasing maximum crop production while decreasing the amount of water required for the process.

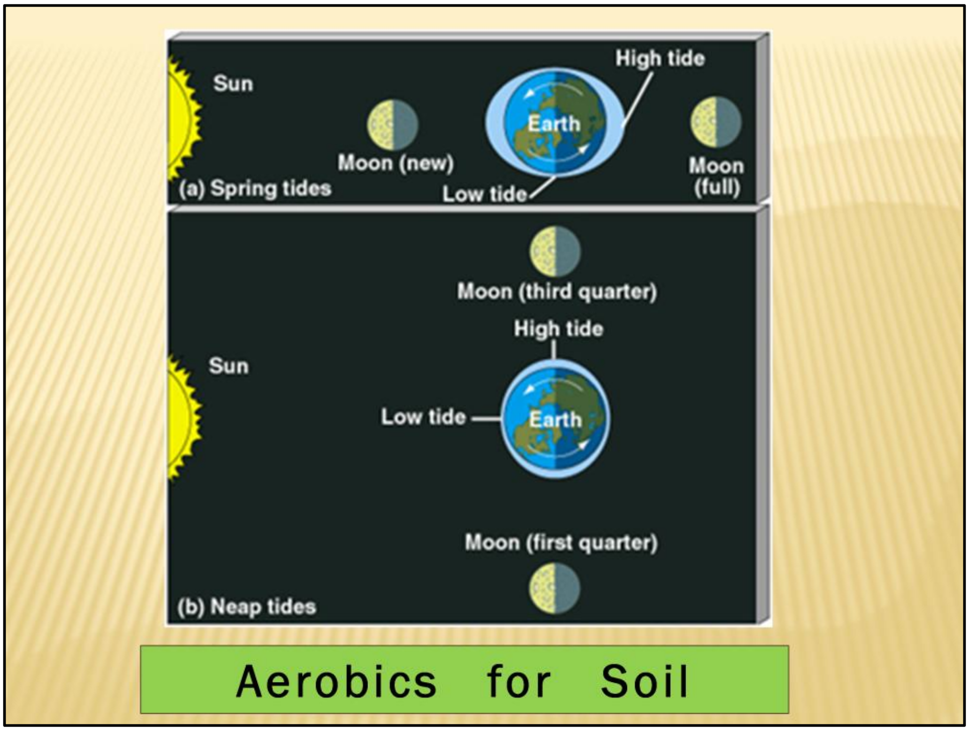
I can't add much to what this says, except to say that it would appear that we have seen these concepts of gas exchange working well beyond our wildest imaginings in the face of severe drought stress in 2012.

The potential in a normal year is even greater.



As we attack soil restrictions to water and air exchange we unleash a powerful force in the earth to bring forth abundance. The curse of Genesis 8:21 has effectively put a gag on the air flow in and out of our soils. We have focused on the potential for soil systems to support more than one crop at a time to the mutual benefit of both.

However, the real unpinning for this success is a soil which is breathing efficiently on a daily or even hourly basis.



The old rural customs of planting by the signs of the moon may well have had more to them than meets to eye. Gravitational forces operating on our planet produce movement of water in relation to the land masses. We call those manifestations "tides".

Whether we see the water rise or not, because we may not live by a seashore where the tide is observable, the water it still being effected by the gravitational pull of the Sun and Moon. The air that rests above the water table in our soils is POTENTIALLY being exhaled or inhaled through the rhizosphere everyday.

Consider what would happen to you if you stopped breathing for very long. "God breathed in to Adam's nostrils and he became a living soul." It all began with the breathe of God and it continues by His Grace until he stops it. He made this curse operative in the events of the Noahidic Flood and his judgment of sin in the Earth. He had a purpose in the curse. I believe it was to draw us closer to Himself.

We can be like this root running horizontally in the soil, responding to a hardness created by a tillage tool, or we can grow beyond the compaction like the other roots visible here.

We have to stop putting these barriers into God’s good earth. We also need to stay soft and teachable in our Spirits and harden not our hearts.

Wherever one goes in the world, the message is the same and the roots of our plants encourage us along the Way.

Soybean 17 days old …. A PROBLEM IN 2012 ????

All is not as straightforward and easily understood unfortantely. This soybean plant never showed drought stress in 2012. It did NOT yield as well as soybean plants in the same area that suffered sever stress AND received well timed rains to finish the crop filling.

The drought taught us of the importance of well-timed stress in causing soybeans to super flower. It is a response to a death threat. If the rain had never come the yields on these stressed beans was less than 30 ba. Where the rains fell the yields were up to 80+ ba.

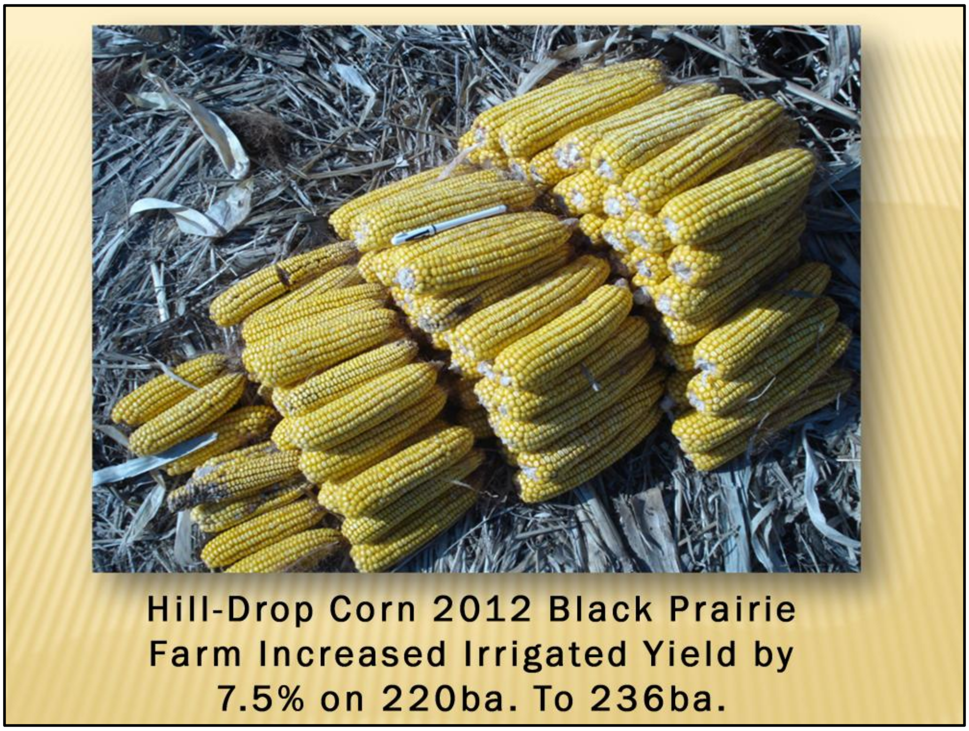
These beans yielded slightly over 50 ba. Disappointing compared to the best yields for sure. A chance to learn for sure.

Here’s an example of double-cropping of winter wheat with Japanese Millet planted near Decatur, IN. This picture was taken to show the impact of failure to address soil density issues in establishing the millet with a no-till drill. The field was vertically tilled using a single rank machine running Smart-Till tines. It was operated I the normal traffic direction. The width of the rigid machine meant that it did not impact the soil in this old dead-furrow.

The delayed emergence is the result.

Still a great yielding result for the most part in 50 days.

….And a great mass of fine roots growing in the plow layer to add carbon to the resources for more growth of beneficial fungi.



Lastly, wrapping up the day, we want to report some preliminary results from an accidental planting of hill drop corn in 2012. We think a goodly portion of the results was from the lack of smaller ears found in the hill-drop row. The final populations were identical.

The other variable which is most intriguing is the ability of the air to circulate more freely inside the crop canopy with 18 inch spaces between hills.

The University of Maryland researched this in the 70’s in the Delmarva area and Virginia. They concluded air change was the limiting factor for the corn there at about 32K plants per acre in 30” rows.

We see something happening that is probably related to this in twin row corn stands. The outside two to four rows will be pollinated and filled normally even in adverse pollinating conditions of temps of over 100°F.

The next row may be badly zippered or barren completely on the outer half of the ear.

Something changed drastically inside the outer 10 to 12 feet of corn. When temperatures have been recorded of over 125 inside cornfields, it could be that air movement has made it impossible to sufficiently cool inside the canopy for pollen survival.

(Plans to continue this study in ‘13 did not materialize. Plans are in place to continue examining this planting protocol in crop year ’14.)